

## รายการอ้างอิง

1. เอกสารเผยแพร่ก๊าซธรรมชาติสำหรับยานยนต์. โครงการก๊าซธรรมชาติสำหรับยานยนต์ การปิโตรเลียมแห่งประเทศไทย, กันยายน 2544: 1-9.
2. Sher, E. Handbook of air pollution from internal combustion engines pollutant formation and control. The United States of America: Academic press Ltd, 1998.
3. Owen, K. and Coley, T. Automotive fuel reference book. 2<sup>nd</sup> edition, The United States of America: Society of automotive engineer, 1995.
4. Liss, W.E. and Thrasher, W.H. Natural gas as stationary engine and vehicular fuel. SAE paper 931828, 1993.
5. Ly, H. Effects of natural gas composition variations on the operation, performance and exhaust emission of natural gas-powered vehicles. IANGV, Dec. 2002.
6. Heywood, J.B. Internal combustion engine fundamental. Singapore: McGraw-Hill, 1988.
7. American Society for Testing and Materials. Standard method of calculating calorific value and specific gravity gaseous fuels. 1980 annual book of ASTM standards/ American Society for Testing and Materials 1980: 187-190.
8. Klimstra, J. Interchangeability of gaseous fuels-the importance of the wobble-index. SAE paper 861578, 1987.
9. Greene, A.B. and Lucus, G.G. Testing of internal combustion engines 2<sup>nd</sup> edition. Great Britain: The English University Press, 1969.
10. The standards association of Australia. AS2789.1-1985 North Sydney: 1985.
11. Kubesh, J. King, R.S. and Liss, E.W Effect of gas composition on octane number of natural gas fuels. SAE paper 922359, 1992.
12. Plint, M. and Martyr, A. Engine testing theory and practice 2<sup>nd</sup> edition. Oxford: Butterworth Heinemann, 1999.



ภาคผนวก

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย



ภาคผนวก ก

มาตรฐาน AS 2789.1-1985 ที่เกี่ยวข้องกับทดสอบ

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

## มาตรฐาน AS 2789.1-1985 ที่เกี่ยวข้องกับ การทดสอบ

### International Combustion Engines - Performance

#### Part 1 - Engines for land, rail-traction and marine use - Standard reference conditions and declarations of power, fuel consumption and lubricating oil consumption

##### 1. Scope

This report of ISO 3046 specifies the standard reference conditions and the methods of declaring of power, fuel consumption and lubricating oil consumption for reciprocating internal combustion engines using liquid or gaseous for particular engine applications.

##### 2. Field of application

This part of ISO 3046 covers reciprocating internal combustion engines for land, rail-traction and marine use, excluding engines to propel agricultural tractors, road vehicles and aircraft.

This part of ISO 3046 may be applied to engines used to proper road construction and earth-moving machines, industrial trucks and for other applications where no suitable International Standard for these engines exist.

##### 3. References

ISO1000, SI units and recommendation for the use of their multiples and of certain other units.

ISO 1204, Reciprocating internal combustion engines - Designation of the direction of rotation.

ISO 1205, Reciprocating internal combustion engines - Designation of the direction of cylinders.

ISO 1585, Road vehicles - Engine test code - Net power.

ISO 2534, Road vehicles - Engine test code - Gross power.

ISO 2710, Reciprocating internal combustion engines - General definitions.

ISO 3046/2, Reciprocating internal combustion engines - Performance - Part 2 : Engine tests.



ISO 3046/4, Reciprocating internal combustion engines - Performance - Part 4 :  
Speed governing.

ISO 3046/6, Reciprocating internal combustion engines - Performance - Part 6 :  
Overspeed protection

#### 4. Units and terms

4.1 The units used are those of the International System of Units (SI Unit) described in ISO 1000.

4.2 The general engine terms used are as defined in ISO 2710.

#### 5. Standard reference conditions

For the purpose of determining the power and fuel consumption of engines, the following standard reference conditions shall be used :

Total barometric pressure :

$$P_r = 100 \text{ kPa}$$

Air temperature :

$$T_r = 300 \text{ K (27 } ^\circ\text{C)}$$

Relative humidity :

$$\phi_r = 60 \%$$

Charge air coolant temperature :

$$T_{cr} = 300 \text{ K (27 } ^\circ\text{C)}$$

If other reference conditions are chosen, these shall be stated.

#### NOTES

1. Relative humidity of 60% corresponds to a water vapor pressure of 2.133 kPa (16 mmHg) at a temperature of 300 K.
2. The air density at the standard reference conditions is equivalent to that at 98 kPa (736 mmHg) and 20 °C and to that at 101 kPa (760 mmHg) and 30 °C
3. For automotive type inboard and outboard marine propulsion engines, the standard reference conditions in ISO 1585 and ISO 2534 may be applied but they shall be stated.

## 6. Auxiliaries

### 6.1 Introduction

In order to show alertly the conditions under which a power is determined, it is necessary to distinguish those auxiliaries which affect the final shaft output of the engine and also those which are necessary for the continuous or repeated use of the engine.

Items of equipment fitted to the engine and without which the engine could not in any circumstance operate at its declared power are considered to be engine components and are not therefore, classed as auxiliaries.

(Such as fuel injection pump, exhaust turbocharger and charge air cooler are in this category of engine components.)

**6.2 dependent auxiliary** : Item of equipment, the presence or absence of which affects the final shaft output of the engine.

**6.3 independent auxiliary** : Item of equipment which uses power supplied from a source other than the engine.

**6.4 essential auxiliary** : Item of equipment which is essential for the continued or repeated operation of the engine.

**6.5 non-essential auxiliary** : Item of equipment which is not essential for the continued or repeated operation of the engine.

## 7. Declarations of power

### 7.1 Introduction

#### 7.1.1 Purpose of statement of power

Statements of power are required for two main purposes :

- a) the declaration by a manufacturer of the value of the power which his engine will deliver under a given set of circumstances. This declared value is known as the "rated power".

b) the verification by measurement that the engine delivers the power which has been declared in a), under the same set of circumstances or after proper allowance has been made for any difference in circumstance.

To specify the set of circumstances under which the declared value of a power would be achieved, the declaration shall state :

- a) the kind of statement of power (see 7.4) and of necessary, the ambient and operating condition (see 7.4.2).
- b) the kind of power output (see 7.3).
- c) the kind of power (see 7.3).
- d) the corresponding engine speed.

#### NOTE

1. The term used in a) to c) may be combined, for example, continuous net brake fuel stop power.
2. Where appropriate to the engine application and the method of manufacture, the power achieved may be subject to a tolerance on the declared power. The existence of and its magnitude shall be stated by the manufacturer.
3. Measurement of the powers referred to in this International Standard shall be determined in accordance with ISO 3046/2.

#### 7.1.2 Unit of power

Power shall be expressed in kilowatts (kW) The addition of the equivalent metric or imperial "horsepower" is permitted for a transitional period.

#### 7.1.3 Power and torque

For engines delivering power by a shaft or shafts, any power in this International Standard is a quantity proportional to the mean torque, calculated or shafts transmitting this torque.

For engines delivering power other than by a shaft or shafts, reference shall be made to the appropriate International Standard for the driven for the driven machine.

#### 7.1.4 Engine speed

The speed of an engine is the mean rotational speed of its crankshaft or crankshatts in revolution per minute, except in the case of "free piston" engines where the speed is the number of cycles per minute of the reciprocating components.

#### 7.1.5 Engine with integral gearing

When stating the power of an engine fined with an integral (built-in) speed increasing or reducing device, the speed of the driving shaft extremist shall also be given at the declared engine speed.

### 7.2 Kinds of power

#### 7.2.1 Indicated power

The total power developed in the working cylinders by the gases on the combustion side of the working pistons.

#### 7.2.2 Brake power

The power of the sum of the powers measured at the extremity of the engine driving shaft or shafts.

7.2.2.1 Any statement of brake powers shall be supported by the following list of auxiliaries :

- a) essential dependent auxiliaries as defined in 6.2 and 6.4;
- b) essential independent as define in 6.3 and 6.4;
- c) non-essential dependent auxiliaries as defined in 6.2 and 6.5.

The power absorbed by the independent and the non-essential dependent auxiliaries may be significant, in such cases, their power requirement shall be declared.

Note - Examples of typical auxiliaries are listed in annex A for guidance purposes. These lists are not necessary complete.

#### 7.2.3 Net brake power

The brake power measured when the engine is using only the auxiliaries listed in 7.2.2 a).



### 7.3 Kinds of power output

#### 7.3.1 continuous power

Power which an engine is capable of delivering continuous, between the normal maintenance intervals stated by the manufacturer, at stated speed and under stated ambient conditions, the maintenance prescribed by the manufacturer being carried out.

#### 7.3.1 Overload power

Power which an engine may be permitted to deliver, at stated ambient conditions, immediately after working at the continuous power.

The duration and frequency of use of overload power which is permitted will depend on the service application but adequate allowance shall be made in setting the engine fuel stop permit the overload power shall be expressed as a percentage of the continuous power, together with the duration and frequency permitted and the appropriate engine speed.

Unless otherwise stated an overload power of 110% of the continuous power at a speed corresponding to the engine application is permitted for a period of 12 hours of operation.

#### NOTES

1. The power of marine main propulsion engines is normally limited to continuous power, so that the overload power cannot be given in service. However, for special applications, marine main propulsion engines may develop overload power in service.
2. If the engine application is not determined, the engine manufacturer shall specify the overload power and the corresponding engine speed.

#### 7.3.2 Fuel stop power

Power which an engine is capable of delivering during a stated period corresponding to its application, and at stated speed and under stated ambient conditions, with the fuel limit so that the fuel stop power cannot exceeded.



## 7.4 Kinds of statements of power

### 7.4.1 ISO powers

#### 7.4.1.1 ISO power

Power determined under the operating conditions of the manufacturer's test bed and adjusted to the standard reference conditions in clause 5.

#### 7.4.1.2 ISO standard power

The name given of the continuous net brake power which the engine manufacturer declares that an engine is capable of delivering continuously, between the normal maintenance intervals stated by the manufacturer, and under the following conditions :

- a) at a stated speed under the operating conditions of the engine manufacturer's test bed;
- b) with the declared power adjusted to the standard reference conditions given in clause 5;
- c) the maintenance prescribed by the engine manufacturer being carried out.

#### 7.4.2 Service power

Power determined under the ambient and operating conditions of an engine application.

To establish service power, the following conditions shall be taken into account :

- a) the ambient conditions, or any nominal ambient conditions according to the special requirements of inspecting and/or legislative authorities and/or classification societies, as specified by the customer (see clause 12);
- b) the normal duty of the engine;
- c) the expected interval between maintenance periods;
- d) the nature and amount of the supervision required;
- e) all information relevant to the operation of the engine in service (see clauses 12 and 13).

## 8. Declarations of fuel consumption

### 8.1 Definitions

#### 8.1.1 Fuel consumption

The quantity of fuel consumed by an engine per unit of time at a state power and under stated conditions.

The quantity of liquid fuels shall be expressed in mass units (kg).

The quantity of gaseous fuels shall be expressed in energy units (J).

#### 8.1.2 Specific fuel consumption

The fuel consumption per unit of power.

#### 8.1.3 ISO specific fuel consumption

The name given in the specific fuel consumption at the ISO standard power.

If not otherwise specified by the manufacturer, a declared specific fuel consumption shall be considered to be the ISO specific fuel consumption.

### 8.2 Reference calorific value of fuels

#### 8.2.1 Liquid fuel engines

The declared specific fuel consumption of a liquid fuel engine shall be related to a reference lower calorific value of 42,000 kJ/kg (10,030 kcal/kg).

#### 8.2.2 Gas engines

The declared specific fuel consumption of a gas engines shall be related to a stated lower calorific value the gas. The type of gas shall be declared.

#### 8.2.3 Specific fuel consumption declarations

The specific fuel consumption of an engine shall be declared at :

- a) the ISO standard power;
- b) (if required by special agreement) at any other declared powers and at specific engine speeds appropriate to the particular engine application.

Unless otherwise states, a deviation of +5% is permitted for the specific fuel consumption for the declared power.

## 9. Declarations of lubricating oil consumption 1 Lubricating oil consumption

### 9.1 Lubricating oil consumption

The quantity of lubricating oil consumed by an engine per unit of time. This quantity is used for guidance. It shall be expressed in litres or kilograms per engine operating hour at the declared power and engine speed.

9.2 The lubricating oil consumption after a stated period of running-in shall be declared.

9.3 The oil discarded during an engine oil change shall be not included in the lubricating oil consumption declaration.

## 10. Adjustment of net brake power for ambient conditions

10.1 When it is required to operate the engine under conditions difference from the standard reference conditions given in clause 5, the net brake power output shall be adjusted to or from the standard reference conditions by the following formulae (see note 1) :

$$P_x = \alpha P_r \quad (1)$$

$$\alpha = k - 0.7(1-k) \left( \frac{1}{\eta_m} - 1 \right) \quad (\text{see note 2}) \quad (2)$$

$$k = \left( \frac{p_x - a\phi_x p_{sx}}{p_r - a\phi_r p_{sr}} \right)^m \left( \frac{T_r}{T_x} \right)^n \left( \frac{T_{cr}}{T_{cx}} \right)^q \quad (3)$$

10.2 In the case of turbocharged engines in which the limits of turbocharger speed and turbocharger turbine inlet temperature have not been reached at the declared power under standard reference conditions, the manufacturer may declare substitute reference conditions to or from which power adjustments is to be made.

The following formulae (4) and (5) will then be used instead of formula (3)

$$k = \left( \frac{p_x}{p_r} \right)^m \left( \frac{T_r}{T_x} \right)^n \left( \frac{T_{cr}}{T_{cx}} \right)^q \quad (4)$$

$$p_{ra} = P_r \times \left( \frac{\pi_r}{\pi_{max}} \right) \quad (5)$$



Where :

$P_r$  is the brake power;

$p_r$  is the standard reference total barometric pressure;

$p_{sr}$  is the saturation vapour pressure under standard reference conditions;

$\phi_r$  is the standard reference relative humidity;

$T_r$  is the standard reference absolute air temperature;

$T_{cr}$  is the standard reference absolute charge or coolant temperature;

$P_{ra}$  is the substitute reference total barometric pressure given by formula (5);

$T_{ra}$  is the substitute reference absolute air temperature to be stated by the manufacturer;

$\pi_r$  is the boost pressure ratio at declared power under standard reference conditions to be stated by the manufacturer;

$\pi_{max}$  is the maximum available boost pressure ratio to be stated by the manufacturer;

$\alpha$  is the power adjustment factor;

$k$  is the ratio of indicated power;

$\eta_m$  is the mechanical efficiency (see note 4);

$P_x$  is the brake power under the conditions being considered;

$p_x$  is the total barometric pressure condition being considered;

$p_{sx}$  is the saturation vapour pressure under pressure the conditions being considered;

$\phi_x$  is the relative humidity condition being considered;

$T_x$  is the absolute air temperature being considered;

$T_{cr}$  is the absolute charge air coolant temperature at charge air cooler inlet being considered.

The factor  $a$  and exponent  $m$ ,  $n$ , and  $q$  have the numerical value given in table 1 (see note 5).

## NOTES

1. For the convenience of users of these formulae, reference may be made to tables and nomograms in annexes B to O, which also include numerical examples.

2. When the ambient conditions are more favourable than the standard reference conditions, the declared power under the ambient conditions may be limited by the manufacturer to the declared power at the standard reference conditions.

3. If the relative humidity is not known, a value of 60% should be assumed in formulae references A, E and G in table 1.

For all other formulae references the power adjustment is independent of humidity ( $a = 0$ ).

4. The value of mechanical efficiency shall be stated by the engine manufacturer. In the absence of any such statement, the value of  $\eta_m = 0.80$  will be assumed.

5. When declaring the ISO standard power the engine manufacturer shall state which of the formulae references in table 1 is applicable.



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย



Table 1 - Numerical values for power adjustment

| Engine type   | Condition                                    |  | Fomula<br>reference | Factor | Exponents |      |      |
|---|--|--|---------------------|--------|-----------|------|------|
|   |  |  |                     | a      | m         | n    | q    |
| Compression<br>ignition oil<br>engine and<br>dual-fuel<br>engines | Non -<br>turbocharged                        | Power limited by<br>air excess               | A                   | 1      | 1         | 0.75 | 0    |
|   |  | Power limited by<br>thermal reason           | B                   | 0      | 1         | 1    | 0    |
|   | Turbocarged<br>without charge<br>air cooling | Low and<br>medium speed                      | C                   | 0      | 0.7       | 2    | 0    |
|   | Turbocarged<br>with charge<br>air cooling    | four-stroke<br>engine                        | D                   | 0      | 0.7       | 1.2  | 1    |
| Spark ignition<br>engines<br>using<br>gaseous fuel                | Non -<br>turbocharged                        |  | E                   | 1      | 0.86      | 0.56 | 0    |
|   | Turbocharged<br>with charge<br>air cooling   | Low and medium<br>speed four-speed<br>engine | F                   | 0      | 0.57      | 0.55 | 1.75 |
| Spark ignition<br>engines<br>using<br>liquid fuel                 | Naturally<br>aspirated                       |  | G                   | 1      | 1         | 0.5  | 0    |

NOTE - The factors and exponents given in table 1 have been established by tests on a number of engines to be generally representative and shall be used in the absence of nay other specific information; for example in formula reference D, for an engine with the charge air cooled by engine jacket water, the value for exponent q could be zero. At present, they apply only to the type of engines specified but table 1 will be extended to include other types when sufficient are available.

## 11. Aajustment of fuel consumption for ambient conditions

11.1 When it is required to operate the engine under conditions different from the standard reference conditions given in clause 5, the fuel consumption will differ from

that declared for the standard reference conditions and shall be adjusted to or from the standard reference conditions.

The following formulae shall be used if other methods are not declared by the engine manufacturers :

$$b_x = \beta b_r \quad (6)$$

where

$$\beta = k/\alpha \quad (7)$$

where :

$b$  is the specific fuel consumption

$\beta$  is the fuel consumption adjustment factor

$\alpha$  is the power adjustment factor (see 10.1)

$k$  is the ratio of indicated power (see 10.1)

Subscript  $r$  corresponds to values under the standard reference conditions.

Subscript  $x$  corresponds to values the conditions being considered.

NOTE - For the convenience of users of these formulae, reference may be made to the tables and nomograms in annexes B to O, which also include numerical examples.

## 12. Information to be supplied by the customer

The customer shall supply the following information concerning the required power :

- a) The application and the power required from the engine and details arising therefrom.
- b) The expected frequency and duration of the required powered and the corresponding engine speeds.
- c) Site conditions
  - 1) Site barometric pressure (highest and lowest reading available; if no pressure data are available the altitude above sea level).
  - 2) The monthly mean minimum and maximum air temperatures during the hottest and coldest months of the year.
  - 3) The highest and lowest ambient air temperatures around the engine.

4) The relative humidity (or alternatively the water vapour pressure or the wet and dry bulb temperature) ruling at the maximum temperature conditions.

5) The maximum and minimum temperature of the cooling water available.

d) The specification and lower calorific value of the fuel available.

e) Whether the engine is to comply with the requirements of any classification society or with special requirements.

f) The probable period for which the engine will be running continuously, and the duration of maximum and minimum load.

g) Any other information appropriate to the particular engine application.

### 13. Information to supplied by the engine manufacturer

The engine manufacturer shall supply the following information :

a) The declared powers.

b) The corresponding crankshaft and output shaft speeds.

**NOTE** - For certain applications of variable engines it is common practice to supply a power/speed diagram covering the ranges of power over which the engine can be used in continuous and in short period operation.

c) The direction of rotation (see ISO 1204).

d) The number and arrangement of cylinders (see ISO 1205).

e) Whether the engine is two-stroke or four-stroke, naturally aspired, mechanically pressure charge or turbocaharged and whether with or without charge air cooler.

f) The quantity of air required for the operation of the engine for :

1) combustion and scavenging;

2) cooling and ventilation.

g) The method of starting, apparatus supplied and additional apparatus required.

h) The type and grade of lubricating oil(s) recommended.

j) The type of governing, with speed droop of required (see ISO 3046/4 and ISO 3046/6).

If for variable speed duties, the working speed range and the idling speed.

If necessary, the critical speed range shall be indicated.

k) The method of cooling and the capacity of the cooling system with the rates of circulation of the cooling fluids.

m) (From air cooled engines only.) Whether hot air discharge ducting can be fitted.

n) A schedule recommended maintenance and overhaul periods.

p) Specifications and lower calorific values of fuels recommended.

q) Maximum permissible back-pressure in the exhaust system and the maximum permissible intake depression.

r) Any other information appropriate to the particular engine application.



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย



## Annex A

### Examples of auxiliaries which may be fitted

NOTE - These lists are govern for guidance purposes only and are not necessary complete.

#### LIST A - Essential dependent auxiliaries (see 6.2 and 6.4)

- 1) Engine-driven lubricating oil pressure pump.
- 2) Engine-driven lubricating oil scavenge pump for dry-sump engines.
- 3) Engine-driven engines cooling water pump.
- 4) Engine-driven raw water pump.
- 5) Engine-driven radiator cooling fan.
- 6) Engine-driven engine cooling fan for air-cooled engines.
- 7) Engine-driven gaseous fuel pump.
- 8) Engine-driven fuel feed pump.
- 9) Engine-driven fuel pressure pump for common rail or servo-injection system.
- 10) Engine-driven generator, air compressor or hydraulic pump when supplying power to items in lists B.
- 11) Engine-driven cylinder lubricating pump.
- 12) Air cleaner or air silencer (normal or special).
- 13) Exhaust silencer (normal or special).

#### LIST B - Essential independent auxiliaries (see 6.3 and 6.4)

- 1) Separately driven lubricating oil pressure pump.
- 2) Separately driven lubricating oil scavenge pump for dry-sump engines.
- 3) Separately driven engine cooling water pump.
- 4) Separately driven raw water pump.
- 5) Separately driven radiator cooling fan
- 6) Separately driven engine cooling fan for air-cooled engines.
- 7) Separately driven gaseous fuel compressor.
- 8) Separately driven fuel feed pump.
- 9) Separately driven scavenge air blower and/or charge air blower.
- 10) Separately driven scavenge air blower and or charge air blower.



- 11) Separately driven crankcase extractor fan.
- 12) Separately driven cylinder lubricating pump.
- 13) Governing or control system using power from fan an external source.

**LIST C - Non-essential dependent auxiliaries (see 6.2 and 6.5)**

- 1) engine-driven starting air compressor.
- 2) Engine-driven generator, air compressor or hydraulic pump when supplying power to items not in list B.
- 3) Engine-driven bilge pump.
- 4) Engine-driven fire pump.
- 5) Engine-driven ventilation fan.
- 6) Engine-driven fuel transfer pump.
- 7) Engine-driven thrust bearing.



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

## Annex B

Determination of the power adjustment factor ( $\alpha$ )

The table below gives values of the power adjustment factor ( $\alpha$ ) for known values of the ratio of indicated power (k) and mechanical efficiency ( $\eta_m$ ).

The value of k can be determined from annex D.

The value of  $\eta_m$  is stated by the manufacturer (see clause 10, note 4).

| k    | $\alpha$ |       |       |       |       |       |
|------|----------|-------|-------|-------|-------|-------|
|      | $\eta_m$ |       |       |       |       |       |
|      | 0.70     | 0.75  | 0.8   | 0.85  | 0.9   | 0.95  |
| 0.50 | 0.350    | 0.383 | 0.413 | 0.438 | 0.461 | 0.482 |
| 0.52 | 0.376    | 0.408 | 0.436 | 0.461 | 0.483 | 0.502 |
| 0.54 | 0.402    | 0.433 | 0.460 | 0.483 | 0.504 | 0.523 |
| 0.56 | 0.428    | 0.457 | 0.483 | 0.506 | 0.526 | 0.544 |
| 0.58 | 0.454    | 0.482 | 0.507 | 0.528 | 0.547 | 0.565 |
| 0.60 | 0.480    | 0.507 | 0.530 | 0.551 | 0.569 | 0.585 |
| 0.62 | 0.506    | 0.531 | 0.554 | 0.573 | 0.590 | 0.606 |
| 0.64 | 0.532    | 0.556 | 0.577 | 0.596 | 0.612 | 0.627 |
| 0.66 | 0.558    | 0.581 | 0.601 | 0.618 | 0.634 | 0.647 |
| 0.68 | 0.584    | 0.605 | 0.624 | 0.641 | 0.655 | 0.668 |
| 0.70 | 0.610    | 0.630 | 0.648 | 0.663 | 0.677 | 0.689 |
| 0.72 | 0.636    | 0.655 | 0.671 | 0.686 | 0.698 | 0.709 |
| 0.74 | 0.662    | 0.679 | 0.695 | 0.708 | 0.720 | 0.730 |
| 0.76 | 0.688    | 0.704 | 0.718 | 0.730 | 0.741 | 0.751 |
| 0.78 | 0.714    | 0.729 | 0.742 | 0.753 | 0.763 | 0.772 |
| 0.80 | 0.740    | 0.753 | 0.765 | 0.775 | 0.784 | 0.793 |
| 0.82 | 0.766    | 0.778 | 0.789 | 0.798 | 0.806 | 0.813 |
| 0.84 | 0.792    | 0.803 | 0.812 | 0.820 | 0.827 | 0.834 |
| 0.86 | 0.818    | 0.827 | 0.836 | 0.843 | 0.849 | 0.855 |
| 0.88 | 0.844    | 0.852 | 0.859 | 0.865 | 0.870 | 0.876 |
| 0.90 | 0.870    | 0.877 | 0.883 | 0.888 | 0.892 | 0.896 |
| 0.92 | 0.896    | 0.901 | 0.906 | 0.910 | 0.913 | 0.917 |
| 0.94 | 0.922    | 0.926 | 0.930 | 0.933 | 0.935 | 0.938 |
| 0.96 | 0.948    | 0.951 | 0.955 | 0.955 | 0.957 | 0.959 |
| 0.98 | 0.974    | 0.975 | 0.978 | 0.978 | 0.978 | 0.979 |
| 1.00 | 1.000    | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 1.02 | 1.026    | 1.025 | 1.024 | 1.023 | 1.023 | 1.021 |
| 1.04 | 1.052    | 1.049 | 1.047 | 1.045 | 1.045 | 1.042 |
| 1.06 | 1.078    | 1.074 | 1.071 | 1.067 | 1.067 | 1.062 |
| 1.08 | 1.104    | 1.099 | 1.094 | 1.090 | 1.090 | 1.083 |
| 1.10 | 1.130    | 1.123 | 1.118 | 1.112 | 1.112 | 1.104 |
| 1.12 | 1.156    | 1.148 | 1.141 | 1.135 | 1.135 | 1.124 |
| 1.14 | 1.182    | 1.173 | 1.165 | 1.157 | 1.157 | 1.145 |
| 1.16 | 1.208    | 1.197 | 1.188 | 1.180 | 1.180 | 1.166 |
| 1.18 | 1.234    | 1.222 | 1.212 | 1.202 | 1.202 | 1.187 |
| 1.20 | 1.260    | 1.247 | 1.235 | 1.225 | 1.225 | 1.207 |

## Annex C

Determination the fuel consumption adjustment factor ( $\beta$ )

The table below gives values of the fuel consumption adjustment factor ( $f_3$ ) for known values of the ratio of indicated power ( $k$ ) and mechanical efficiency ( $\eta_m$ )

The value of  $k$  can be determined from annex D.

The value of  $\eta_m$  is stated by the manufacturer (see clause 10, note 4).

| k    | $\beta$  |       |       |       |       |       |
|------|----------|-------|-------|-------|-------|-------|
|      | $\eta_m$ |       |       |       |       |       |
|      | 0.70     | 0.75  | 0.8   | 0.85  | 0.9   | 0.95  |
| 0.50 | 1.429    | 1.304 | 1.212 | 1.141 | 1.084 | 1.038 |
| 0.52 | 1.383    | 1.275 | 1.193 | 1.129 | 1.077 | 1.035 |
| 0.54 | 1.343    | 1.248 | 1.175 | 1.118 | 1.071 | 1.032 |
| 0.56 | 1.308    | 1.225 | 1.159 | 1.108 | 1.065 | 1.030 |
| 0.58 | 1.278    | 1.203 | 1.145 | 1.098 | 1.060 | 1.027 |
| 0.60 | 1.250    | 1.184 | 1.132 | 1.090 | 1.055 | 1.025 |
| 0.62 | 1.225    | 1.167 | 1.120 | 1.082 | 1.050 | 1.023 |
| 0.64 | 1.203    | 1.151 | 1.109 | 1.075 | 1.046 | 1.021 |
| 0.66 | 1.184    | 1.137 | 1.099 | 1.068 | 1.042 | 1.019 |
| 0.68 | 1.164    | 1.123 | 1.090 | 1.062 | 1.038 | 1.018 |
| 0.70 | 1.148    | 1.111 | 1.081 | 1.056 | 1.035 | 1.016 |
| 0.72 | 1.132    | 1.100 | 1.073 | 1.051 | 1.031 | 1.015 |
| 0.74 | 1.118    | 1.089 | 1.066 | 1.045 | 1.028 | 1.013 |
| 0.76 | 1.105    | 1.080 | 1.059 | 1.041 | 1.025 | 1.012 |
| 0.78 | 1.092    | 1.070 | 1.052 | 1.035 | 1.022 | 1.011 |
| 0.80 | 1.081    | 1.062 | 1.046 | 1.032 | 1.020 | 1.009 |
| 0.82 | 1.071    | 1.054 | 1.040 | 1.028 | 1.017 | 1.008 |
| 0.84 | 1.061    | 1.047 | 1.035 | 1.024 | 1.015 | 1.007 |
| 0.86 | 1.051    | 1.040 | 1.029 | 1.021 | 1.013 | 1.006 |
| 0.88 | 1.043    | 1.033 | 1.024 | 1.017 | 1.011 | 1.005 |
| 0.90 | 1.035    | 1.027 | 1.020 | 1.014 | 1.009 | 1.004 |
| 0.92 | 1.027    | 1.021 | 1.016 | 1.011 | 1.007 | 1.003 |
| 0.94 | 1.020    | 1.015 | 1.011 | 1.008 | 1.005 | 1.002 |
| 0.96 | 1.013    | 1.010 | 1.007 | 1.005 | 1.003 | 1.002 |
| 0.98 | 1.006    | 1.005 | 1.004 | 1.003 | 1.002 | 1.001 |
| 1.00 | 1.000    | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 1.02 | 0.994    | 0.995 | 0.997 | 0.998 | 0.999 | 0.999 |
| 1.04 | 0.989    | 0.991 | 0.993 | 0.995 | 0.997 | 0.999 |
| 1.06 | 0.983    | 0.987 | 0.990 | 0.993 | 0.996 | 0.998 |
| 1.08 | 0.978    | 0.983 | 0.987 | 0.991 | 0.996 | 0.997 |
| 1.10 | 0.974    | 0.979 | 0.984 | 0.989 | 0.993 | 0.997 |
| 1.12 | 0.969    | 0.976 | 0.982 | 0.987 | 0.992 | 0.996 |
| 1.14 | 0.965    | 0.972 | 0.979 | 0.985 | 0.991 | 0.996 |
| 1.16 | 0.960    | 0.969 | 0.976 | 0.983 | 0.989 | 0.995 |
| 1.18 | 0.956    | 0.966 | 0.974 | 0.982 | 0.988 | 0.994 |
| 1.20 | 0.952    | 0.963 | 0.972 | 0.980 | 0.987 | 0.994 |

## Annex D

## Determination of the ratio of indicated power (k)

Formula (3) or (4) can be written as :  $k = (R_1)^{y_1}(R_2)^{y_2}(R_3)^{y_3}$  (3)

Where

$$R_1 = \left( \frac{p_x - a\phi_x p_{sx}}{p_r - a\phi_r p_{sr}} \right) \text{ or } \left( \frac{p_x}{p_r} \right)$$

$$R_2 = \frac{T_r}{T_x} \text{ or } \frac{T_{ra}}{T_x} \quad R_3 = \frac{T_{cr}}{T_{\alpha}}$$

and  $y_1 = m$        $y_2 = n$        $y_3 = q$

The value of  $R_1 = \left( \frac{p_x - a\phi_x p_{sx}}{p_r - a\phi_r p_{sr}} \right)$  can be obtained from annex E and other values of R can be calculated.

The value of m, n, q are obtained from table 1.

The table below then gives values of  $R^y$  for known ratios R and known factors y.

The value of k is then obtained by multiplying together the appropriate values of  $R^y$ .

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย



| R    | R <sup>Y</sup> |       |       |       |       |       |       |       |       |
|------|----------------|-------|-------|-------|-------|-------|-------|-------|-------|
|      | Y              |       |       |       |       |       |       |       |       |
|      | 0.50           | 0.55  | 0.57  | 0.70  | 0.75  | 0.86  | 1.20  | 1.75  | 2.00  |
| 0.60 | 0.775          | 0.755 | 0.747 | 0.699 | 0.682 | 0.645 | 0.542 | 0.409 | 0.360 |
| 0.62 | 0.787          | 0.769 | 0.762 | 0.716 | 0.699 | 0.663 | 0.564 | 0.433 | 0.384 |
| 0.64 | 0.800          | 0.782 | 0.775 | 0.732 | 0.716 | 0.681 | 0.585 | 0.458 | 0.410 |
| 0.66 | 0.812          | 0.796 | 0.789 | 0.748 | 0.732 | 0.700 | 0.607 | 0.483 | 0.436 |
| 0.68 | 0.825          | 0.809 | 0.803 | 0.763 | 0.749 | 0.718 | 0.630 | 0.509 | 0.462 |
| 0.70 | 0.837          | 0.822 | 0.816 | 0.779 | 0.765 | 0.736 | 0.652 | 0.536 | 0.490 |
| 0.72 | 0.849          | 0.835 | 0.829 | 0.795 | 0.782 | 0.754 | 0.674 | 0.593 | 0.518 |
| 0.74 | 0.860          | 0.847 | 0.842 | 0.810 | 0.798 | 0.772 | 0.697 | 0.590 | 0.548 |
| 0.76 | 0.872          | 0.860 | 0.855 | 0.825 | 0.814 | 0.790 | 0.719 | 0.619 | 0.578 |
| 0.78 | 0.883          | 0.872 | 0.868 | 0.840 | 0.830 | 0.808 | 0.742 | 0.647 | 0.608 |
| 0.80 | 0.894          | 0.885 | 0.881 | 0.855 | 0.846 | 0.825 | 0.765 | 0.677 | 0.640 |
| 0.82 | 0.906          | 0.897 | 0.893 | 0.870 | 0.862 | 0.843 | 0.788 | 0.707 | 0.672 |
| 0.84 | 0.917          | 0.909 | 0.905 | 0.885 | 0.877 | 0.861 | 0.811 | 0.737 | 0.706 |
| 0.86 | 0.927          | 0.920 | 0.918 | 0.900 | 0.893 | 0.878 | 0.834 | 0.768 | 0.740 |
| 0.88 | 0.938          | 0.932 | 0.930 | 0.914 | 0.909 | 0.896 | 0.858 | 0.800 | 0.774 |
| 0.90 | 0.949          | 0.944 | 0.942 | 0.929 | 0.924 | 0.913 | 0.881 | 0.832 | 0.810 |
| 0.92 | 0.959          | 0.955 | 0.954 | 0.943 | 0.939 | 0.931 | 0.905 | 0.864 | 0.846 |
| 0.94 | 0.970          | 0.967 | 0.965 | 0.958 | 0.955 | 0.948 | 0.928 | 0.897 | 0.884 |
| 0.96 | 0.980          | 0.978 | 0.977 | 0.972 | 0.970 | 0.966 | 0.952 | 0.931 | 0.922 |
| 0.98 | 0.990          | 0.989 | 0.989 | 0.986 | 0.985 | 0.983 | 0.976 | 0.965 | 0.960 |
| 1.00 | 1.000          | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 1.02 | 1.010          | 1.011 | 1.011 | 1.014 | 1.015 | 1.017 | 1.024 | 1.035 | 1.040 |
| 1.04 | 1.020          | 1.022 | 1.023 | 1.028 | 1.030 | 1.034 | 1.048 | 1.071 | 1.082 |
| 1.06 | 1.030          | 1.033 | 1.034 | 1.042 | 1.045 | 1.051 | 1.072 | 1.107 | 1.124 |
| 1.08 | 1.038          | 1.043 | 1.045 | 1.055 | 1.059 | 1.068 | 1.097 | 1.144 | 1.166 |
| 1.10 | 1.049          | 1.054 | 1.056 | 1.069 | 1.074 | 1.085 | 1.121 | 1.182 | 1.210 |
| 1.12 | 1.058          | 1.064 | 1.067 | 1.083 | 1.089 | 1.102 | 1.146 | 1.219 | 1.254 |
| 1.14 | 1.068          | 1.075 | 1.078 | 1.096 | 1.103 | 1.119 | 1.170 | 1.258 | 1.300 |
| 1.16 | 1.077          | 1.085 | 1.088 | 1.110 | 1.118 | 1.136 | 1.195 | 1.297 | 1.346 |
| 1.18 | 1.086          | 1.095 | 1.099 | 1.123 | 1.132 | 1.153 | 1.220 | 1.336 | 1.392 |
| 1.20 | 1.095          | 1.106 | 1.110 | 1.135 | 1.147 | 1.170 | 1.245 | 1.376 | 1.440 |

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย



## Annex E

## Determination dry air pressure ratio

The dry air pressure ratio  $\left( \frac{p_x - \alpha \phi_x p_{sx}}{p_r - \alpha \phi_r p_{sr}} \right)$  used in formula (3) given in the table below for

the value of  $\alpha = 1$  of formula references A, E and G and for different values of total barometric pressure ( $\phi_x$ ) and water vapor pressure ( $\phi_x p_{sx}$ ).

If the water vapour pressure is not known it can be obtained from the air temperature and relative humidity by the use of annex F.



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

| Altitude<br>m | Total<br>barometric<br>pressure<br>Pa, kPa | $p_x - a\phi_x p_{sx}$ |      |      |      |      |      |      |      |      |      |      |      |      |      |
|---------------|--|------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|
|               |  | $p_r - a\phi_r p_{sr}$ |      |      |      |      |      |      |      |      |      |      |      |      |      |
|               |  | $\phi_x p_{sx}$ (kPa)  |      |      |      |      |      |      |      |      |      |      |      |      |      |
|               |  | 0                      | 1    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 10   | 11   | 12   | 13   |
| 0             | 101.3                                      | 1.04                   | 1.02 | 1.01 | 1.00 | 0.99 | 0.98 | 0.97 | 0.96 | 0.95 | 0.94 | 0.93 | 0.92 | 0.91 | 0.90 |
| 100           | 100.0                                      | 1.02                   | 1.01 | 1.00 | 0.99 | 0.98 | 0.97 | 0.96 | 0.95 | 0.94 | 0.93 | 0.92 | 0.91 | 0.90 | 0.89 |
| 200           | 98.9                                       | 1.01                   | 1.00 | 0.99 | 0.98 | 0.97 | 0.96 | 0.95 | 0.94 | 0.93 | 0.92 | 0.91 | 0.90 | 0.89 | 0.88 |
| 400           | 96.7                                       | 0.99                   | 0.98 | 0.97 | 0.96 | 0.95 | 0.94 | 0.93 | 0.92 | 0.91 | 0.90 | 0.89 | 0.88 | 0.87 | 0.86 |
| 600           | 94.4                                       | 0.96                   | 0.95 | 0.94 | 0.93 | 0.92 | 0.91 | 0.90 | 0.89 | 0.88 | 0.87 | 0.86 | 0.85 | 0.84 | 0.83 |
| 800           | 92.1                                       | 0.94                   | 0.93 | 0.92 | 0.91 | 0.90 | 0.89 | 0.88 | 0.87 | 0.86 | 0.85 | 0.84 | 0.83 | 0.82 | 0.81 |
| 1000          | 89.9                                       | 0.92                   | 0.91 | 0.90 | 0.89 | 0.88 | 0.87 | 0.86 | 0.85 | 0.84 | 0.83 | 0.82 | 0.81 | 0.80 | 0.79 |
| 1200          | 87.7                                       | 0.90                   | 0.89 | 0.88 | 0.87 | 0.86 | 0.85 | 0.84 | 0.82 | 0.81 | 0.80 | 0.79 | 0.78 | 0.77 | 0.76 |
| 1400          | 85.6                                       | 0.87                   | 0.86 | 0.85 | 0.84 | 0.83 | 0.82 | 0.81 | 0.80 | 0.79 | 0.78 | 0.77 | 0.76 | 0.75 | 0.74 |
| 1600          | 83.5                                       | 0.85                   | 0.84 | 0.83 | 0.82 | 0.81 | 0.80 | 0.79 | 0.78 | 0.77 | 0.76 | 0.75 | 0.74 | 0.73 | 0.72 |
| 1800          | 81.5                                       | 0.83                   | 0.82 | 0.81 | 0.80 | 0.79 | 0.78 | 0.77 | 0.76 | 0.75 | 0.74 | 0.73 | 0.72 | 0.71 | 0.70 |
| 2000          | 79.5                                       | 0.81                   | 0.80 | 0.79 | 0.78 | 0.77 | 0.76 | 0.75 | 0.74 | 0.73 | 0.72 | 0.71 | 0.70 | 0.69 | 0.68 |
| 2200          | 77.6                                       | 0.79                   | 0.78 | 0.77 | 0.76 | 0.75 | 0.74 | 0.73 | 0.72 | 0.71 | 0.70 | 0.69 | 0.68 | 0.67 | 0.66 |
| 2400          | 75.6                                       | 0.77                   | 0.76 | 0.75 | 0.74 | 0.73 | 0.72 | 0.71 | 0.70 | 0.69 | 0.68 | 0.67 | 0.66 | 0.65 | 0.64 |
| 2600          | 73.7                                       | 0.75                   | 0.74 | 0.73 | 0.72 | 0.71 | 0.70 | 0.69 | 0.68 | 0.67 | 0.66 | 0.65 | 0.64 | 0.63 | 0.62 |
| 2800          | 71.9                                       | 0.73                   | 0.72 | 0.71 | 0.70 | 0.69 | 0.68 | 0.67 | 0.66 | 0.65 | 0.64 | 0.63 | 0.62 | 0.61 | 0.60 |
| 3000          | 70.1                                       | 0.72                   | 0.71 | 0.70 | 0.69 | 0.68 | 0.67 | 0.66 | 0.64 | 0.63 | 0.62 | 0.61 | 0.60 | 0.59 | 0.58 |
| 3200          | 68.4                                       | 0.70                   | 0.69 | 0.68 | 0.67 | 0.66 | 0.65 | 0.64 | 0.63 | 0.62 | 0.61 | 0.60 | 0.59 | 0.58 | 0.57 |
| 3400          | 66.7                                       | 0.68                   | 0.67 | 0.66 | 0.65 | 0.64 | 0.63 | 0.62 | 0.61 | 0.60 | 0.59 | 0.58 | 0.57 | 0.56 | 0.55 |
| 3600          | 64.9                                       | 0.66                   | 0.65 | 0.64 | 0.63 | 0.62 | 0.61 | 0.60 | 0.59 | 0.58 | 0.57 | 0.56 | 0.55 | 0.54 | 0.53 |
| 3800          | 63.2                                       | 0.65                   | 0.64 | 0.63 | 0.62 | 0.60 | 0.59 | 0.58 | 0.57 | 0.56 | 0.55 | 0.54 | 0.53 | 0.52 | 0.51 |
| 4000          | 61.5                                       | 0.63                   | 0.62 | 0.61 | 0.60 | 0.59 | 0.58 | 0.57 | 0.56 | 0.56 | 0.54 | 0.53 | 0.52 | 0.51 | 0.50 |
| 4200          | 60.1                                       | 0.61                   | 0.60 | 0.59 | 0.58 | 0.57 | 0.56 | 0.55 | 0.54 | 0.53 | 0.52 | 0.51 | 0.50 | 0.49 | 0.48 |
| 4400          | 58.5                                       | 0.60                   | 0.59 | 0.58 | 0.57 | 0.56 | 0.55 | 0.54 | 0.53 | 0.52 | 0.51 | 0.50 | 0.49 | 0.48 | 0.47 |
| 4600          | 56.9                                       | 0.58                   | 0.57 | 0.56 | 0.55 | 0.54 | 0.53 | 0.52 | 0.51 | 0.52 | 0.49 | 0.48 | 0.47 | 0.46 | 0.45 |
| 4800          | 55.3                                       | 0.57                   | 0.55 | 0.54 | 0.53 | 0.52 | 0.51 | 0.50 | 0.49 | 0.50 | 0.47 | 0.46 | 0.45 | 0.44 | 0.43 |
| 5000          | 54.1                                       | 0.55                   | 0.54 | 0.53 | 0.52 | 0.51 | 0.50 | 0.49 | 0.48 | 0.49 | 0.46 | 0.45 | 0.44 | 0.43 | 0.42 |

## Annex F

## Determination of water vapour pressure

The water vapour pressure ( $\phi_x p_{sx}$ ) is given in the table below in units of kPa for different values of the air temperature in degrees Celsius and relative humidity  $\phi_x$ .

| $T_x$<br>(°C) | $\phi_x p_{sx}$ (kPa) |     |     |     |     |
|---------------|-----------------------|-----|-----|-----|-----|
|               | $\phi_x$              |     |     |     |     |
|               | 1                     | 0.8 | 0.6 | 0.4 | 0.2 |
| -10           | 0.3                   | 0.2 | 0.2 | 0.1 | 0.1 |
| -5            | 0.4                   | 0.3 | 0.2 | 0.2 | 0.1 |
| 0             | 0.6                   | 0.5 | 0.4 | 0.2 | 0.1 |
| 5             | 0.9                   | 0.7 | 0.5 | 0.4 | 0.2 |
| 10            | 1.2                   | 1   | 0.7 | 0.5 | 0.2 |
| 15            | 1.7                   | 1.4 | 1   | 0.7 | 0.5 |
| 20            | 2.3                   | 1.9 | 1.4 | 0.9 | 0.5 |
| 25            | 3.2                   | 2.5 | 1.9 | 1.3 | 0.6 |
| 27            | 3.6                   | 2.9 | 2.1 | 1.4 | 0.7 |
| 30            | 4.2                   | 3.4 | 2.5 | 1.7 | 0.9 |
| 32            | 4.8                   | 3.8 | 2.9 | 1.9 | 1   |
| 34            | 5.3                   | 4.3 | 3.2 | 2.1 | 1.1 |
| 36            | 6                     | 4.8 | 3.6 | 2.6 | 1.2 |
| 38            | 6.6                   | 5.3 | 4   | 2.7 | 1.3 |
| 40            | 7.4                   | 5.9 | 4.4 | 3   | 1.5 |
| 42            | 8.2                   | 6.6 | 4.9 | 3.3 | 1.6 |
| 44            | 9.1                   | 7.3 | 5.5 | 3.6 | 1.8 |
| 46            | 10.1                  | 8.1 | 6.1 | 4   | 2   |
| 48            | 11.2                  | 8.9 | 6.7 | 4.5 | 2.2 |
| 50            | 12.3                  | 9.9 | 7.4 | 4.9 | 2.5 |



ภาคผนวก ข

คุณสมบัติทางทฤษฎีของแก๊สผสม

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย



## คุณสมบัติทางทฤษฎีของแก๊สผสม

คุณสมบัติของแก๊สสามารถหาได้จากคุณสมบัติของสารประกอบแต่ละชนิดโดยกำหนดความสัมพันธ์ดังนี้

### 1. เศษส่วนโมล (mole fraction, $x_i$ )

เป็นอัตราส่วนระหว่างจำนวนโมลของสารประกอบแต่ละส่วน( $N_i$ ) กับจำนวนโมลทั้งหมดของสารผสม ( $N$ ) หรือเป็นอัตราส่วนระหว่างความเข้มข้นโดยโมลของสารประกอบ ( $n_i$ ) กับความเข้มข้นโดยโมลของสารผสมทั้งหมด ( $n$ ) และสามารถหาความสัมพันธ์ระหว่างเศษส่วนมวลกับเศษส่วนโมลได้

$$x_i = \frac{N_i}{N} = \frac{n_i}{n} \quad \text{ดังนั้น} \quad x_i = \frac{My_i}{M_i}$$

### 2. น้ำหนักโมเลกุล (Molecular weight, $M$ )

การหาน้ำหนักโมเลกุลของแก๊สผสม หาได้จาก

$$M = \sum x_i M_i = x_1 M_1 + x_2 M_2 + \dots + x_n M_n$$

เมื่อ  $x_1, x_2, \dots, x_n =$  เศษส่วนโมลของแก๊สแต่ละชนิดในแก๊สผสม

### 3. ค่าความร้อน (heating value, $H$ )

การหาค่าความร้อนของแก๊สผสม หาได้จาก

$$H = \sum x_i H_i = x_1 H_1 + x_2 H_2 + \dots + x_n H_n$$

โดยคุณสมบัติของแก๊สผสมซึ่งในการศึกษานี้ คือ แก๊สธรรมชาติหาได้จากตารางแสดงคุณสมบัติของสารประกอบไฮโดรคาร์บอนและแก๊สเฉื่อย ดังแสดงในตารางที่ ข-1

### 4. ขีดจำกัดการติดไฟ (Flammability limit, FL)

เป็นสภาวะที่ส่วนผสมของอากาศต่อเชื้อเพลิงสูงสุดที่ยังสามารถทำให้เกิดการเผาไหม้ได้ โดยมีสมการในการคำนวณหาขีดจำกัดการติดไฟของเชื้อเพลิงแก๊สผสม Le chatelier's modification of mixture law ดังนี้

$$FL = \frac{100}{\frac{P_1}{FL_1} + \frac{P_2}{FL_2} + \dots + \frac{P_n}{FL_n}}$$

โดย FL = limit of flammability of mixture

$P_1$  = เปอร์เซ็นต์ของเชื้อเพลิงชนิดแรก

$P_2$  = เปอร์เซ็นต์ของเชื้อเพลิงชนิดที่สอง

$P_n$  = เปอร์เซ็นต์ของเชื้อเพลิงชนิดที่ n

- $FL_1$  = limit of flammability ของเชื้อเพลิงชนิดแรก  
 $FL_2$  = limit of flammability ของเชื้อเพลิงชนิดที่สอง  
 $FL_n$  = limit of flammability ของเชื้อเพลิงชนิดที่ n

ตารางที่ ข-1 แสดงคุณสมบัติของสารประกอบไฮโดรคาร์บอนและแก๊สเฉื่อย [7]

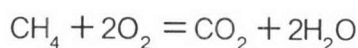
| Compound                                       | Molecular Weight, $M_i$ | Higher heating value, HHV (Btu/ft <sup>3</sup> ) | Lower heating value, LHV (Btu/ft <sup>3</sup> ) | Lower Flammability limit, LFL (%vol) | Higher Flammability limit, HFL (%vol) |
|--|-------------------------|--|---|--------------------------------------|---------------------------------------|
| Methane (CH <sub>4</sub> )                     | 16.043                  | 1012.0   | 911.2   | 5.0                                  | 15.0                                  |
| Ethane (C <sub>2</sub> H <sub>6</sub> )        | 30.070                  | 1772.9   | 1621.6  | 2.9                                  | 13.0                                  |
| Propane (C <sub>3</sub> H <sub>8</sub> )       | 44.097                  | 2523.0   | 2321.4  | 2.0                                  | 9.5                                   |
| Isobutane (i-C <sub>3</sub> H <sub>10</sub> )  | 58.123                  | 3260.1   | 3008.0  | 1.8                                  | 8.5                                   |
| n-Butane (n-C <sub>3</sub> H <sub>10</sub> )   | 58.123                  | 3269.6   | 3017.5  | 1.5                                  | 9.0                                   |
| Isopentane (i-C <sub>5</sub> H <sub>12</sub> ) | 72.150                  | 4009.4   | 3716.0  | 1.3                                  | 8.0                                   |
| n-Pentane (n-C <sub>5</sub> H <sub>12</sub> )  | 72.150                  | 4018.5   | 3711.0  | 1.4                                  | 8.3                                   |
| Hexanes (C <sub>6</sub> H <sub>14</sub> )      | 86.177                  | 4758.0   | 4405.0  | 1.1                                  | 7.7                                   |
| Carbon dioxide (CO <sub>2</sub> )              | 44.010                  | -  | -   | -                                    | -                                     |
| Nitrogen (N <sub>2</sub> )                     | 28.0134                 | -  | -   | -                                    | -                                     |

### 5. อัตราส่วนอากาศต่อเชื้อเพลิงทางทฤษฎี

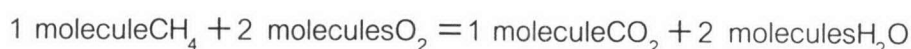
ในการปล่อยความร้อนจากเชื้อเพลิงนั้นจำเป็นต้องใช้ปริมาณอากาศที่เพียงพอการที่อากาศไม่เพียงพอจะทำให้เกิดการสูญเสียความร้อนเนื่องจากการเผาไหม้ไม่สมบูรณ์ ในกรณีที่อากาศเกินนั้นจะทำให้สูญเสียความร้อนสัมผัส (Sensible Heat) การทราบปริมาณความต้องการ

อากาศทางทฤษฎี หรือ Stoichiometric หรืออัตราส่วนของอากาศต่อแก๊สนั้นเป็นสิ่งสำคัญที่จะทำให้ทราบถึงการเผาไหม้ที่สมบูรณ์

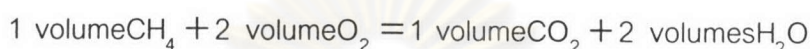
พิจารณาสมการเผาไหม้ของมีเทน



จากกฎของ Avogadro กล่าวว่าภายใต้สภาวะอุณหภูมิและความดันเดียวกันแก๊สที่มีปริมาณเท่ากัน จะมีจำนวนโมเลกุลเท่ากัน กล่าวคือ



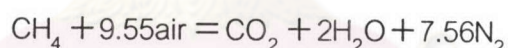
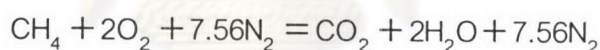
ดังนั้น



(สมมติว่าแก๊สมีพฤติกรรมเป็นแก๊สอุดมคติ)

เนื่องจากองค์ประกอบของแก๊สแสดงในรูปของเปอร์เซ็นต์โดยปริมาตรซึ่งนำไปสู่การคำนวณการเผาไหม้ที่ง่ายขึ้น

สำหรับเชื้อเพลิงแก๊สสมการการเผาไหม้ที่สำคัญแสดงไว้ในตารางที่ ข-2 เนื่องจากอากาศประกอบด้วยออกซิเจน 20.95 เปอร์เซ็นต์โดยปริมาตร ปริมาณความต้องการอากาศสำหรับแต่ละเชื้อเพลิงแก๊สจะกำหนดโดยความต้องการออกซิเจนคูณด้วย 100/20.95 เช่น แต่ละปริมาตรของออกซิเจนจะมาพร้อมกับไนโตรเจนอีก 3.78 ปริมาตร ซึ่งประกอบเป็นอากาศ 4.78 ปริมาตร ดังตัวอย่าง



ตารางที่ ข-2 แสดงสมการการเผาไหม้ของเชื้อเพลิงแก๊ส

| (1)<br>Gas                     | (2)<br>Equation   | (3)<br>Stoichiometric<br>O <sub>2</sub> per unit<br>volume of gas | (4)<br>Stoichiometric<br>Air per unit<br>Volume of gas,<br>m <sub>a</sub> |
|--------------------------------|---|---|---|
| CH <sub>4</sub>                | CH <sub>4</sub> + 2O <sub>2</sub> = CO <sub>2</sub> + 2H <sub>2</sub> O                   | 2.0   | 9.55  |
| C <sub>2</sub> H <sub>6</sub>  | C <sub>2</sub> H <sub>6</sub> + 3O <sub>2</sub> = 2CO <sub>2</sub> + 3H <sub>2</sub> O    | 3.5   | 16.71   |
| C <sub>3</sub> H <sub>8</sub>  | C <sub>3</sub> H <sub>8</sub> + 5O <sub>2</sub> = 3CO <sub>2</sub> + 4H <sub>2</sub> O    | 5.0   | 23.87   |
| C <sub>4</sub> H <sub>10</sub> | C <sub>4</sub> H <sub>10</sub> + 6½O <sub>2</sub> = 4CO <sub>2</sub> + 5H <sub>2</sub> O  | 6.5   | 31.03   |
| C <sub>5</sub> H <sub>12</sub> | C <sub>5</sub> H <sub>12</sub> + 8O <sub>2</sub> = 5CO <sub>2</sub> + 6H <sub>2</sub> O   | 8.0   | 38.24   |
| C <sub>6</sub> H <sub>14</sub> | C <sub>6</sub> H <sub>14</sub> + 9.5O <sub>2</sub> = 6CO <sub>2</sub> + 7H <sub>2</sub> O | 9.5   | 45.41   |



ในการหาอัตราส่วนผสมอากาศต่อเชื้อเพลิงทางทฤษฎีของเชื้อเพลิงแก๊สผสม หาได้จาก

$$\left(\frac{A}{F}\right)_s = \frac{\dot{m}_a}{\dot{m}_f}$$

เมื่อ  $\dot{m}_a$  = ผลรวมของมวลอากาศทั้งหมดที่ต้องการใช้ในการเผาไหม้กับเชื้อเพลิงแต่ละตัวได้สมบูรณ์

$$= \left[\sum m_a x_i\right] \cdot M_{air} = 28.96 \cdot \left[\sum m_a x_i\right]$$

$m_a$  = Stoichiometric air per unit volume of gas (ดูได้จากตารางที่ ข-2)

$x$  = เศษส่วนโมล

$M_{air}$  = น้ำหนักโมเลกุลของอากาศ เท่ากับ 28.96

$\dot{m}_f$  = มวลของเชื้อเพลิง 1 หน่วยที่ใช้ในการเผาไหม้กับอากาศได้สมบูรณ์

$$= 1 \text{ (mol of fuel)} \cdot M_{fuel}$$

$M_{fuel}$  = น้ำหนักโมเลกุลของเชื้อเพลิงแก๊สผสม

## 6. เลขออกเทน

King และ Liss [11] ได้ทดสอบและหาความสัมพันธ์ระหว่างองค์ประกอบของแก๊สธรรมชาติกับ Motor octane number (MON) ในรูปของสมการเชิงเส้นดังนี้

$$MON = a \cdot CH_4 + b \cdot C_2H_6 + c \cdot C_3H_8 + d \cdot C_4H_{10} + e \cdot CO_2 + f \cdot N_2$$

เมื่อ  $CH_4, C_2H_6, C_3H_8, C_4H_{10}, CO_2, N_2$  = เศษส่วนโมลขององค์ประกอบแต่ละแก๊ส

$$a = 137.780 \text{ (สัมประสิทธิ์สำหรับองค์ประกอบของ } CH_4)$$

$$b = 29.948 \text{ (สัมประสิทธิ์สำหรับองค์ประกอบของ } C_2H_6)$$

$$c = -18.193 \text{ (สัมประสิทธิ์สำหรับองค์ประกอบของ } C_3H_8)$$

$$d = -167.062 \text{ (สัมประสิทธิ์สำหรับองค์ประกอบของ } C_4H_{10})$$

$$e = 181.233 \text{ (สัมประสิทธิ์สำหรับองค์ประกอบของ } CO_2)$$

$$f = 26.994 \text{ (สัมประสิทธิ์สำหรับองค์ประกอบของ } N_2)$$

จากความสัมพันธ์ดังกล่าวจะเห็นว่า หากมีองค์ประกอบของ  $C_3H_8$  และ  $C_4H_{10}$  ในแก๊สผสมซึ่งมีสัมประสิทธิ์เป็นลบ จะเป็นตัวลดความต้านทานการน็อกของเชื้อเพลิง เนื่องจากองค์ประกอบทั้งสองโดยเฉพาะ  $C_4H_{10}$  มีความต้านทานการน็อกต่ำกว่ามีเทน ส่วนองค์ประกอบของแก๊สเฉื่อย ได้แก่  $CO_2$  และ  $N_2$  ซึ่งทำหน้าที่เป็นตัวเจือจางส่วนผสมเชื้อเพลิงกับอากาศ และลดอุณหภูมิการเผาไหม้ลง จะเป็นตัวเพิ่มความต้านทานการน็อกของเชื้อเพลิง

ในการศึกษานี้ทำการประเมินความต้านทานการน็อกของเชื้อเพลิงแก๊สธรรมชาติเท่านั้น เนื่องจากเงื่อนไขการใช้ความสัมพันธ์ดังกล่าว คือ



1. ความสัมพันธ์ดังกล่าวไม่ควรใช้กับแก๊สผสมที่มีองค์ประกอบของแก๊สเฉื่อยเกิน 5 % โดยปริมาตร
2. หากมีองค์ประกอบของสารไฮโดรคาร์บอนหนัก อาทิ  $C_5H_{10}$  และ  $C_6H_{12}$  ในแก๊สผสม ไม่สามารถนำมาคิดความต้านทานการน็อกได้



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย



ภาคผนวก ค

การวัดอัตราการบริโภคอากาศและเชื้อเพลิง

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

## การวัดการบริโภคอากาศและเชื้อเพลิง

### ค.1 การวัดการบริโภคอากาศ

ปริมาณอากาศที่ผสมกับเชื้อเพลิงเพื่อให้เกิดการเผาไหม้ ขึ้นอยู่กับรอบและภาระการทำงานของเครื่องยนต์ ในการศึกษาใช้วิธีการวัดอัตราการไหลของอากาศที่ไหลเข้าเครื่องยนต์แบบ Orifice air flow meter ดังแสดงในรูปที่ ค-1 ประกอบไปด้วยเครื่องมือวัดความดันตกคร่อม (Pressure drop) ระหว่างบรรยากาศกับแผ่นออริฟิส (Orifice plate) และถังพักที่ต้องมีขนาดใหญ่พอจะลดการกระเพื่อมของอากาศ ซึ่งขนาดของปริมาตรถังพักที่น้อยที่สุดคำนวณได้จากสมการ [9]

$$V_{\text{Tank}} = \frac{4.57 \times 10^6 \times d^4 E^2}{N_{\text{min}}^2 n V_d} \quad (\text{ค-1})$$

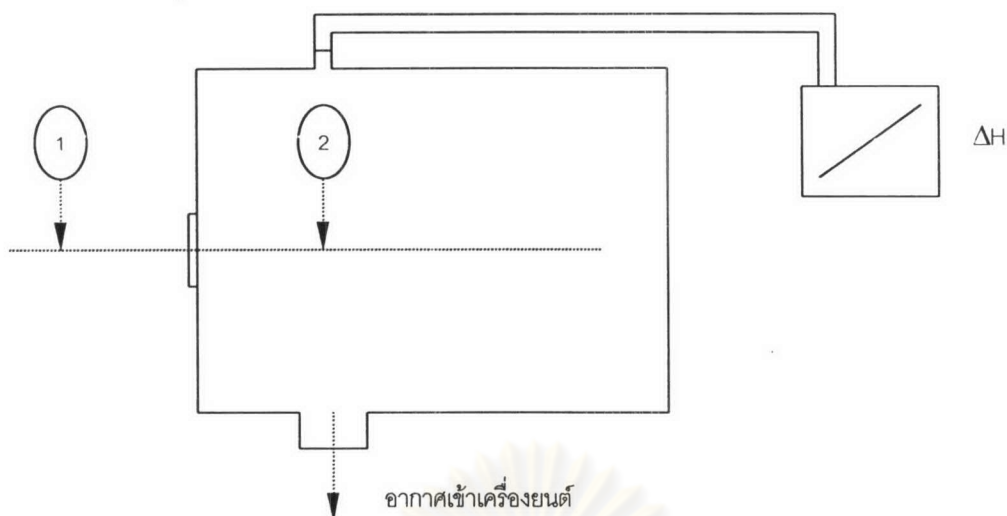
|     |                  |   |   |
|-----|------------------|---|---|
| โดย | d                | = | ขนาดเส้นผ่านศูนย์กลางของแผ่นออริฟิส (m)                                       |
|     | E                | = | ค่าคงที่มีค่าเป็น 1 ในเครื่องยนต์ 2 จังหวะและเท่ากับ 2 ในเครื่องยนต์ 4 จังหวะ |
|     | n                | = | จำนวนกระบอกสูบของเครื่องยนต์  |
|     | V <sub>d</sub>   | = | ปริมาตรแทนที่ (Displacement volume) ของเครื่องยนต์ทั้งหมด (m <sup>3</sup> )   |
|     | N <sub>min</sub> | = | ความเร็วรอบเพลลาข้อเหวี่ยงที่ต่ำสุด (rad/sec)                                 |

การคำนวณหาปริมาณอากาศที่ไหลเข้าเครื่องยนต์สามารถหาได้จากสมการดังนี้

$$\dot{m}_{\text{air}} = \rho_{\text{air}} Q_{\text{air}} \quad (\text{ค-2})$$

|     |                  |   |   |
|-----|------------------|---|---|
| โดย | m                | = | อัตราการไหลเชิงมวลของอากาศ (kg/sec.)                  |
|     | ρ <sub>air</sub> | = | ความหนาแน่นของอากาศ (kg/m <sup>3</sup> )              |
|     | Q <sub>air</sub> | = | อัตราการไหลเชิงปริมาตรของอากาศ (m <sup>3</sup> /sec.) |

การไหลผ่านออริฟิสของอากาศให้คิดเป็นการไหลแบบอัดตัวไม่ได้ (Incompressible flow) ซึ่งมีขั้นตอนในการหาปริมาณอากาศดังนี้



รูปที่ ค-1 แสดง Orifice flow meter

จากรูปที่ ค-1 ที่สภาวะการไหลของอากาศ 1 ไป 2 จากสมการ Bernoulli จะได้ว่า

$$\frac{P_1}{\gamma_{\text{air}}} + \frac{v_1^2}{2g} + Z_1 = \frac{P_2}{\gamma_{\text{air}}} + \frac{v_2^2}{2g} + Z_2 \quad (\text{ค-3})$$

- โดย  $P_1, P_2$  = ความดันที่สภาวะที่ 1 และ 2 ตามลำดับ ( $\text{N/m}^2$ )  
 $v_1, v_2$  = ความเร็วที่สภาวะที่ 1 และ 2 ตามลำดับ ( $\text{m/sec}$ )  
 $Z_1, Z_2$  = ระดับของสภาวะที่ 1 และ 2 ตามลำดับ เทียบกับระดับอ้างอิง ( $\text{m}$ )  
 $\gamma_{\text{air}}$  = Specific weight ของอากาศ ( $\text{kg/m}^3 \cdot \text{sec}^2$ )  
 เท่ากับ  $\rho g$   
 $g$  = ความเร่งเนื่องจากแรงโน้มถ่วงของโลก ( $\text{m/sec}^2$ ) =  $9.81 \text{ m/sec}^2$

โดยกำหนดสมมติฐาน คือ

1. ที่สภาวะ 1 กำหนดให้มวลอากาศมีความเร็วต่ำโดยให้ค่าเป็นศูนย์
2. กำหนดให้สภาวะทั้ง 1 และ 2 อยู่ในระดับเดียวกันนั่นคือ  $Z_1 = Z_2$

จากสมการ (ค-2) จะได้ว่า

$$\frac{P_1}{\gamma_{\text{air}}} + Z_1 = \frac{P_2}{\gamma_{\text{air}}} + \frac{v_2^2}{2g} + Z_2$$

$$v_2^2 = 2g \frac{(P_1 - P_2)}{\gamma_{\text{air}}}$$



เมื่อ  $\gamma_{\text{air}} = \rho_{\text{air}} g$  จะได้

$$v_2^2 = 2g \frac{\Delta P}{\rho_{\text{air}} g} = \frac{2\Delta P}{\rho_{\text{air}}}$$

$$v_2 = \sqrt{\frac{2\Delta P}{\rho_{\text{air}}}} \quad (\text{ค-4})$$

เมื่อพิจารณาเป็นการไหลแบบคงตัว จะได้ว่า

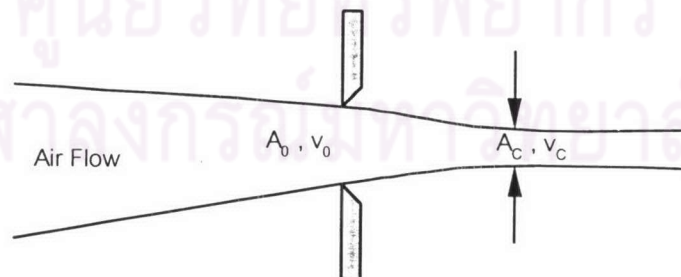
$$\begin{aligned} Q_{\text{air}} &= AV \\ &= \frac{\pi d^2}{4} v_2 \end{aligned} \quad (\text{ค-5})$$

โดย A = พื้นที่หน้าตัดของแผ่นออริฟิส ( $\text{m}^2$ )  
 V = ความเร็วที่ down stream เท่ากับ  $v_2$  (m/sec)  
 d = ขนาดเส้นผ่านศูนย์กลางของออริฟิส (m)

เมื่อพิจารณาการไหลผ่านออริฟิส พบว่าจะเกิดปรากฏการณ์ที่เรียกว่า Vena contracta ซึ่งจะ  
 ทำให้ค่าการไหลตามความเป็นจริงมีค่าน้อยกว่า หรืออีกนัยหนึ่งคือ เนื่องจากอากาศเป็นของไหลที่  
 สามารถอัดตัวได้ เมื่อไหลผ่านออริฟิสจึงเกิดการหดตัวของของไหลในช่องที่ไหลผ่านนั่นคือของไหล  
 ไม่ได้ไหลผ่านพื้นที่ทั้งหมดของออริฟิสดังรูป ค-2 และเนื่องจากของไหลมีความหนืด ดังนั้นความเร็ว  
 จริงที่ไหลผ่านจะลดลง ดังนั้นจึงเกิดสัมประสิทธิ์ขึ้นมาเรียก Coefficient of discharge ( $C_D$ ) โดยทั่วไป  
 สามารถใช้ค่า  $C_D = 0.6$  [12]

ดังนั้น

$$Q_{\text{actual}} = C_D \times Q_{\text{theory}}$$



รูปที่ ค-2 แสดงปรากฏการณ์ Vena contracta

จากสมการ (ค-4) และ (ค-5) จะได้ว่า

$$Q_{\text{air}} = C_D \frac{\pi d^2}{4} \sqrt{\frac{2\Delta P}{\rho_{\text{air}}}}$$

เนื่องจากในการทดสอบมีการเปลี่ยนแปลงสถานะของอากาศจึงจำเป็นต้องคิดผลกระทบดังกล่าวต่อปริมาณอากาศที่เข้าสู่เครื่องยนต์ โดยที่

$$\rho_{\text{air}} = \frac{P_a}{RT_a}$$

- โดยที่  $P_a$  = ความดันบรรยากาศ (Pa)  
 $R$  = Gas constant ของอากาศ เท่ากับ 287 J·kg/K  
 $T_a$  = อุณหภูมิอากาศภายในถังพักอากาศ (K)

ค่า  $\Delta P$  หาได้จากการวัดผลต่างความดันด้วยแมนอมิเตอร์ซึ่งมีค่าเทียบเท่ากับ  $h$  มีหน่วยเป็น mmH<sub>2</sub>O  
 ดังนั้น

$$Q_{\text{air}} = C_D \frac{\pi d^2}{4} \sqrt{\frac{2 \times 9.81h \times RT_a}{P_a}} \quad (\text{ค-6})$$

จาก (ค-2) และ (ค-6) จะได้อัตราการไหลเชิงมวลของอากาศ

$$\dot{m}_{\text{air}} = \rho_{\text{air}} Q_{\text{air}} = \frac{P_a Q_{\text{air}}}{RT_a} \quad (\text{ค-7})$$

$$\dot{m}_{\text{air}} = C_D \frac{\pi d^2}{4} \sqrt{\frac{2 \times 9.81h \times P_a}{RT_a}} \quad \dots \quad (\text{ค-8})$$

**ตัวอย่างการคำนวณอัตราการบริโภคาากาศของเครื่องยนต์**

สำหรับการคำนวณการบริโภคาากาศของเครื่องยนต์ ( $\dot{m}_{\text{air}}$ ). ในการศึกษาสามารถหาได้จากสมการ (ค-8) ดังตัวอย่างต่อไปนี้

หาอัตราการไหลเชิงมวลของอากาศเข้าสู่เครื่องยนต์ทำงานที่ตำแหน่ง WOT และความเร็วรอบ 1500 rev/min กำหนดให้

- $C_D$  = 0.6  
 $d$  = 0.0379 m  
 $h$  = 8.90 mm H<sub>2</sub>O

$$T_a = 32.6 \text{ }^{\circ}\text{C} \text{ (305.6 K)}$$

$$P_a = 100 \text{ kPa}$$

จะได้  $\dot{m}_{\text{air}} = 0.00955 \text{ kg/sec} \text{ (9.55 g/sec)}$

## ค.2 การวัดการบริโภคเชื้อเพลิงแก๊ส

ในการศึกษานี้ใช้แก๊สมิเตอร์ซึ่งวัดปริมาตรการไหลของแก๊สที่ไหลผ่าน สามารถอ่านค่าได้จากการหมุนของเข็มบนหน้าปัดในแต่ละรอบพร้อมทั้งจับเวลาในช่วงที่เครื่องยนต์ทำงานในสภาวะเสถียรภาพ โดยปริมาตรของแก๊สมิเตอร์ที่วัดต่อรอบมีค่า 1 ลูกบาศก์ฟุตหรือเท่ากับ  $0.0283 \text{ m}^3$  ดังแสดงในรูปที่ 3-15 ซึ่งอัตราการบริโภคเชื้อเพลิงของเครื่องยนต์หาได้จากสมการ

$$Q_f = \frac{V_f}{t} \quad (\text{ค-9})$$

เมื่อ  $Q_f =$  อัตราการไหลเชิงปริมาตรของเชื้อเพลิง ( $\text{m}^3/\text{sec}$ )

$V_f =$  ปริมาตรของแก๊สที่ทำการวัดผ่านแก๊สมิเตอร์ ในการศึกษาเท่ากับ  $0.0283 \text{ m}^3$  ซึ่งเท่ากับเข็มบนหน้าปัดแก๊สมิเตอร์หมุนครบ 1 รอบ

$t =$  เวลาเฉลี่ยที่อ่านค่าได้จากการหมุนของเข็มบนหน้าปัดแก๊สมิเตอร์ครบ 1 รอบ (sec)

โดยที่อัตราการไหลเชิงมวลของเชื้อเพลิง ( $\dot{m}_f$ )หาได้จาก

$$\dot{m}_f = \rho_f Q_f \quad (\text{ค-10})$$

เมื่อ  $\rho_f =$  ความหนาแน่นของเชื้อเพลิง ( $\text{m}^3/\text{kg}$ )

การหาความหนาแน่น (density) ของแก๊สผสมจาก Equation of state

$$\frac{P_g}{\rho} = \frac{\bar{R}}{M} T_g$$

$$\rho = \frac{P_g M}{\bar{R} T_g} \quad (\text{ค-11})$$

เมื่อ  $P_g =$  ความดันสัมบูรณ์ของแก๊สเข้าอุปกรณ์วัดการบริโภคเชื้อเพลิงแก๊ส (kPa)

$M =$  น้ำหนักโมเลกุลของแก๊สผสม

$\bar{R} =$  Universal gas constant =  $8.314 \text{ J}/(\text{mol}\cdot\text{K})$

$T_g =$  อุณหภูมิของแก๊สเข้าอุปกรณ์วัดการบริโภคเชื้อเพลิงแก๊ส (K)

### ตัวอย่างการคำนวณการบริโภคเชื้อเพลิงแก๊สของเครื่องยนต์

สำหรับการคำนวณการบริโภคเชื้อเพลิงแก๊สของเครื่องยนต์ ( $\dot{m}_f$ ). ในการศึกษาสามารถหาได้จากสมการ (ค-10) ดังตัวอย่างต่อไปนี้

หาอัตราการไหลเชิงมวลของอากาศเข้าสู่เครื่องยนต์ทำงานที่ตำแหน่ง WOT และความเร็วรอบ 1500 rev/min กำหนดให้

$$\Delta P_g = \text{ความดันแก๊สขาเข้าอุปกรณ์วัดการบริโภคเชื้อเพลิงแก๊สที่วัดได้จากแมนอมิเตอร์ ซึ่งเป็นความดันแตกต่างเทียบกับบรรยากาศ มีหน่วยเป็น inch H}_2\text{O. ในตัวอย่างนี้กำหนดให้เป็น -0.5 inch H}_2\text{O}$$

$$P_g = P_{\text{atm}} + \Delta P_g = 401.46 - 0.5 = 400.96 \text{ inch H}_2\text{O (99.84 kPa)}$$

$$M = 22.55$$

$$T_g = 29.8 \text{ }^\circ\text{C (302.8 K)}$$

$$t = 32.88 \text{ sec}$$

จาก (ค-9) จะได้อัตราการไหลเชิงปริมาตรของเชื้อเพลิงแก๊ส

$$Q_f = 0.0008607 \text{ m}^3/\text{sec}$$

จาก (ค-11) จะได้ความหนาแน่นของเชื้อเพลิงแก๊ส

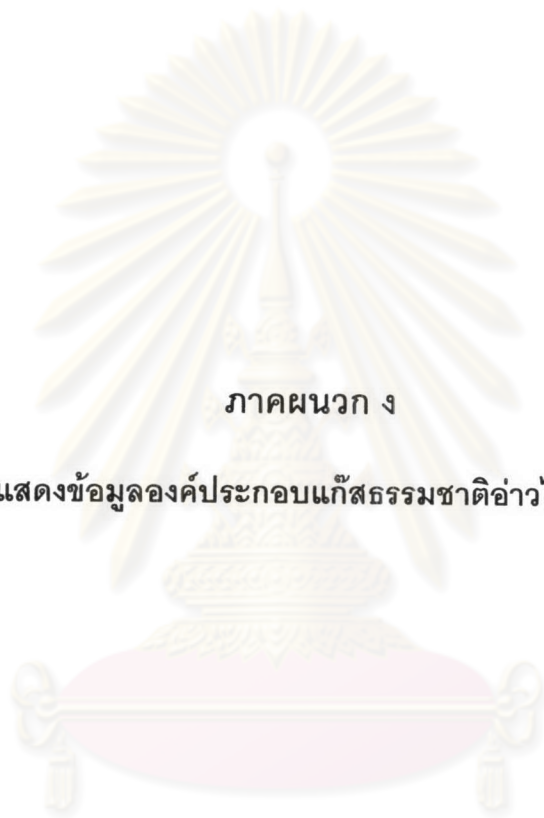
$$\rho_f = 0.894 \text{ kg/m}^3$$

จาก (ค-10) จะได้อัตราการไหลเชิงมวลของเชื้อเพลิงแก๊ส

$$\dot{m}_f = 0.00077 \text{ kg/sec (0.77 g/sec)}$$

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย





ภาคผนวก ง

ตารางแสดงข้อมูลองค์ประกอบแก๊สธรรมชาติอ่าวไทยและพม่า

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

ตารางที่ ง-1 แสดงข้อมูลสัดส่วนองค์ประกอบโดยปริมาตรของแก๊สธรรมชาติจากอ่าวไทย ที่ใช้เป็นเชื้อเพลิงทดสอบ

| Compound | 27/11/03 | 3/12/03 | 16/12/03 | 15/1/04 |
|----------|----------|---------|----------|---------|
| C1       | 71.72    | 73.35   | 71.11    | 72.47   |
| C2       | 7.19     | 7.07    | 7.40     | 6.62    |
| C3       | 2.29     | 1.91    | 2.73     | 1.91    |
| i-C4     | 0.52     | 0.42    | 0.62     | 0.41    |
| n-C4     | 0.47     | 0.38    | 0.57     | 0.36    |
| i-C5     | 0.15     | 0.11    | 0.17     | 0.10    |
| n-C5     | 0.10     | 0.07    | 0.11     | 0.06    |
| C6+      | 0.09     | 0.05    | 0.10     | 0.04    |
| N2       | 2.74     | 2.33    | 2.45     | 2.75    |
| CO2      | 14.73    | 14.30   | 14.72    | 15.27   |
| S.G.     | 0.79     | 0.78    | 0.80     | 0.79    |

ตารางที่ ง-2 แสดงข้อมูลสัดส่วนองค์ประกอบโดยปริมาตรแก๊สธรรมชาติจากแหล่งพม่าที่ใช้เป็นเชื้อเพลิงทดสอบ

| Compound | 14/10/03 | 15/10/03 | 7/11/03 | 13/11/03 | 14/11/03 | 17/11/03 | 18/11/03 |
|----------|----------|----------|---------|----------|----------|----------|----------|
| C1       | 71.78    | 71.74    | 71.70   | 71.68    | 71.73    | 71.89    | 71.89    |
| C2       | 2.93     | 2.94     | 2.93    | 2.94     | 2.93     | 3.06     | 2.95     |
| C3       | 0.86     | 0.86     | 0.85    | 0.86     | 0.86     | 0.89     | 0.87     |
| i-C4     | 0.17     | 0.17     | 0.17    | 0.17     | 0.17     | 0.17     | 0.17     |
| n-C4     | 0.20     | 0.19     | 0.19    | 0.20     | 0.19     | 0.20     | 0.20     |
| i-C5     | 0.07     | 0.07     | 0.07    | 0.08     | 0.07     | 0.08     | 0.07     |
| n-C5     | 0.04     | 0.04     | 0.04    | 0.04     | 0.04     | 0.04     | 0.04     |
| C6+      | 0.07     | 0.07     | 0.07    | 0.07     | 0.07     | 0.07     | 0.07     |
| N2       | 18.21    | 18.14    | 18.17   | 18.10    | 18.17    | 17.73    | 18.15    |
| CO2      | 5.67     | 5.79     | 5.81    | 5.87     | 5.77     | 5.87     | 5.59     |
| S.G.     | 0.717    | 0.718    | 0.718   | 0.718    | 0.718    | 0.717    | 0.716    |

ตารางที่ ง-2 (ต่อ) แสดงข้อมูลสัดส่วนองค์ประกอบโดยปริมาตรแก๊สธรรมชาติจากแหล่งพม่าที่ใช้  
เป็นเชื้อเพลิงทดสอบ

| Compound | 19/11/03 | 20/11/03 | 25/11/03 | 26/11/03 | 27/11/03 | 24/12/03 | 25/12/03 |
|----------|----------|----------|----------|----------|----------|----------|----------|
| C1       | 71.82    | 71.78    | 71.71    | 71.76    | 71.72    | 71.83    | 72.00    |
| C2       | 2.95     | 2.93     | 2.95     | 2.95     | 7.19     | 3.01     | 2.92     |
| C3       | 0.86     | 0.85     | 0.86     | 0.86     | 2.29     | 0.88     | 0.82     |
| i-C4     | 0.17     | 0.17     | 0.17     | 0.16     | 0.52     | 0.17     | 0.15     |
| n-C4     | 0.19     | 0.19     | 0.19     | 0.19     | 0.47     | 0.19     | 0.17     |
| i-C5     | 0.07     | 0.07     | 0.07     | 0.07     | 0.15     | 0.07     | 0.06     |
| n-C5     | 0.04     | 0.04     | 0.04     | 0.04     | 0.10     | 0.04     | 0.03     |
| C6+      | 0.07     | 0.06     | 0.07     | 0.07     | 0.09     | 0.07     | 0.07     |
| N2       | 18.12    | 18.18    | 18.11    | 18.13    | 2.74     | 17.87    | 17.87    |
| CO2      | 5.71     | 5.73     | 5.83     | 5.77     | 14.73    | 5.81     | 5.85     |
| S.G.     | 0.717    | 0.717    | 0.718    | 0.717    | 0.788    | 0.717    | 0.716    |

| Compound | 29/12/03 | 29/1/04 | 7/1/04 | 8/1/04 | 9/1/04 | 12/1/04 | 13/1/04 |
|----------|----------|---------|--------|--------|--------|---------|---------|
| C1       | 71.70    | 71.83   | 71.69  | 71.69  | 71.70  | 71.92   | 71.80   |
| C2       | 2.90     | 2.90    | 2.90   | 2.90   | 2.90   | 3.05    | 2.96    |
| C3       | 0.86     | 0.83    | 0.86   | 0.86   | 0.86   | 0.91    | 0.87    |
| i-C4     | 0.17     | 0.16    | 0.16   | 0.17   | 0.17   | 0.18    | 0.17    |
| n-C4     | 0.19     | 0.18    | 0.20   | 0.20   | 0.19   | 0.20    | 0.19    |
| i-C5     | 0.07     | 0.07    | 0.07   | 0.07   | 0.07   | 0.08    | 0.07    |
| n-C5     | 0.04     | 0.04    | 0.04   | 0.04   | 0.04   | 0.04    | 0.04    |
| C6+      | 0.08     | 0.08    | 0.08   | 0.08   | 0.08   | 0.07    | 0.06    |
| N2       | 18.29    | 17.96   | 18.28  | 18.29  | 18.29  | 17.76   | 18.07   |
| CO2      | 5.70     | 5.95    | 5.72   | 5.70   | 5.70   | 5.80    | 5.77    |
| S.G.     | 0.717    | 0.718   | 0.718  | 0.717  | 0.717  | 0.717   | 0.717   |



ภาคผนวก จ

ตารางแสดงข้อมูลการทดสอบและข้อมูลที่แก้ไข

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย



ตารางที่ จ-1 แสดงข้อมูลการทดสอบความเร็วเปลวไฟ เมื่อใช้มีเทนเป็นเชื้อเพลิง

| Indicated CH <sub>4</sub><br>(cm) | CH <sub>4</sub> flow<br>(10 <sup>-3</sup> m <sup>3</sup> /sec) | Indicated air flow<br>(cm) | Air flow<br>(10 <sup>-3</sup> m <sup>3</sup> /sec) | Time (sec) |     |      |      |                  | Flame speed<br>(m/sec) | A/F<br>(by vol.) | φ     |
|-----------------------------------|--|----------------------------|--|------------|-----|------|------|------------------|------------------------|------------------|-------|
|                                   |  |                            |  | t1         | t2  | t3   | t4   | t <sub>avg</sub> |                        |                  |       |
| 10                                | 0.072  | 28                         | 0.545  | 8.5        | 8.5 | 8.8  | 8.6  | 8.6              | 0.355                  | 7.57             | 1.266 |
| 9                                 | 0.066  | 28                         | 0.545  | 5.5        | 5.4 | 5.6  | 5.5  | 5.5              | 0.555                  | 8.26             | 1.160 |
| 8                                 | 0.06   | 28                         | 0.545  | 3.5        | 4.5 | 4.0  | 4.0  | 4                | 0.763                  | 9.08             | 1.055 |
| 7                                 | 0.055  | 28                         | 0.545  | 3.8        | 4.2 | 4.0  | 3.8  | 3.95             | 0.772                  | 9.91             | 0.967 |
| 6                                 | 0.047  | 28                         | 0.545  | 4.8        | 4.8 | 4.7  | 4.8  | 4.76             | 0.641                  | 11.60            | 0.826 |
| 5                                 | 0.043  | 28                         | 0.545  | 5.9        | 6.1 | 6.0  | 6.0  | 6                | 0.508                  | 12.67            | 0.756 |
| 4                                 | 0.036  | 28                         | 0.545  | 10.0       | 9.5 | 10.3 | 10.2 | 10               | 0.305                  | 15.14            | 0.633 |

ตารางที่ จ-2 แสดงข้อมูลการทดสอบความเร็วเปลวไฟ เมื่อใช้เชื้อเพลิงแก๊สผสมที่มีมีเทนและ CO<sub>2</sub> เป็นองค์ประกอบหลัก (แก๊สธรรมชาติจากอ่าวไทย)

| Indicated Thai<br>gulf NG flow<br>(cm) | Thai gulf NG<br>corrected flow<br>(10 <sup>-3</sup> m <sup>3</sup> /sec) | Indicated air<br>flow<br>(cm) | Air flow<br>(10 <sup>-3</sup> m <sup>3</sup> /sec) | Time (sec) |      |      |                  | Flame speed<br>(m/s) | A/F<br>(by vol.) | φ     |
|--|--|-------------------------------|--|------------|------|------|------------------|----------------------|------------------|-------|
|  |  |                               |  | t1         | t2   | t3   | t <sub>avg</sub> |                      |                  |       |
| 11                                     | 0.066  | 26                            | 0.51   | 4.53       | 4.57 | 4.54 | 4.547            | 0.671                | 7.76             | 1.139 |
| 10                                     | 0.061  | 27                            | 0.53   | 4.10       | 4.13 | 4.09 | 4.107            | 0.743                | 8.73             | 1.012 |
| 9.5                                    | 0.058  | 27                            | 0.53   | 4.16       | 4.16 | 4.12 | 4.147            | 0.736                | 9.11             | 0.970 |
| 9                                      | 0.056  | 27                            | 0.53   | 4.32       | 4.31 | 4.28 | 4.303            | 0.709                | 9.53             | 0.928 |
| 8                                      | 0.051  | 27                            | 0.53   | 4.78       | 4.78 | 4.75 | 4.770            | 0.639                | 10.48            | 0.843 |
| 7                                      | 0.046  | 27                            | 0.53   | 5.66       | 5.69 | 5.56 | 5.637            | 0.541                | 11.43            | 0.773 |

ตารางที่ จ-3 แสดงข้อมูลการทดสอบความเร็วเปลวไฟ เมื่อใช้เชื้อเพลิงแก๊สผสมที่มีมีเทนและ N<sub>2</sub> เป็นองค์ประกอบหลัก (แก๊สธรรมชาติจากแหล่งพม่า)

| Indicated<br>Myanmar NG<br>(cm) | Myanmar NG<br>corrected flow<br>(10 <sup>-3</sup> m <sup>3</sup> /sec) | Indicated air<br>flow<br>(cm) | Air flow<br>(10 <sup>-3</sup> m <sup>3</sup> /sec) | Time (sec) |      |      |                  | Flame speed<br>(m/s) | A/F<br>(by vol.) | φ     |
|---------------------------------|--|-------------------------------|--|------------|------|------|------------------|----------------------|------------------|-------|
|                                 |  |                               |  | t1         | t2   | t3   | t <sub>avg</sub> |                      |                  |       |
| 11                              | 0.068  | 24                            | 0.465  | 4.81       | 4.81 | 4.85 | 4.823            | 0.632                | 6.79             | 1.141 |
| 11                              | 0.068  | 25                            | 0.485  | 4.40       | 4.44 | 4.47 | 4.437            | 0.687                | 7.08             | 1.094 |
| 11                              | 0.068  | 26                            | 0.51   | 4.44       | 4.41 | 4.41 | 4.420            | 0.690                | 7.45             | 1.040 |
| 10.4                            | 0.066  | 26                            | 0.51   | 4.44       | 4.43 | 4.47 | 4.447            | 0.686                | 7.77             | 0.998 |
| 9.5                             | 0.061  | 27                            | 0.53   | 5.03       | 5.10 | 5.06 | 5.063            | 0.602                | 8.70             | 0.891 |
| 9                               | 0.058  | 27                            | 0.53   | 5.47       | 5.47 | 5.37 | 5.437            | 0.561                | 9.15             | 0.847 |
| 8.5                             | 0.056  | 27                            | 0.53   | 5.62       | 5.69 | 5.84 | 5.717            | 0.534                | 9.52             | 0.814 |

ตารางที่ ๑-4 แสดงผลการทดสอบเครื่องยนต์ Daihatsu รุ่น AB 547cc ด้วย carburetor ที่รอบต่าง ๆ โดยใช้น้ำมันแก๊สไลน์ออกเทน 91 เป็นเชื้อเพลิง ปรับ Spark timing ที่ MBT ตามเมทริกซ์ทดสอบรูปที่ 3-21

| speed (rev/min) | MAP (inHg) | P diff (mm H2O) | Fuel consumption 53 cc (sec) |                |                |                  | $\theta_s$ | Tb (kg) | Ambient              |                       | P <sub>exhaust</sub> (inH2O) | Cooling              |                       | T <sub>oil</sub> (°C) | ma (g/sec) | m <sub>corrected</sub> (g/sec) | Air/fuel ratio | $\phi$ | Tb <sub>corrected</sub> (N-m) | Pb (kW) | bmepp (kPa) | $\eta_{in}$ (%) | bsfc (g/kW-h) | mf (g/sec) | Tb (N-m) | P <sub>viable</sub> | k      | $\alpha$ |        |
|-----------------|------------|-----------------|------------------------------|----------------|----------------|------------------|------------|---------|----------------------|-----------------------|------------------------------|----------------------|-----------------------|-----------------------|------------|--------------------------------|----------------|--------|-------------------------------|---------|-------------|-----------------|---------------|------------|----------|---------------------|--------|----------|--------|
|                 |            |                 | t <sub>1</sub>               | t <sub>2</sub> | t <sub>3</sub> | t <sub>avg</sub> |            |         | T <sub>db</sub> (°C) | P <sub>a</sub> (mmHg) |                              | T <sub>in</sub> (°C) | T <sub>out</sub> (°C) |                       |            |                                |                |        |                               |         |             |                 |               |            |          |                     |        |          |        |
| 1500            | 18         | 0.70            | 198.06                       | 197.47         | 199.31         | 198.28           | 20         | 2.85    | 31.3                 | 754.7                 | 225                          | 0.3                  | 78                    | 84                    | 89         | 2.68                           | 0.21           | 13.8   | 1.061                         | 10.8    | 1.69        | 247.0           | 18.66         | 448        | 0.20     | 9.9                 | 2.7498 | 0.9288   | 0.9163 |
| 1500            | 21         | 1.10            | 164.50                       | 165.94         | 165.53         | 165.32           | 18         | 3.95    | 31.0                 | 756.7                 | 244                          | 0.4                  | 75                    | 83                    | 89         | 3.37                           | 0.25           | 14.4   | 1.015                         | 14.8    | 2.32        | 339.0           | 21.53         | 388        | 0.23     | 13.7                | 2.7033 | 0.9363   | 0.9251 |
| 1500            | 24         | 1.50            | 140.16                       | 141.65         | 143.28         | 141.70           | 18         | 4.90    | 32.6                 | 753.3                 | 262                          | 1.0                  | 75                    | 83                    | 93         | 3.92                           | 0.30           | 14.4   | 1.017                         | 19.0    | 2.99        | 437.2           | 23.03         | 363        | 0.27     | 16.9                | 2.9595 | 0.9064   | 0.8900 |
| 1500            | 26         | 3.20            | 121.34                       | 121.53         | 121.40         | 121.42           | 12         | 6.05    | 33.3                 | 755.5                 | 312                          | 2.0                  | 76                    | 83                    | 93         | 5.72                           | 0.35           | 18.0   | 0.813                         | 23.8    | 3.73        | 545.5           | 24.41         | 342        | 0.32     | 20.9                | 3.0780 | 0.8984   | 0.8806 |
| 1500            | 27         | 4.40            | 113.83                       | 114.47         | 115.53         | 114.61           | 12         | 6.63    | 32.8                 | 755.0                 | 320                          | 2.0                  | 80                    | 84                    | 93         | 6.71                           | 0.37           | 19.9   | 0.794                         | 25.8    | 4.05        | 592.3           | 25.21         | 331        | 0.34     | 22.9                | 2.9929 | 0.9054   | 0.8889 |
| 1500            | 28         | 5.70            | 100.71                       | 99.87          | 100.10         | 100.23           | 10         | 7.58    | 31.6                 | 755.8                 | 329                          | 3.5                  | 79                    | 85                    | 94         | 7.66                           | 0.42           | 19.8   | 0.736                         | 28.7    | 4.51        | 659.8           | 25.10         | 333        | 0.39     | 26.2                | 2.7970 | 0.9253   | 0.9122 |
| 1500            | 29.75      | 12.30           | 57.06                        | 57.53          | 57.54          | 57.38            | 10         | 8.98    | 33.1                 | 756.0                 | 313                          | 3.5                  | 76                    | 84                    | 97         | 11.22                          | 0.75           | 16.6   | 0.878                         | 35.1    | 5.51        | 805.7           | 17.11         | 488        | 0.67     | 31.1                | 3.0437 | 0.9021   | 0.8849 |
| 1800            | 18         | 1.20            | 154.31                       | 153.50         | 156.55         | 154.79           | 16         | 3.28    | 30.9                 | 757.0                 | 260                          | 0.6                  | 77                    | 83                    | 93         | 3.52                           | 0.27           | 14.1   | 1.038                         | 12.2    | 2.31        | 280.8           | 20.08         | 416        | 0.25     | 11.3                | 2.6879 | 0.9383   | 0.9275 |
| 1800            | 21         | 1.70            | 126.07                       | 127.69         | 127.91         | 127.22           | 18         | 4.23    | 31.3                 | 756.8                 | 284                          | 2.0                  | 73                    | 82                    | 93         | 4.18                           | 0.33           | 13.8   | 1.061                         | 15.9    | 3.00        | 365.3           | 21.31         | 392        | 0.30     | 14.6                | 2.7498 | 0.9314   | 0.9194 |
| 1800            | 24         | 2.90            | 105.41                       | 104.06         | 104.56         | 104.68           | 18         | 5.38    | 32.2                 | 754.7                 | 300                          | 2.0                  | 79                    | 84                    | 96         | 5.46                           | 0.40           | 14.8   | 0.989                         | 20.7    | 3.90        | 475.0           | 22.38         | 373        | 0.37     | 18.6                | 2.8935 | 0.9144   | 0.8994 |
| 1800            | 26         | 4.60            | 97.15                        | 98.34          | 96.80          | 97.43            | 15         | 6.23    | 35.5                 | 755.5                 | 329                          | 2.5                  | 70                    | 82                    | 98         | 6.83                           | 0.46           | 17.2   | 0.848                         | 25.5    | 4.82        | 586.6           | 24.38         | 343        | 0.40     | 21.5                | 3.4777 | 0.8666   | 0.8432 |
| 1800            | 27         | 6.10            | 93.16                        | 93.56          | 92.59          | 93.10            | 12         | 6.88    | 32.5                 | 756.5                 | 354                          | 3.4                  | 71                    | 82                    | 97         | 7.91                           | 0.46           | 19.0   | 0.767                         | 26.5    | 5.00        | 609.4           | 25.47         | 328        | 0.42     | 23.8                | 2.9429 | 0.9119   | 0.8965 |
| 1800            | 28         | 7.60            | 73.38                        | 73.25          | 72.22          | 72.95            | 12         | 7.90    | 32.8                 | 755.8                 | 348                          | 4.0                  | 78                    | 85                    | 97         | 8.82                           | 0.59           | 16.6   | 0.878                         | 30.7    | 5.79        | 704.8           | 22.94         | 364        | 0.53     | 27.3                | 2.9929 | 0.9064   | 0.8900 |
| 1800            | 29.7       | 19.20           | 43.91                        | 43.97          | 44.09          | 43.99            | 12         | 9.25    | 34.0                 | 756.4                 | 347                          | 5.0                  | 74                    | 83                    | 99         | 14.00                          | 0.99           | 15.9   | 0.917                         | 36.8    | 6.93        | 844.6           | 16.26         | 514        | 0.88     | 32.0                | 3.2006 | 0.8890   | 0.8696 |



ตารางที่ ๓-4 (ต่อ) แสดงผลการทดสอบเครื่องยนต์ Daihatsu รุ่น AB 547cc ด้วย carburetor ที่รอบต่าง ๆ โดยใช้น้ำมันแก๊สโซลีนออกเทน 91 เป็นเชื้อเพลิง ปรับ Spark timing ที่ MBT เมทริกซ์ทดสอบรูปที่ 3-21

| speed (rev/min) | MAP (inHg) | P diff (mm H <sub>2</sub> O) | Fuel consumption 53 cc (sec) |                |                |                  | $\theta_s$ | Ambient              |                       | P <sub>exhaust</sub> (inH <sub>2</sub> O) | Cooling                   |                      | T <sub>oil</sub> (°C) | ma (g/sec) | m <sub>corrected</sub> (g/sec) | Air/fuel ratio | $\phi$ | Tb <sub>corrected</sub> (N-m) | Pb (kW) | bmp (KPa) | $\eta_{th}$ (%) | bsfc (g/KW-h) | mf (g/sec) | Tb (N-m) | P <sub>v,table</sub> | k      | $\alpha$ |                       |
|-----------------|------------|------------------------------|------------------------------|----------------|----------------|------------------|------------|----------------------|-----------------------|---|---------------------------|----------------------|-----------------------|------------|--------------------------------|----------------|--------|-------------------------------|---------|-----------|-----------------|---------------|------------|----------|----------------------|--------|----------|-----------------------|
|                 |            |                              | t <sub>1</sub>               | t <sub>2</sub> | t <sub>3</sub> | t <sub>avg</sub> |            | T <sub>db</sub> (°C) | P <sub>a</sub> (mmHg) |   | T <sub>exhaust</sub> (°C) | T <sub>in</sub> (°C) |                       |            |                                |                |        |                               |         |           |                 |               |            |          |                      |        |          | T <sub>out</sub> (°C) |
| 2100            | 18         | 1.65                         | 128.34                       | 129.09         | 130.03         | 129.15           | 20         | 31.5                 | 756.8                 | 288                                       | 0.3                       | 75                   | 83                    | 97         | 4.12                           | 0.32           | 13.8   | 1.062                         | 13.0    | 2.85      | 297.4           | 20.48         | 408        | 0.30     | 11.9                 | 2.7812 | 0.9282   | 0.9156                |
| 2100            | 21         | 2.30                         | 107.06                       | 106.41         | 106.82         | 106.76           | 20         | 31.4                 | 756.8                 | 301                                       | 0.8                       | 68                   | 82                    | 97         | 4.87                           | 0.39           | 13.4   | 1.088                         | 16.7    | 3.67      | 383.4           | 21.86         | 382        | 0.36     | 15.3                 | 2.7654 | 0.9298   | 0.9175                |
| 2100            | 24         | 3.80                         | 93.63                        | 93.22          | 93.65          | 93.50            | 18         | 36.2                 | 755.4                 | 340                                       | 1.0                       | 72                   | 83                    | 100        | 6.20                           | 0.48           | 15.0   | 0.974                         | 22.4    | 4.94      | 515.5           | 23.72         | 352        | 0.41     | 18.7                 | 3.6139 | 0.8568   | 0.8318                |
| 2100            | 26         | 7.30                         | 87.28                        | 87.65          | 87.53          | 87.49            | 18         | 35.0                 | 755.5                 | 358                                       | 2.0                       | 71                   | 82                    | 100        | 8.62                           | 0.51           | 19.5   | 0.749                         | 26.4    | 5.81      | 606.1           | 26.61         | 314        | 0.44     | 22.5                 | 3.3831 | 0.8736   | 0.8515                |
| 2100            | 27         | 10.20                        | 70.19                        | 69.03          | 70.87          | 70.03            | 14         | 33.0                 | 756.6                 | 380                                       | 2.5                       | 67                   | 82                    | 101        | 10.22                          | 0.61           | 18.5   | 0.789                         | 29.6    | 6.51      | 679.9           | 24.73         | 338        | 0.55     | 26.3                 | 3.0267 | 0.9043   | 0.8876                |
| 2100            | 28         | 11.65                        | 59.00                        | 59.16          | 59.59          | 59.25            | 12         | 35.0                 | 755.8                 | 383                                       | 2.5                       | 80                   | 85                    | 98         | 10.89                          | 0.75           | 16.7   | 0.876                         | 34.5    | 7.59      | 792.3           | 23.56         | 354        | 0.65     | 29.4                 | 3.3831 | 0.8740   | 0.8519                |
| 2100            | 29.65      | 23.40                        | 38.43                        | 38.56          | 38.81          | 38.60            | 12         | 34.0                 | 756.4                 | 367                                       | 5.5                       | 79                   | 85                    | 101        | 15.45                          | 1.13           | 15.4   | 0.947                         | 40.2    | 8.83      | 922.2           | 18.18         | 460        | 1.00     | 34.9                 | 3.2006 | 0.8890   | 0.8696                |
| 2400            | 18         | 1.95                         | 113.94                       | 113.31         | 113.50         | 113.58           | 21         | 31.5                 | 756.8                 | 297                                       | 0.2                       | 79                   | 84                    | 99         | 4.48                           | 0.37           | 13.1   | 1.110                         | 13.3    | 3.35      | 306.1           | 21.18         | 394        | 0.34     | 12.2                 | 2.7812 | 0.9282   | 0.9156                |
| 2400            | 21         | 3.10                         | 94.84                        | 94.41          | 95.31          | 94.85            | 20         | 32.0                 | 756.8                 | 329                                       | 0.9                       | 77                   | 84                    | 100        | 5.64                           | 0.44           | 13.8   | 1.055                         | 16.9    | 4.25      | 388.2           | 22.24         | 376        | 0.41     | 15.3                 | 2.8610 | 0.9202   | 0.9062                |
| 2400            | 24         | 5.20                         | 85.97                        | 86.00          | 85.84          | 85.94            | 18         | 34.0                 | 753.3                 | 356                                       | 1.0                       | 82                   | 86                    | 94         | 7.28                           | 0.51           | 16.2   | 0.902                         | 22.5    | 5.65      | 516.6           | 25.80         | 324        | 0.45     | 19.5                 | 3.2006 | 0.8853   | 0.8653                |
| 2400            | 26         | 10.10                        | 70.06                        | 70.78          | 69.88          | 70.24            | 18         | 34.7                 | 755.5                 | 378                                       | 1.4                       | 76                   | 84                    | 101        | 10.14                          | 0.63           | 18.4   | 0.793                         | 27.3    | 6.85      | 625.8           | 25.33         | 330        | 0.55     | 23.3                 | 3.3275 | 0.8779   | 0.8565                |
| 2400            | 27         | 13.20                        | 56.34                        | 56.90          | 56.72          | 56.65            | 14         | 34.5                 | 754.5                 | 391                                       | 2.0                       | 79                   | 84                    | 106        | 11.60                          | 0.78           | 17.0   | 0.860                         | 31.1    | 7.83      | 715.0           | 23.39         | 357        | 0.68     | 26.7                 | 3.2908 | 0.8795   | 0.8584                |
| 2400            | 28         | 15.10                        | 47.71                        | 47.69          | 47.72          | 47.71            | 12         | 35.3                 | 755.9                 | 400                                       | 2.0                       | 73                   | 83                    | 104        | 12.39                          | 0.93           | 15.3   | 0.956                         | 35.9    | 9.03      | 824.9           | 22.47         | 372        | 0.81     | 30.4                 | 3.4396 | 0.8698   | 0.8471                |
| 2400            | 29.75      | 25.30                        | 37.47                        | 37.78          | 37.78          | 37.68            | 12         | 35.8                 | 755.7                 | 421                                       | 5.5                       | 78                   | 84                    | 107        | 16.02                          | 1.19           | 15.6   | 0.936                         | 43.7    | 10.99     | 1003.6          | 21.41         | 390        | 1.03     | 36.7                 | 3.5355 | 0.8627   | 0.8386                |

ตารางที่ ๑-4 (ต่อ) แสดงผลการทดสอบเครื่องยนต์ Daihatsu รุ่น AB 547cc ด้วย carburetor ที่รอบต่าง ๆ โดยใช้น้ำมันแก๊สโซลีนออกเทน 91 เป็นเชื้อเพลิง ปรับ Spark timing ที่ MBT เมทริกซ์ทดสอบรูปที่ 3-21

| speed(rev/min) | MAP(inHg) | P diff (mm H2O) | Fuel consumption 53 cc(sec) |                       |                     |                       | $\theta_s$ | Tb (kg) | Ambient |       | T <sub>exhaust</sub> (°C) | P <sub>exhaust</sub> (mmH2O) | Cooling |    | T <sub>oil</sub> (°C) | ma (g/sec) | m <sub>f</sub> <sup>corrected</sup> (g/sec) | Air/fuel ratio | $\phi$ | Tb <sup>corrected</sup> (N-m) | Pd (kW) | bmp (kPa) | $\eta_{th}$ (%) | bsfc (g/kW-h) | mf (g/sec) | Tb (N-m) | P <sub>v,table</sub> | k      | $\alpha$ |
|----------------|-----------|-----------------|-----------------------------|-----------------------|---------------------|-----------------------|------------|---------|---------|-------|---------------------------|------------------------------|---------|----|-----------------------|------------|---|----------------|--------|-------------------------------|---------|-----------|-----------------|---------------|------------|----------|----------------------|--------|----------|
|                |           |                 | T <sub>db</sub> (°C)        | P <sub>a</sub> (mmHg) | T <sub>m</sub> (°C) | T <sub>out</sub> (°C) |            |         |         |       |                           |                              |         |    |                       |            |   |                |        |                               |         |           |                 |               |            |          |                      |        |          |
| 2700           | 18        | 2.60            | 98.55                       | 99.28                 | 99.57               | 99.13                 | 21         | 3.50    | 32.9    | 756.8 | 329                       | 0.8                          | 75      | 82 | 101                   | 5.16       | 0.43  | 13.2           | 1.104  | 13.6                          | 3.85    | 312.4     | 20.72           | 403           | 0.39       | 12.1     | 3.0098               | 0.9060 | 0.8896   |
| 2700           | 21        | 4.20            | 82.47                       | 83.00                 | 83.31               | 82.93                 | 20         | 4.60    | 33.2    | 756.9 | 364                       | 1.5                          | 77      | 84 | 103                   | 6.55       | 0.52  | 14.0           | 1.039  | 18.0                          | 5.09    | 413.0     | 22.80           | 366           | 0.47       | 15.9     | 3.0608               | 0.9017 | 0.8844   |
| 2700           | 24        | 6.50            | 75.50                       | 75.94                 | 75.22               | 75.55                 | 20         | 5.58    | 36.2    | 755.4 | 383                       | 1.2                          | 70      | 82 | 105                   | 8.11       | 0.60  | 15.8           | 0.921  | 23.2                          | 6.56    | 532.7     | 25.46           | 328           | 0.51       | 19.3     | 3.6139               | 0.8568 | 0.8318   |
| 2700           | 26        | 12.30           | 58.69                       | 58.69                 | 58.22               | 58.53                 | 16         | 7.00    | 35.4    | 756.0 | 396                       | 1.7                          | 78      | 84 | 107                   | 11.18      | 0.76  | 16.9           | 0.863  | 28.6                          | 8.09    | 657.3     | 24.68           | 338           | 0.66       | 24.2     | 3.4586               | 0.8686 | 0.8456   |
| 2700           | 27        | 15.20           | 49.07                       | 49.88                 | 49.90               | 49.62                 | 14         | 7.73    | 35.3    | 754.5 | 414                       | 0.8                          | 77      | 83 | 107                   | 12.43      | 0.90  | 15.9           | 0.916  | 31.6                          | 8.94    | 726.3     | 23.10           | 362           | 0.78       | 26.7     | 3.4396               | 0.8681 | 0.8450   |
| 2700           | 28        | 19.40           | 39.09                       | 39.31                 | 39.16               | 39.19                 | 14         | 8.85    | 35.5    | 755.9 | 412                       | 1.5                          | 73      | 83 | 106                   | 14.04      | 1.14  | 14.2           | 1.027  | 36.3                          | 10.25   | 832.8     | 20.89           | 400           | 0.99       | 30.6     | 3.4777               | 0.8671 | 0.8438   |
| 2700           | 29.65     | 27.20           | 34.58                       | 35.15                 | 35.00               | 34.91                 | 12         | 10.63   | 35.6    | 755.5 | 440                       | 4.0                          | 79      | 84 | 110                   | 16.62      | 1.28  | 15.0           | 0.974  | 43.7                          | 12.35   | 1002.9    | 22.37           | 373           | 1.11       | 36.8     | 3.4969               | 0.8652 | 0.8416   |
| 3300           | 21        | 5.80            | 74.85                       | 74.78                 | 74.78               | 74.80                 | 24         | 4.40    | 34.5    | 756.9 | 393                       | 3.0                          | 76      | 83 | 108                   | 7.69       | 0.59  | 14.9           | 0.982  | 17.7                          | 6.10    | 405.4     | 24.15           | 346           | 0.52       | 15.2     | 3.2908               | 0.8824 | 0.8618   |
| 3300           | 24        | 8.10            | 64.75                       | 64.78                 | 64.72               | 64.75                 | 20         | 5.40    | 36.8    | 755.5 | 420                       | 0.1                          | 77      | 84 | 111                   | 9.05       | 0.70  | 15.1           | 0.964  | 22.7                          | 7.85    | 521.3     | 25.86           | 323           | 0.60       | 18.7     | 3.7344               | 0.8489 | 0.8224   |
| 3300           | 26        | 14.10           | 48.16                       | 48.84                 | 48.31               | 48.44                 | 15         | 6.88    | 36.3    | 756.0 | 438                       | 2.5                          | 77      | 84 | 107                   | 11.95      | 0.93  | 15.0           | 0.976  | 28.6                          | 9.89    | 657.4     | 24.60           | 339           | 0.80       | 23.8     | 3.6338               | 0.8562 | 0.8310   |
| 3300           | 27        | 20.10           | 39.37                       | 39.37                 | 39.97               | 39.57                 | 15         | 7.83    | 36.3    | 757.0 | 432                       | 4.2                          | 78      | 84 | 111                   | 14.27      | 1.14  | 14.6           | 1.001  | 32.5                          | 11.24   | 746.9     | 22.87           | 365           | 0.98       | 27.1     | 3.6338               | 0.8574 | 0.8324   |
| 3300           | 28        | 28.60           | 28.87                       | 29.03                 | 29.00               | 28.97                 | 18         | 8.85    | 35.4    | 756.2 | 420                       | 6.0                          | 75      | 83 | 111                   | 17.04      | 1.54  | 12.8           | 1.144  | 36.2                          | 12.50   | 830.8     | 18.87           | 443           | 1.34       | 30.6     | 3.4586               | 0.8688 | 0.8458   |
| 3300           | 29.25     | 37.50           | 25.47                       | 25.66                 | 25.65               | 25.59                 | 16         | 10.40   | 36.6    | 755.0 | 446                       | 6.0                          | 81      | 85 | 115                   | 19.48      | 1.78  | 12.9           | 1.133  | 43.6                          | 15.07   | 1001.1    | 19.68           | 424           | 1.51       | 36.0     | 3.6938               | 0.8510 | 0.8249   |
| 3900           | 24        | 11.70           | 52.13                       | 52.39                 | 52.28               | 52.27                 | 20         | 5.30    | 37.2    | 755.5 | 470                       | 3.8                          | 77      | 84 | 112                   | 10.87      | 0.88  | 14.7           | 0.994  | 22.5                          | 9.17    | 515.6     | 24.25           | 344           | 0.74       | 18.3     | 3.8166               | 0.8436 | 0.8162   |
| 3900           | 26        | 19.00           | 39.94                       | 40.28                 | 40.09               | 40.10                 | 17         | 6.65    | 36.8    | 756.0 | 461                       | 3.5                          | 79      | 85 | 107                   | 13.86      | 1.14  | 14.4           | 1.016  | 27.9                          | 11.41   | 641.5     | 23.31           | 358           | 0.96       | 23.0     | 3.7344               | 0.8495 | 0.8231   |
| 3900           | 27        | 27.80           | 31.43                       | 31.18                 | 31.28               | 31.30                 | 17         | 7.53    | 36.3    | 757.0 | 442                       | 5.5                          | 77      | 84 | 115                   | 16.78      | 1.44  | 13.6           | 1.076  | 31.3                          | 12.78   | 718.3     | 20.56           | 406           | 1.24       | 26.0     | 3.6338               | 0.8574 | 0.8324   |
| 3900           | 28        | 39.50           | 25.43                       | 25.50                 | 25.62               | 25.52                 | 18         | 8.60    | 36.3    | 756.5 | 440                       | 7.0                          | 79      | 85 | 116                   | 20.00      | 1.77  | 13.2           | 1.107  | 35.8                          | 14.60   | 821.0     | 19.15           | 436           | 1.52       | 29.7     | 3.6338               | 0.8568 | 0.8317   |
| 3900           | 29.2      | 52.00           | 21.21                       | 21.31                 | 21.40               | 21.31                 | 16         | 10.10   | 36.8    | 755.0 | 456                       | 9.0                          | 75      | 85 | 116                   | 22.93      | 2.14  | 12.6           | 1.156  | 42.5                          | 17.36   | 975.9     | 18.81           | 444           | 1.82       | 34.9     | 3.7344               | 0.8483 | 0.8218   |



ตารางที่ ๑-4 (ต่อ) แสดงผลการทดสอบเครื่องยนต์ Daihatsu รุ่น AB 547cc ด้วย carburetor ที่รอบต่าง ๆ โดยใช้แก๊สออกเทน 91 เป็นเชื้อเพลิง ปรับ Spark timing ที่ MBT เมทริกซ์ทดสอบรูปที่ 3-21

| speed (rev/min) | MAP (inHg) | P diff (mm H <sub>2</sub> O) | Fuel consumption 53 cc (sec) |                       |                      |                       | $\theta_s$ | T <sub>b</sub> (kg) | Ambient              |                       | P <sub>exhaust</sub> (inH <sub>2</sub> O) | T <sub>exhaust</sub> (°C) | Cooling |    | T <sub>oil</sub> (°C) | ma (g/sec) | m <sub>f</sub> <sup>corrected</sup> (g/sec) | Air/fuel ratio | $\phi$ | T <sub>D</sub> <sup>corrected</sup> (N-m) | P <sub>b</sub> (kW) | b <sub>mep</sub> (kPa) | $\eta_{th}$ (%) | bsfc (g/kW-h) | mf (g/sec) | N (N-m) | P <sub>v,table</sub> | k      | $\alpha$ |
|-----------------|------------|------------------------------|------------------------------|-----------------------|----------------------|-----------------------|------------|---------------------|----------------------|-----------------------|---|---------------------------|---------|----|-----------------------|------------|---|----------------|--------|---|---------------------|------------------------|-----------------|---------------|------------|---------|----------------------|--------|----------|
|                 |            |                              | T <sub>db</sub> (°C)         | P <sub>a</sub> (mmHg) | T <sub>in</sub> (°C) | T <sub>out</sub> (°C) |            |                     | T <sub>in</sub> (°C) | T <sub>out</sub> (°C) |   |                           |         |    |                       |            |   |                |        |   |                     |                        |                 |               |            |         |                      |        |          |
| 1500            | 18         | 0.50                         | t <sub>1</sub>               | t <sub>2</sub>        | t <sub>3</sub>       | t <sub>vvg</sub>      | 16         | 2.33                | 30.8                 | 758.0                 | 230                                       | 230                       | 77      | 80 | 83                    | 2.27       | 0.21  | 11.4           | 1.276  | 8.7                                       | 1.36                | 198.7                  | 14.96           | 558           | 0.20       | 8.1     | 2.6726               | 0.9412 | 0.9310   |
| 1500            | 21         | 0.90                         | 195.00                       | 159.97                | 194.00               | 194.99                | 14         | 3.65                | 31.4                 | 758.0                 | 267                                       | 267                       | 74      | 78 | 86                    | 3.04       | 0.26  | 12.6           | 1.154  | 13.7                                      | 2.16                | 315.3                  | 19.37           | 431           | 0.24       | 12.6    | 2.7654               | 0.9313 | 0.9193   |
| 1500            | 24         | 1.80                         | 126.75                       | 127.97                | 126.81               | 127.18                | 12         | 5.13                | 32.6                 | 757.8                 | 297                                       | 297                       | 72      | 77 | 87                    | 4.30       | 0.33  | 14.1           | 1.034  | 19.8                                      | 3.11                | 454.4                  | 21.62           | 386           | 0.30       | 17.7    | 2.9595               | 0.9119 | 0.8965   |
| 1500            | 26         | 3.40                         | 122.22                       | 122.25                | 122.50               | 122.32                | 14         | 5.85                | 32.4                 | 757.5                 | 288                                       | 288                       | 78      | 83 | 93                    | 5.91       | 0.34  | 18.7           | 0.782  | 21.7                                      | 3.41                | 498.5                  | 23.56           | 354           | 0.32       | 20.2    | 2.9429               | 0.9420 | 0.9319   |
| 1500            | 27         | 4.40                         | 125.85                       | 125.63                | 125.16               | 125.55                | 14         | 6.00                | 32.2                 | 757.6                 | 290                                       | 290                       | 78      | 82 | 94                    | 6.72       | 0.34  | 21.8           | 0.670  | 23.0                                      | 3.61                | 527.5                  | 24.93           | 335           | 0.31       | 20.7    | 2.8935               | 0.9175 | 0.9031   |
| 1500            | 28         | 6.60                         | 102.03                       | 102.32                | 102.22               | 102.19                | 10         | 7.35                | 32.2                 | 757.8                 | 321                                       | 321                       | 78      | 84 | 93                    | 8.23       | 0.41  | 21.7           | 0.672  | 28.1                                      | 4.42                | 645.6                  | 24.85           | 336           | 0.38       | 25.4    | 2.8935               | 0.9182 | 0.9039   |
| 1500            | 29.8       | 12.80                        | 61.07                        | 61.07                 | 61.15                | 61.10                 | 10         | 8.85                | 32.2                 | 757.8                 | 303                                       | 303                       | 75      | 80 | 89                    | 11.46      | 0.69  | 18.1           | 0.807  | 33.9                                      | 5.32                | 777.4                  | 17.89           | 467           | 0.63       | 30.6    | 2.8935               | 0.9182 | 0.9039   |
| 1800            | 18         | 1.20                         | 151.22                       | 152.10                | 152.78               | 152.03                | 18         | 2.45                | 32.4                 | 756.5                 | 275                                       | 275                       | 73      | 77 | 84                    | 3.51       | 0.28  | 13.8           | 1.059  | 9.4                                       | 1.78                | 216.6                  | 14.81           | 564           | 0.25       | 8.5     | 2.9429               | 0.9133 | 0.8982   |
| 1800            | 21         | 1.80                         | 124.72                       | 125.50                | 124.00               | 124.74                | 16         | 3.85                | 33.9                 | 756.4                 | 292                                       | 292                       | 69      | 73 | 89                    | 4.29       | 0.35  | 13.8           | 1.056  | 15.3                                      | 2.88                | 350.8                  | 19.18           | 435           | 0.31       | 13.3    | 3.1829               | 0.8906 | 0.8714   |
| 1800            | 24         | 2.80                         | 103.44                       | 103.44                | 104.00               | 103.63                | 16         | 5.18                | 33.6                 | 756.5                 | 313                                       | 313                       | 72      | 76 | 90                    | 5.35       | 0.42  | 14.3           | 1.019  | 20.4                                      | 3.85                | 469.1                  | 21.42           | 390           | 0.37       | 17.9    | 3.1301               | 0.8951 | 0.8768   |
| 1800            | 26         | 5.30                         | 104.23                       | 103.66                | 103.69               | 103.86                | 16         | 5.90                | 33.6                 | 756.4                 | 337                                       | 337                       | 73      | 78 | 92                    | 7.36       | 0.42  | 19.8           | 0.739  | 23.3                                      | 4.39                | 534.4                  | 24.45           | 342           | 0.37       | 20.4    | 3.1301               | 0.8950 | 0.8766   |
| 1800            | 27         | 7.20                         | 92.72                        | 93.81                 | 93.75                | 93.43                 | 16         | 6.73                | 34.8                 | 756.4                 | 353                                       | 353                       | 71      | 77 | 95                    | 8.56       | 0.47  | 20.7           | 0.706  | 27.2                                      | 5.12                | 624.3                  | 25.19           | 332           | 0.41       | 23.3    | 3.3459               | 0.8775 | 0.8560   |
| 1800            | 28         | 8.30                         | 76.72                        | 76.46                 | 76.87                | 76.68                 | 14         | 7.93                | 34.8                 | 756.4                 | 360                                       | 360                       | 73      | 79 | 96                    | 9.19       | 0.58  | 18.2           | 0.802  | 32.0                                      | 6.04                | 735.6                  | 24.37           | 343           | 0.50       | 27.4    | 3.3459               | 0.8775 | 0.8560   |
| 1800            | 29.7       | 19.20                        | 50.00                        | 50.09                 | 50.66                | 50.25                 | 14         | 9.13                | 36.1                 | 756.2                 | 359                                       | 359                       | 70      | 76 | 96                    | 13.95      | 0.90  | 18.1           | 0.806  | 37.8                                      | 7.13                | 868.7                  | 18.46           | 452           | 0.77       | 31.6    | 3.5942               | 0.8591 | 0.8345   |

ตารางที่ ๑-4 (ต่อ) แสดงผลการทดสอบเครื่องยนต์ Daihatsu รุ่น AB 547cc ด้วย carburetor ที่รอบต่าง ๆ โดยใช้น้ำมันแก๊ซลิ้นออกแทน 91 เป็นเชื้อเพลิง ปรับ Spark timing ที่ MBT เมทริกซ์ทดสอบรูปที่ 3-21

| speed(rev/min) | MAP(inHg) | P diff (mm H2O) | Fuel consumption 53 cc(sec) |                       |                      |                       | $\theta_s$ | Tb (kg) | Ambient        |                | T <sub>exhaust</sub> (°C) | P <sub>exhaust</sub> (inH2O) | Cooling        |                  | T <sub>oil</sub> (°C) | ma (g/sec) | m <sub>corrected</sub> (g/sec) | Air/fuel ratio | $\phi$ | Tb <sub>corrected</sub> (N-m) | Pb (kW) | bmp (kPa) | $\eta_{th}$ (%) | bsfc (g/kW-h) | mf (g/sec) | Tb (N-m) | P <sub>v,table</sub> | k      | $\alpha$ |
|----------------|-----------|-----------------|-----------------------------|-----------------------|----------------------|-----------------------|------------|---------|----------------|----------------|---------------------------|------------------------------|----------------|------------------|-----------------------|------------|--------------------------------|----------------|--------|-------------------------------|---------|-----------|-----------------|---------------|------------|----------|----------------------|--------|----------|
|                |           |                 | T <sub>amb</sub> (°C)       | P <sub>a</sub> (mmHg) | T <sub>in</sub> (°C) | T <sub>out</sub> (°C) |            |         | t <sub>1</sub> | t <sub>2</sub> |                           |                              | t <sub>3</sub> | t <sub>avg</sub> |                       |            |                                |                |        |                               |         |           |                 |               |            |          |                      |        |          |
| 2100           | 18        | 1.40            | 129.21                      | 129.56                | 130.65               | 129.81                | 20         | 2.63    | 33.6           | 756.0          | 285                       | 0.5                          | 68             | 72               | 89                    | 3.78       | 0.33                           | 12.7           | 1.151  | 10.4                          | 2.28    | 238.4     | 15.90           | 525           | 0.30       | 9.1      | 3.1301               | 0.8945 | 0.8761   |
| 2100           | 21        | 2.40            | 107.28                      | 107.97                | 105.94               | 107.06                | 18         | 3.95    | 33.9           | 756.4          | 317                       | 0.8                          | 71             | 75               | 92                    | 4.95       | 0.41                           | 13.7           | 1.066  | 15.7                          | 3.45    | 359.9     | 19.71           | 424           | 0.36       | 13.7     | 3.1829               | 0.8906 | 0.8714   |
| 2100           | 24        | 4.40            | 97.18                       | 97.28                 | 97.98                | 97.48                 | 18         | 5.18    | 35.7           | 753.0          | 345                       | 0.9                          | 71             | 76               | 96                    | 6.68       | 0.46                           | 16.8           | 0.867  | 21.4                          | 4.71    | 491.7     | 23.70           | 352           | 0.40       | 17.9     | 3.5162               | 0.8608 | 0.8365   |
| 2100           | 26        | 8.20            | 89.90                       | 90.94                 | 91.53                | 90.79                 | 18         | 6.00    | 35.5           | 756.4          | 361                       | 1.2                          | 72             | 76               | 96                    | 9.12       | 0.49                           | 21.4           | 0.682  | 24.6                          | 5.40    | 564.1     | 25.52           | 327           | 0.43       | 20.7     | 3.4777               | 0.8676 | 0.8445   |
| 2100           | 27        | 10.60           | 73.10                       | 74.63                 | 74.57                | 74.10                 | 16         | 7.23    | 35.7           | 756.4          | 384                       | 1.8                          | 73             | 79               | 99                    | 10.37      | 0.60                           | 19.9           | 0.735  | 29.7                          | 6.54    | 682.4     | 25.12           | 333           | 0.52       | 25.0     | 3.5162               | 0.8649 | 0.8412   |
| 2100           | 28        | 12.20           | 63.25                       | 62.75                 | 63.72                | 63.24                 | 14         | 8.30    | 37.0           | 756.4          | 387                       | 2.5                          | 72             | 79               | 100                   | 11.10      | 0.72                           | 18.1           | 0.804  | 35.0                          | 7.69    | 803.2     | 24.72           | 338           | 0.61       | 28.7     | 3.7753               | 0.8473 | 0.8206   |
| 2100           | 29.7      | 24.50           | 41.25                       | 41.44                 | 41.41                | 41.37                 | 14         | 9.73    | 36.7           | 756.4          | 372                       | 4.4                          | 68             | 74               | 99                    | 15.74      | 1.10                           | 16.8           | 0.867  | 40.8                          | 8.97    | 936.4     | 18.94           | 441           | 0.94       | 33.6     | 3.7344               | 0.8511 | 0.8250   |
| 2400           | 18        | 2.20            | 110.28                      | 110.16                | 110.00               | 110.15                | 18         | 2.73    | 34.4           | 756.6          | 322                       | 0.4                          | 74             | 77               | 93                    | 4.73       | 0.40                           | 13.5           | 1.083  | 10.9                          | 2.75    | 251.1     | 16.04           | 521           | 0.35       | 9.4      | 3.2726               | 0.8835 | 0.8631   |
| 2400           | 21        | 3.20            | 92.40                       | 91.59                 | 92.15                | 92.05                 | 16         | 4.23    | 35.0           | 756.6          | 348                       | 0.7                          | 70             | 74               | 96                    | 5.70       | 0.48                           | 13.6           | 1.076  | 17.1                          | 4.31    | 393.7     | 20.81           | 401           | 0.42       | 14.6     | 3.3831               | 0.8749 | 0.8530   |
| 2400           | 24        | 6.20            | 82.53                       | 82.78                 | 82.69                | 82.67                 | 16         | 5.40    | 35.8           | 756.6          | 377                       | 1.1                          | 73             | 77               | 98                    | 7.93       | 0.54                           | 16.9           | 0.862  | 22.2                          | 5.59    | 510.5     | 23.93           | 349           | 0.47       | 18.7     | 3.5355               | 0.8637 | 0.8399   |
| 2400           | 26        | 11.20           | 69.66                       | 69.97                 | 69.25                | 69.63                 | 14         | 6.73    | 37.5           | 756.5          | 404                       | 0.8                          | 71             | 76               | 102                   | 10.63      | 0.66                           | 19.1           | 0.763  | 28.6                          | 7.19    | 657.3     | 25.26           | 331           | 0.56       | 23.3     | 3.8792               | 0.8408 | 0.8130   |
| 2400           | 27        | 14.00           | 55.50                       | 56.00                 | 55.47                | 55.66                 | 12         | 7.68    | 36.4           | 756.5          | 408                       | 2.0                          | 73             | 79               | 101                   | 11.91      | 0.81                           | 17.1           | 0.852  | 32.0                          | 8.04    | 734.6     | 22.96           | 364           | 0.70       | 26.6     | 3.6537               | 0.8554 | 0.8301   |
| 2400           | 28        | 16.00           | 42.65                       | 42.72                 | 42.78                | 42.72                 | 12         | 8.83    | 36.6           | 756.5          | 409                       | 3.0                          | 71             | 76               | 101                   | 12.72      | 1.06                           | 14.0           | 1.039  | 36.9                          | 9.28    | 847.8     | 20.27           | 412           | 0.91       | 30.5     | 3.6938               | 0.8527 | 0.8270   |
| 2400           | 29.6      | 24.80           | 38.78                       | 38.66                 | 38.54                | 38.66                 | 12         | 10.68   | 37.0           | 756.5          | 438                       | 2.5                          | 73             | 80               | 103                   | 15.83      | 1.18                           | 15.8           | 0.923  | 45.0                          | 11.31   | 1033.3    | 22.22           | 376           | 1.00       | 36.9     | 3.7753               | 0.8474 | 0.8207   |



ตารางที่ ๑-4 (ต่อ) แสดงผลการทดสอบเครื่องยนต์ Daihatsu รุ่น AB 547cc ด้วย carburetor ที่รอบต่าง ๆ โดยใช้น้ำมันแก๊สซินออกเทน 91 เป็นเชื้อเพลิง ปรับ Spark timing ที่ MBT เมทริกซ์ทดสอบรูปที่ 3-21

| speed (rev/min) | MAP (inHg) | P diff (mm H2O) | Fuel consumption 53 cc (sec) |                |                |                  | $\theta_s$ | Ambient              |                       | P <sub>exhaust</sub> (inH2O) | Cooling              |                       | T <sub>oil</sub> (°C) | ma (g/sec) | m <sub>f</sub> <sup>corrected</sup> (g/sec) | Air/fuel ratio | $\phi$ | Tb <sup>corrected</sup> (N-m) | Pd (kW) | bmep (kPa) | $\eta_{ih}$ (%) | bsfc (g/kW-h) | mf (g/sec) | Tb (N-m) | P <sub>v,iable</sub> | k      | $\alpha$ |                           |
|-----------------|------------|-----------------|------------------------------|----------------|----------------|------------------|------------|----------------------|-----------------------|------------------------------|----------------------|-----------------------|-----------------------|------------|---|----------------|--------|-------------------------------|---------|------------|-----------------|---------------|------------|----------|----------------------|--------|----------|---------------------------|
|                 |            |                 | t <sub>1</sub>               | t <sub>2</sub> | t <sub>3</sub> | t <sub>avg</sub> |            | T <sub>db</sub> (°C) | P <sub>a</sub> (mmHg) |                              | T <sub>in</sub> (°C) | T <sub>out</sub> (°C) |                       |            |   |                |        |                               |         |            |                 |               |            |          |                      |        |          | T <sub>exhaust</sub> (°C) |
| 2700            | 18         | 2.60            | 98.55                        | 99.28          | 99.57          | 99.13            | 21         | 32.9                 | 756.8                 | 329                          | 82                   | 75                    | 82                    | 101        | 5.16  | 0.43           | 13.2   | 1.104                         | 13.6    | 3.85       | 312.4           | 20.72         | 403        | 0.39     | 12.1                 | 3.0098 | 0.9060   | 0.8896                    |
| 2700            | 21         | 4.20            | 82.47                        | 83.00          | 83.31          | 82.93            | 20         | 33.2                 | 756.9                 | 364                          | 84                   | 77                    | 84                    | 103        | 6.55  | 0.52           | 14.0   | 1.039                         | 18.0    | 5.09       | 413.0           | 22.80         | 366        | 0.47     | 15.9                 | 3.0608 | 0.9017   | 0.8844                    |
| 2700            | 24         | 6.50            | 75.50                        | 75.94          | 75.22          | 75.55            | 20         | 36.2                 | 755.4                 | 383                          | 82                   | 70                    | 82                    | 105        | 8.11  | 0.60           | 15.8   | 0.921                         | 23.2    | 6.56       | 532.7           | 25.46         | 328        | 0.51     | 19.3                 | 3.6139 | 0.8568   | 0.8318                    |
| 2700            | 26         | 12.30           | 58.69                        | 58.69          | 58.22          | 58.53            | 16         | 35.4                 | 756.0                 | 396                          | 78                   | 84                    | 107                   | 11.18      | 0.76  | 16.9           | 0.863  | 28.6                          | 8.09    | 657.3      | 24.68           | 338           | 0.66       | 24.2     | 3.4586               | 0.8686 | 0.8456   |                           |
| 2700            | 27         | 15.20           | 49.07                        | 49.88          | 49.90          | 49.62            | 14         | 35.3                 | 754.5                 | 414                          | 83                   | 77                    | 83                    | 107        | 12.43                                       | 0.90           | 15.9   | 0.916                         | 31.6    | 8.94       | 726.3           | 23.10         | 362        | 0.78     | 26.7                 | 3.4396 | 0.8681   | 0.8450                    |
| 2700            | 28         | 19.40           | 39.09                        | 39.31          | 39.16          | 39.19            | 14         | 35.5                 | 755.9                 | 412                          | 83                   | 73                    | 83                    | 106        | 14.04                                       | 1.14           | 14.2   | 1.027                         | 36.3    | 10.25      | 832.8           | 20.89         | 400        | 0.99     | 30.6                 | 3.4777 | 0.8671   | 0.8438                    |
| 2700            | 29.65      | 27.20           | 34.58                        | 35.15          | 35.00          | 34.91            | 12         | 35.6                 | 755.5                 | 440                          | 84                   | 79                    | 84                    | 110        | 16.62                                       | 1.28           | 15.0   | 0.974                         | 43.7    | 12.95      | 1002.9          | 22.37         | 373        | 1.11     | 36.8                 | 3.4969 | 0.8652   | 0.8416                    |
| 3300            | 21         | 5.80            | 74.85                        | 74.78          | 74.78          | 74.80            | 24         | 34.5                 | 756.9                 | 393                          | 83                   | 76                    | 83                    | 108        | 7.69  | 0.59           | 14.9   | 0.982                         | 17.7    | 6.10       | 405.4           | 24.15         | 346        | 0.52     | 15.2                 | 3.2908 | 0.8824   | 0.8618                    |
| 3300            | 24         | 8.10            | 64.75                        | 64.78          | 64.72          | 64.75            | 20         | 36.8                 | 755.5                 | 420                          | 84                   | 77                    | 84                    | 111        | 9.05  | 0.70           | 15.1   | 0.964                         | 22.7    | 7.85       | 521.3           | 25.86         | 323        | 0.60     | 18.7                 | 3.7344 | 0.8489   | 0.8224                    |
| 3300            | 26         | 14.10           | 48.16                        | 48.84          | 48.31          | 48.44            | 15         | 36.3                 | 756.0                 | 438                          | 84                   | 77                    | 84                    | 107        | 11.95                                       | 0.93           | 15.0   | 0.976                         | 28.6    | 9.89       | 657.4           | 24.60         | 339        | 0.80     | 23.8                 | 3.6338 | 0.8562   | 0.8310                    |
| 3300            | 27         | 20.10           | 39.37                        | 39.37          | 39.97          | 39.57            | 15         | 36.3                 | 757.0                 | 432                          | 84                   | 78                    | 84                    | 111        | 14.27                                       | 1.14           | 14.6   | 1.001                         | 32.5    | 11.24      | 746.9           | 22.87         | 365        | 0.98     | 27.1                 | 3.6338 | 0.8574   | 0.8324                    |
| 3300            | 28         | 28.60           | 28.87                        | 29.03          | 29.00          | 28.97            | 18         | 35.4                 | 756.2                 | 420                          | 83                   | 75                    | 83                    | 111        | 17.04                                       | 1.54           | 12.8   | 1.144                         | 36.2    | 12.50      | 830.8           | 18.87         | 443        | 1.34     | 30.6                 | 3.4586 | 0.8688   | 0.8458                    |
| 3300            | 29.25      | 37.50           | 25.47                        | 25.66          | 25.65          | 25.59            | 16         | 36.6                 | 755.0                 | 446                          | 85                   | 81                    | 85                    | 115        | 19.48                                       | 1.78           | 12.9   | 1.133                         | 43.6    | 15.07      | 1001.1          | 19.68         | 424        | 1.51     | 36.0                 | 3.6938 | 0.8510   | 0.8249                    |
| 3900            | 24         | 11.70           | 52.13                        | 52.39          | 52.28          | 52.27            | 20         | 37.2                 | 755.5                 | 470                          | 84                   | 77                    | 84                    | 112        | 10.87                                       | 0.88           | 14.7   | 0.994                         | 22.5    | 9.17       | 515.6           | 24.25         | 344        | 0.74     | 18.3                 | 3.8166 | 0.8436   | 0.8162                    |
| 3900            | 26         | 19.00           | 39.94                        | 40.28          | 40.09          | 40.10            | 17         | 36.8                 | 756.0                 | 461                          | 85                   | 79                    | 85                    | 107        | 13.86                                       | 1.14           | 14.4   | 1.016                         | 27.9    | 11.41      | 641.5           | 23.31         | 358        | 0.96     | 23.0                 | 3.7344 | 0.8495   | 0.8231                    |
| 3900            | 27         | 27.80           | 31.43                        | 31.18          | 31.28          | 31.30            | 17         | 36.3                 | 757.0                 | 442                          | 84                   | 77                    | 84                    | 115        | 16.78                                       | 1.44           | 13.6   | 1.076                         | 31.3    | 12.78      | 718.3           | 20.56         | 406        | 1.24     | 26.0                 | 3.6338 | 0.8574   | 0.8324                    |
| 3900            | 28         | 39.50           | 25.43                        | 25.50          | 25.62          | 25.52            | 18         | 36.3                 | 756.5                 | 440                          | 85                   | 79                    | 85                    | 116        | 20.00                                       | 1.77           | 13.2   | 1.107                         | 35.8    | 14.60      | 821.0           | 19.15         | 436        | 1.52     | 29.7                 | 3.6338 | 0.8568   | 0.8317                    |
| 3900            | 29.2       | 52.00           | 21.21                        | 21.31          | 21.40          | 21.31            | 16         | 36.8                 | 755.0                 | 456                          | 85                   | 75                    | 85                    | 116        | 22.93                                       | 2.14           | 12.6   | 1.156                         | 42.5    | 17.36      | 975.9           | 18.81         | 444        | 1.82     | 34.9                 | 3.7344 | 0.8483   | 0.8218                    |



ตารางที่ จ-5 แสดงผลการทดสอบเครื่องยนต์ Daihatsu รุ่น AB 547cc ด้วย gas mixer ชนิดผสมคาร์บอเนต carburetor ที่รอบต่าง ๆ โดยใช้เชื้อเพลิงแก๊สผสมที่มี มีเทนและ CO<sub>2</sub> เป็นองค์ประกอบหลัก (แก้สูตรมาจากชาวไทย) ปรับ Spark timing ที่ MBT เมทริกซ์ทดสอบรูปที่ 3-22

| speed (rev/min) | MAP (inHg) | P diff (mm H2O) | Fuel consumption 1 ft <sup>3</sup> (sec) |                       |                      |                       | θ <sub>s</sub> | Tb (kg) | Ambient              |                       | T <sub>exhaust</sub> (°C) | P <sub>exhaust</sub> (inH2O) | Cooling                |                     | T <sub>oil</sub> (°C) | Gas cond. |      | ma (g/sec) | m <sub>corrected</sub> (g/sec) | Air/Fuel ratio | φ     | Tb <sub>corrected</sub> (N-m) | Pb (kW) | bmep (Kpa) | η <sub>m</sub> (%) | basc (g/kW-h) | gas density (kg/m <sup>3</sup> ) | mf (g/sec) | Tb (N-m) | P <sub>v,table</sub> | k      | α      |
|-----------------|------------|-----------------|--|-----------------------|----------------------|-----------------------|----------------|---------|----------------------|-----------------------|---------------------------|------------------------------|------------------------|---------------------|-----------------------|-----------|------|------------|--------------------------------|----------------|-------|-------------------------------|---------|------------|--------------------|---------------|----------------------------------|------------|----------|----------------------|--------|--------|
|                 |            |                 | T <sub>amb</sub> (°C)                    | P <sub>a</sub> (mmHg) | T <sub>in</sub> (°C) | T <sub>out</sub> (°C) |                |         | T <sub>in</sub> (°C) | T <sub>out</sub> (°C) |                           |                              | P <sub>g</sub> (inH2O) | T <sub>g</sub> (°C) |                       |           |      |            |                                |                |       |                               |         |            |                    |               |                                  |            |          |                      |        |        |
| 1500            | 24         | 1.80            | 73.81                                    | 73.84                 | 73.88                | 73.84                 | 22             | 2.58    | 30.2                 | 757.8                 | 220                       | 0.8                          | 73                     | 76                  | 87                    | 27.6      | -0.3 | 4.31       | 0.37                           | 12.4           | 0.932 | 9.6                           | 1.50    | 219.3      | 12.14              | 887           | 0.910                            | 0.35       | 8.9      | 2.5825               | 0.9439 | 0.9341 |
| 1500            | 25         | 2.30            | 65.87                                    | 65.81                 | 65.93                | 65.87                 | 18             | 3.13    | 30.2                 | 757.8                 | 239                       | 0.9                          | 79                     | 82                  | 86                    | 27.4      | -0.3 | 4.87       | 0.41                           | 12.5           | 0.925 | 11.6                          | 1.82    | 266.0      | 13.13              | 820           | 0.910                            | 0.39       | 10.8     | 2.5825               | 0.9439 | 0.9341 |
| 1500            | 26         | 3.00            | 57.00                                    | 57.07                 | 56.98                | 57.02                 | 14             | 4.03    | 30.6                 | 757.9                 | 250                       | 1.2                          | 80                     | 83                  | 86                    | 26.6      | -0.3 | 5.56       | 0.48                           | 12.3           | 0.939 | 15.1                          | 2.36    | 345.7      | 14.61              | 737           | 0.913                            | 0.45       | 13.9     | 2.6423               | 0.9367 | 0.9256 |
| 1500            | 27         | 3.90            | 49.06                                    | 49.09                 | 49.13                | 49.09                 | 14             | 5.03    | 31.6                 | 757.8                 | 273                       | 1.9                          | 79                     | 83                  | 87                    | 26.3      | -0.3 | 6.33       | 0.57                           | 12.0           | 0.959 | 19.2                          | 3.02    | 441.6      | 15.75              | 684           | 0.914                            | 0.53       | 17.4     | 2.7970               | 0.9186 | 0.9044 |
| 1500            | 28         | 4.90            | 41.94                                    | 41.97                 | 42.00                | 41.97                 | 14             | 6.10    | 31.4                 | 757.7                 | 287                       | 2.3                          | 82                     | 83                  | 97                    | 26.2      | -0.4 | 7.10       | 0.67                           | 11.5           | 1.000 | 23.2                          | 3.65    | 533.2      | 16.31              | 660           | 0.914                            | 0.62       | 21.1     | 2.7654               | 0.9220 | 0.9084 |
| 1500            | 29.3       | 9.40            | 32.94                                    | 32.91                 | 33.03                | 32.96                 | 14             | 7.05    | 30.0                 | 757.7                 | 302                       | 1.7                          | 82                     | 89                  | 90                    | 26.3      | -0.5 | 9.86       | 0.83                           | 12.6           | 0.917 | 26.0                          | 4.08    | 596.5      | 14.74              | 730           | 0.913                            | 0.78       | 24.4     | 2.5531               | 0.9477 | 0.9385 |
| 1800            | 24         | 2.70            | 56.50                                    | 56.56                 | 56.52                | 56.52                 | 22             | 2.98    | 29.8                 | 759.5                 | 262                       | 1.3                          | 76                     | 79                  | 90                    | 26.2      | -0.3 | 5.29       | 0.48                           | 11.5           | 0.998 | 10.9                          | 2.05    | 250.3      | 12.80              | 841           | 0.914                            | 0.46       | 10.3     | 2.5239               | 0.9534 | 0.9452 |
| 1800            | 25         | 3.50            | 51.88                                    | 51.82                 | 51.81                | 51.84                 | 20             | 3.58    | 29.6                 | 759.5                 | 270                       | 1.4                          | 75                     | 79                  | 92                    | 25.6      | -0.3 | 6.02       | 0.52                           | 12.0           | 0.957 | 13.0                          | 2.46    | 299.3      | 14.06              | 766           | 0.916                            | 0.50       | 12.4     | 2.4951               | 0.9572 | 0.9498 |
| 1800            | 26         | 4.60            | 46.27                                    | 46.25                 | 46.28                | 46.27                 | 16             | 4.38    | 29.1                 | 759.5                 | 292                       | 1.6                          | 75                     | 79                  | 93                    | 25        | -0.4 | 6.91       | 0.58                           | 12.3           | 0.937 | 15.8                          | 2.97    | 361.8      | 15.30              | 704           | 0.918                            | 0.56       | 15.1     | 2.4242               | 0.9670 | 0.9612 |
| 1800            | 27         | 5.80            | 39.37                                    | 39.38                 | 39.40                | 39.38                 | 14             | 5.43    | 30.3                 | 759.5                 | 322                       | 1.9                          | 74                     | 79                  | 93                    | 24.4      | -0.4 | 7.74       | 0.70                           | 11.7           | 0.984 | 20.1                          | 3.79    | 461.6      | 16.18              | 665           | 0.919                            | 0.66       | 18.8     | 2.5974               | 0.9439 | 0.9341 |
| 1800            | 28         | 7.00            | 33.75                                    | 33.75                 | 33.78                | 33.76                 | 14             | 6.43    | 29.9                 | 759.5                 | 338                       | 2.1                          | 76                     | 81                  | 90                    | 24.2      | -0.5 | 8.51       | 0.81                           | 11.0           | 1.045 | 23.6                          | 4.44    | 541.4      | 16.39              | 657           | 0.920                            | 0.77       | 22.2     | 2.5385               | 0.9515 | 0.9430 |
| 1800            | 29         | 9.40            | 28.22                                    | 28.21                 | 28.25                | 28.23                 | 14             | 7.10    | 29.8                 | 759.5                 | 345                       | 2.5                          | 70                     | 76                  | 81                    | 24.7      | -0.5 | 9.86       | 0.97                           | 10.7           | 1.076 | 26.0                          | 4.90    | 596.4      | 15.16              | 710           | 0.918                            | 0.92       | 24.6     | 2.5239               | 0.9534 | 0.9452 |
| 2100            | 24         | 4.00            | 47.28                                    | 47.25                 | 47.22                | 47.25                 | 24             | 3.28    | 32.2                 | 757.7                 | 285                       | 0.6                          | 75                     | 79                  | 95                    | 26.7      | -0.4 | 6.41       | 0.60                           | 11.7           | 0.983 | 12.7                          | 2.80    | 292.0      | 13.89              | 775           | 0.912                            | 0.55       | 11.3     | 2.8935               | 0.9081 | 0.8920 |
| 2100            | 25         | 5.40            | 42.03                                    | 41.97                 | 41.94                | 41.98                 | 20             | 4.00    | 33.0                 | 757.7                 | 306                       | 0.8                          | 75                     | 79                  | 97                    | 27.8      | -0.4 | 7.43       | 0.69                           | 12.1           | 0.950 | 15.8                          | 3.47    | 362.5      | 15.15              | 711           | 0.909                            | 0.61       | 13.8     | 3.0267               | 0.8947 | 0.8763 |
| 2100            | 26         | 7.20            | 36.66                                    | 36.69                 | 36.69                | 36.68                 | 18             | 4.93    | 33.6                 | 757.7                 | 328                       | 1.0                          | 74                     | 80                  | 99                    | 29.6      | -0.4 | 8.58       | 0.79                           | 12.3           | 0.937 | 19.7                          | 4.34    | 452.7      | 16.45              | 654           | 0.903                            | 0.70       | 17.0     | 3.1301               | 0.8849 | 0.8648 |
| 2100            | 27         | 9.20            | 31.38                                    | 31.40                 | 31.47                | 31.42                 | 14             | 6.03    | 33.7                 | 757.7                 | 363                       | 1.2                          | 74                     | 80                  | 100                   | 30        | -0.5 | 9.69       | 0.92                           | 11.9           | 0.966 | 24.2                          | 5.32    | 555.1      | 17.27              | 623           | 0.902                            | 0.81       | 20.9     | 3.1829               | 0.8830 | 0.8625 |
| 2100            | 28         | 10.60           | 27.32                                    | 27.35                 | 27.34                | 27.34                 | 14             | 6.78    | 33.3                 | 757.7                 | 371                       | 1.6                          | 77                     | 83                  | 99                    | 29.8      | -0.6 | 10.41      | 1.05                           | 11.1           | 1.034 | 26.9                          | 5.92    | 618.5      | 16.86              | 639           | 0.902                            | 0.93       | 23.4     | 3.0780               | 0.8898 | 0.8705 |
| 2100            | 28.7       | 12.00           | 24.53                                    | 24.53                 | 24.56                | 24.54                 | 14             | 7.35    | 33.0                 | 757.7                 | 375                       | 1.6                          | 76                     | 81                  | 93                    | 29.6      | -0.7 | 11.08      | 1.16                           | 10.6           | 1.083 | 29.0                          | 6.38    | 666.0      | 16.38              | 657           | 0.903                            | 1.04       | 25.4     | 3.0267               | 0.8947 | 0.8763 |



ตารางที่ ๓-5 (ต่อ) แสดงผลการทดสอบเครื่องยนต์ Daihatsu รุ่น AB 547cc ด้วย gas mixer ชนิดผสมร่วมกับ carburetor ที่รอบต่าง ๆ โดยใช้เชื้อเพลิงแก๊สผสมที่มีเทนและ CO<sub>2</sub> เป็นองค์ประกอบหลัก (แก๊สธรรมชาติจากอ่าวไทย) ปรับ Spark timing ที่ MBT เมทริกซ์ทดสอบรูปที่ 3-22

| speed (rev/min) | MAP (inHg) | P diff (mm H2O) | Fuel consumption 1 ft <sup>3</sup> (sec) |                |                |                  | θ <sub>s</sub> | T <sub>b</sub> (kg) | Ambient               |                       | Cooling                   |                              | Gas cond.            |                       | ma (g/sec) | mf <sub>corrected</sub> (g/sec) | Air/fuel ratio | φ    | T <sub>d</sub> corrected (N-m) | P <sub>b</sub> (KW) | bmep (kPa) | η <sub>th</sub> (%) | bsfc (g/kw-h) | gas density (kg/m <sup>3</sup> ) | mf (g/sec) | T <sub>b</sub> (N-m) | P <sub>v,table</sub> | k      | α      |                     |
|-----------------|------------|-----------------|--|----------------|----------------|------------------|----------------|---------------------|-----------------------|-----------------------|---------------------------|------------------------------|----------------------|-----------------------|------------|---------------------------------|----------------|------|--------------------------------|---------------------|------------|---------------------|---------------|----------------------------------|------------|----------------------|----------------------|--------|--------|---------------------|
|                 |            |                 | t <sub>1</sub>                           | t <sub>2</sub> | t <sub>3</sub> | t <sub>avg</sub> |                |                     | T <sub>amb</sub> (°C) | P <sub>a</sub> (mmHg) | T <sub>exhaust</sub> (°C) | P <sub>exhaust</sub> (inH2O) | T <sub>in</sub> (°C) | T <sub>out</sub> (°C) |            |                                 |                |      |                                |                     |            |                     |               |                                  |            |                      |                      |        |        | T <sub>g</sub> (°C) |
| 2400            | 24         | 5.40            | 39.84                                    | 39.84          | 39.84          | 39.84            | 20             | 3.43                | 30.6                  | 760.0                 | 347                       | 0.5                          | 79                   | 99                    | 25         | -0.4                            | 7.46           | 11.3 | 1.024                          | 12.8                | 3.21       | 293.4               | 13.58         | 786                              | 0.927      | 0.66                 | 11.9                 | 2.6423 | 0.9390 | 0.9283              |
| 2400            | 25         | 7.40            | 35.56                                    | 35.63          | 35.58          | 35.58            | 18             | 4.30                | 30.6                  | 760.0                 | 363                       | 0.9                          | 77                   | 81                    | 100        | -0.5                            | 8.74           | 11.8 | 0.981                          | 16.0                | 4.03       | 367.8               | 15.18         | 703                              | 0.928      | 0.74                 | 14.9                 | 2.6423 | 0.9390 | 0.9283              |
| 2400            | 26         | 9.60            | 30.97                                    | 30.97          | 31.00          | 30.98            | 16             | 5.15                | 30.6                  | 760.0                 | 395                       | 1.2                          | 79                   | 83                    | 101        | -0.6                            | 9.95           | 11.7 | 0.991                          | 19.2                | 4.82       | 440.5               | 15.81         | 675                              | 0.929      | 0.85                 | 17.8                 | 2.6423 | 0.9390 | 0.9283              |
| 2400            | 27         | 11.60           | 26.50                                    | 26.53          | 26.51          | 26.51            | 16             | 6.00                | 31.0                  | 760.0                 | 405                       | 1.5                          | 76                   | 81                    | 100        | -0.6                            | 10.93          | 11.0 | 1.056                          | 22.6                | 5.67       | 518.0               | 15.76         | 677                              | 0.931      | 0.99                 | 20.7                 | 2.7033 | 0.9317 | 0.9197              |
| 2400            | 28         | 14.20           | 22.78                                    | 22.72          | 22.76          | 22.76            | 16             | 6.80                | 30.8                  | 760.0                 | 414                       | 7.7                          | 75                   | 80                    | 95         | -0.8                            | 12.10          | 10.5 | 1.110                          | 25.4                | 6.40       | 584.3               | 15.34         | 696                              | 0.930      | 1.16                 | 23.5                 | 2.6726 | 0.9353 | 0.9240              |
| 2400            | 28.3       | 14.70           | 22.25                                    | 22.25          | 22.25          | 22.25            | 16             | 6.93                | 30.1                  | 760.2                 | 417                       | 1.5                          | 79                   | 83                    | 86         | -0.8                            | 12.33          | 10.5 | 1.110                          | 25.5                | 6.41       | 585.9               | 15.30         | 698                              | 0.926      | 1.18                 | 24.0                 | 2.5974 | 0.9482 | 0.9392              |
| 2700            | 24         | 6.20            | 35.85                                    | 35.85          | 35.88          | 35.86            | 22             | 3.63                | 32.3                  | 758.0                 | 346                       | 1.2                          | 74                   | 78                    | 102        | -0.5                            | 7.98           | 11.1 | 1.037                          | 14.1                | 3.99       | 323.7               | 15.06         | 715                              | 0.909      | 0.72                 | 12.6                 | 2.9099 | 0.9067 | 0.8904              |
| 2700            | 25         | 8.00            | 32.28                                    | 32.28          | 32.25          | 32.27            | 20             | 4.30                | 32.8                  | 758.1                 | 365                       | 1.3                          | 79                   | 83                    | 104        | -0.5                            | 9.05           | 11.3 | 1.018                          | 16.9                | 4.77       | 387.7               | 16.04         | 671                              | 0.911      | 0.80                 | 14.9                 | 2.9929 | 0.8984 | 0.8806              |
| 2700            | 26         | 10.40           | 28.88                                    | 28.88          | 28.88          | 28.88            | 18             | 5.13                | 33.5                  | 758.1                 | 386                       | 1.6                          | 76                   | 81                    | 106        | -0.6                            | 10.31          | 11.5 | 1.003                          | 20.5                | 5.78       | 469.7               | 17.08         | 630                              | 0.916      | 0.90                 | 17.7                 | 3.1126 | 0.8869 | 0.8671              |
| 2700            | 27         | 13.80           | 24.16                                    | 24.16          | 24.17          | 24.17            | 16             | 6.18                | 32.7                  | 758.2                 | 407                       | 1.9                          | 77                   | 82                    | 104        | -0.7                            | 11.89          | 11.1 | 1.042                          | 24.2                | 6.85       | 555.9               | 17.14         | 628                              | 0.918      | 1.08                 | 21.4                 | 2.9762 | 0.9002 | 0.8827              |
| 2700            | 28         | 17.20           | 20.66                                    | 20.66          | 20.66          | 20.66            | 16             | 6.98                | 32.7                  | 758.2                 | 404                       | 2.5                          | 79                   | 83                    | 93         | -0.8                            | 13.28          | 10.6 | 1.086                          | 27.3                | 7.73       | 627.9               | 16.62         | 648                              | 0.913      | 1.25                 | 24.1                 | 2.9762 | 0.9002 | 0.8827              |
| 3000            | 24         | 6.80            | 32.16                                    | 32.13          | 32.15          | 32.15            | 22             | 3.63                | 31.3                  | 759.6                 | 365                       | 2.1                          | 79                   | 82                    | 106        | -0.5                            | 8.37           | 10.4 | 1.113                          | 13.8                | 4.32       | 315.7               | 14.80         | 728                              | 0.918      | 0.81                 | 12.6                 | 2.7498 | 0.9259 | 0.9129              |
| 3000            | 25         | 8.60            | 29.35                                    | 29.35          | 29.36          | 29.36            | 20             | 4.28                | 31.5                  | 759.6                 | 388                       | 2.1                          | 80                   | 84                    | 108        | -0.6                            | 9.41           | 10.6 | 1.087                          | 16.3                | 5.12       | 374.0               | 15.90         | 677                              | 0.920      | 0.89                 | 14.8                 | 2.7812 | 0.9223 | 0.9087              |
| 3000            | 26         | 11.80           | 25.41                                    | 25.40          | 25.40          | 25.40            | 20             | 5.35                | 32.6                  | 759.7                 | 418                       | 2.6                          | 80                   | 85                    | 110        | -0.7                            | 11.00          | 10.7 | 1.078                          | 20.9                | 6.56       | 479.2               | 17.20         | 626                              | 0.924      | 1.03                 | 18.5                 | 2.9595 | 0.9035 | 0.8866              |
| 3000            | 27         | 15.60           | 21.78                                    | 21.84          | 21.80          | 21.80            | 18             | 6.23                | 32.3                  | 759.7                 | 434                       | 3.1                          | 80                   | 85                    | 107        | -0.8                            | 12.65          | 10.5 | 1.094                          | 24.1                | 7.58       | 554.2               | 17.14         | 628                              | 0.925      | 1.20                 | 21.5                 | 2.9099 | 0.9085 | 0.8925              |
| 3000            | 27.7       | 18.60           | 19.31                                    | 19.31          | 19.31          | 19.31            | 18             | 6.80                | 32.3                  | 759.7                 | 426                       | 4.0                          | 78                   | 82                    | 97         | -0.9                            | 13.81          | 10.2 | 1.128                          | 26.3                | 8.26       | 603.6               | 16.62         | 648                              | 0.922      | 1.35                 | 23.5                 | 2.7033 | 0.9102 | 0.8945              |

ตารางที่ ๑-5 (ต่อ) แสดงผลการทดสอบเครื่องยนต์ Daihatsu รุ่น AB 547cc ด้วย gas mixer ชนิดผสมคาร์บูเรเตอร์ carburetor ที่รอบต่าง ๆ โดยใช้เชื้อเพลิงแก๊สผสมที่มีมีเทนและ CO<sub>2</sub> เป็นองค์ประกอบหลัก (แก๊สธรรมชาติจากอ่าวไทย) ปรับ Spark timing ที่ MBT เมทริกซ์ทดสอบรูปที่ 3-22

| speed(rev/min) | MAP(mHg) | P diff (mm H2O) | Fuel consumption 1 ft <sup>3</sup> (sec) |                |                |                  | θ <sub>s</sub> | Tb (kg) | Ambient               |                       | T <sub>exhaust</sub> (°C) | P <sub>exhaust</sub> (mmH2O) | Cooling              |                       | T <sub>oil</sub> (°C) | Gas cond.           |                        | ma (g/sec) | m <sub>corrected</sub> (g/sec) | Air/fuel ratio | φ     | Tb <sub>corrected</sub> (N-m) | Pb (kW) | bmep (Kpa) | η <sub>br</sub> (%) | bsfc (g/kW-h) | gas density(kg/m <sup>3</sup> ) | m <sub>f</sub> (g/sec) | Tb (N-m) | P <sub>v,table</sub> | k      | α      |
|----------------|----------|-----------------|--|----------------|----------------|------------------|----------------|---------|-----------------------|-----------------------|---------------------------|------------------------------|----------------------|-----------------------|-----------------------|---------------------|------------------------|------------|--------------------------------|----------------|-------|-------------------------------|---------|------------|---------------------|---------------|---------------------------------|------------------------|----------|----------------------|--------|--------|
|                |          |                 | t <sub>1</sub>                           | t <sub>2</sub> | t <sub>3</sub> | t <sub>avg</sub> |                |         | T <sub>amb</sub> (°C) | P <sub>a</sub> (mmHg) |                           |                              | T <sub>in</sub> (°C) | T <sub>out</sub> (°C) |                       | T <sub>g</sub> (°C) | P <sub>g</sub> (mmH2O) |            |                                |                |       |                               |         |            |                     |               |                                 |                        |          |                      |        |        |
| 3300           | 24       | 8.00            | 29.60                                    | 29.60          | 29.60          | 29.60            | 26             | 3.70    | 32.0                  | 759.8                 | 368                       | 1.7                          | 80                   | 84                    | 109                   | 23.4                | -0.5                   | 9.06       | 0.97                           | 10.3           | 1.121 | 14.2                          | 4.92    | 326.9      | 15.24               | 706           | 0.922                           | 0.88                   | 12.8     | 2.8610               | 0.9138 | 0.8987 |
| 3300           | 25       | 9.80            | 26.63                                    | 26.63          | 26.64          | 26.64            | 24             | 4.38    | 31.3                  | 759.8                 | 389                       | 1.9                          | 80                   | 83                    | 109                   | 21.9                | -0.6                   | 10.04      | 1.06                           | 10.2           | 1.130 | 16.6                          | 5.73    | 380.9      | 16.12               | 668           | 0.927                           | 0.99                   | 15.1     | 2.7498               | 0.9261 | 0.9131 |
| 3300           | 26       | 13.20           | 23.40                                    | 23.41          | 23.41          | 23.41            | 20             | 5.30    | 32.5                  | 759.8                 | 425                       | 2.3                          | 79                   | 83                    | 112                   | 20                  | -0.7                   | 11.63      | 1.25                           | 10.3           | 1.117 | 20.6                          | 7.13    | 473.6      | 17.11               | 629           | 0.932                           | 1.13                   | 18.3     | 2.9429               | 0.9052 | 0.8887 |
| 3300           | 27       | 17.50           | 20.06                                    | 20.06          | 20.06          | 20.06            | 20             | 6.23    | 31.8                  | 759.8                 | 442                       | 2.2                          | 80                   | 85                    | 109                   | 19.1                | -0.8                   | 13.41      | 1.44                           | 10.2           | 1.134 | 23.9                          | 8.25    | 547.9      | 17.14               | 628           | 0.935                           | 1.32                   | 21.5     | 2.8289               | 0.9173 | 0.9028 |
| 3300           | 27.5     | 20.40           | 18.56                                    | 18.56          | 18.54          | 18.55            | 18             | 6.55    | 31.8                  | 759.8                 | 451                       | 2.2                          | 80                   | 84                    | 99                    | 20.1                | -0.9                   | 14.48      | 1.55                           | 10.2           | 1.131 | 25.1                          | 8.67    | 576.1      | 16.73               | 644           | 0.932                           | 1.42                   | 22.7     | 2.8289               | 0.9173 | 0.9028 |
| 3600           | 25       | 11.10           | 24.53                                    | 24.53          | 24.56          | 24.54            | 24             | 4.25    | 36.0                  | 758.4                 | 425                       | 2.0                          | 77                   | 81                    | 113                   | 21.6                | -0.6                   | 10.61      | 1.26                           | 9.9            | 1.162 | 17.9                          | 6.74    | 410.4      | 15.98               | 674           | 0.928                           | 1.07                   | 14.7     | 3.5746               | 0.8487 | 0.8222 |
| 3600           | 26       | 14.80           | 21.41                                    | 21.41          | 21.44          | 21.42            | 20             | 5.20    | 36.4                  | 758.4                 | 460                       | 3.1                          | 80                   | 85                    | 113                   | 20.6                | -0.8                   | 12.24      | 1.46                           | 10.0           | 1.157 | 22.1                          | 8.31    | 506.4      | 17.04               | 632           | 0.930                           | 1.23                   | 18.0     | 3.6537               | 0.8429 | 0.8154 |
| 3600           | 27       | 19.20           | 18.71                                    | 18.71          | 18.75          | 18.72            | 20             | 5.98    | 36.3                  | 758.0                 | 473                       | 3.6                          | 82                   | 86                    | 112                   | 20                  | -0.9                   | 13.94      | 1.67                           | 9.9            | 1.164 | 25.3                          | 9.55    | 581.4      | 17.09               | 630           | 0.932                           | 1.41                   | 20.7     | 3.6338               | 0.8440 | 0.8167 |
| 3600           | 27.5     | 21.80           | 17.59                                    | 17.59          | 17.60          | 17.59            | 20             | 6.33    | 33.7                  | 758.0                 | 473                       | 4.4                          | 83                   | 85                    | 103                   | 23.5                | -1                     | 14.92      | 1.68                           | 10.1           | 1.144 | 25.4                          | 9.56    | 582.5      | 17.05               | 632           | 0.921                           | 1.48                   | 21.9     | 3.1829               | 0.8833 | 0.8629 |
| 3900           | 25       | 12.80           | 22.90                                    | 22.91          | 22.88          | 22.90            | 24             | 4.23    | 36.3                  | 757.6                 | 440                       | 3.1                          | 81                   | 85                    | 116                   | 20.3                | -0.8                   | 11.39      | 1.37                           | 9.9            | 1.165 | 17.9                          | 7.32    | 411.5      | 16.03               | 672           | 0.931                           | 1.15                   | 14.6     | 3.6338               | 0.8436 | 0.8162 |
| 3900           | 26       | 16.60           | 20.43                                    | 20.47          | 20.47          | 20.46            | 22             | 5.23    | 36.0                  | 757.6                 | 471                       | 4.0                          | 80                   | 85                    | 116                   | 18.1                | -0.9                   | 12.97      | 1.53                           | 10.0           | 1.153 | 22.0                          | 8.99    | 505.6      | 17.56               | 613           | 0.938                           | 1.30                   | 18.1     | 3.5746               | 0.8479 | 0.8213 |
| 3900           | 27       | 21.60           | 18.00                                    | 18.03          | 18.00          | 18.01            | 22             | 6.15    | 36.2                  | 757.3                 | 482                       | 5.4                          | 76                   | 81                    | 114                   | 17.5                | -1                     | 14.79      | 1.75                           | 10.0           | 1.151 | 26.0                          | 10.62   | 597.3      | 18.16               | 593           | 0.940                           | 1.48                   | 21.3     | 3.6139               | 0.8447 | 0.8175 |
| 3900           | 27.4     | 23.80           | 17.28                                    | 17.31          | 17.32          | 17.30            | 22             | 6.38    | 33.1                  | 757.3                 | 484                       | 6.3                          | 80                   | 84                    | 104                   | 21.1                | -1                     | 15.61      | 1.70                           | 10.3           | 1.121 | 25.2                          | 10.31   | 579.7      | 18.12               | 594           | 0.928                           | 1.52                   | 22.1     | 3.0437               | 0.8926 | 0.8738 |



ตารางที่ จ-5 (ต่อ) แสดงผลการทดสอบเครื่องยนต์ Daihatsu รุ่น AB 547cc ด้วย gas mixer ชนิดผสมคาร์บอนกับ carburetor ที่รอบต่าง ๆ โดยใช้เชื้อเพลิงแก๊สผสมที่มี มีมีเทนและ CO<sub>2</sub> เป็นองค์ประกอบหลัก (แก๊สธรรมชาติจากอ่าวไทย) ปรับ Spark timing ที่ MBT เมทริกซ์ทดสอบรูปที่ 3-22

| speed (rev/min) | MAP (inHg) | P diff (mm H <sub>2</sub> O) | Fuel consumption 1 ft <sup>3</sup> (sec) |                       |                      |                       | θ <sub>s</sub> | Tb (kg) | Ambient              |                       | T <sub>exhaust</sub> (°C) | P <sub>exhaust</sub> (inH <sub>2</sub> O) | Cooling        |                | T <sub>in</sub> (°C) | T <sub>out</sub> (°C) | T <sub>in</sub> (°C) | T <sub>out</sub> (°C) | P <sub>g</sub> (inH <sub>2</sub> O) | T <sub>g</sub> (°C) | P <sub>g</sub> (inH <sub>2</sub> O) | ma (g/sec) | m <sub>corrected</sub> (g/sec) | Air/fuel ratio | φ   | T <sub>b corrected</sub> (N-m) | P <sub>b</sub> (kW) | bmeq (kPa) | η <sub>in</sub> (%) | bsfc (g/kW-h) | gas density (kg/m <sup>3</sup> ) | mf (g/sec) | Tb (N-m) | P <sub>v,table</sub> | k | α |
|-----------------|------------|------------------------------|--|-----------------------|----------------------|-----------------------|----------------|---------|----------------------|-----------------------|---------------------------|---|----------------|----------------|----------------------|-----------------------|----------------------|-----------------------|-------------------------------------|---------------------|-------------------------------------|------------|--------------------------------|----------------|-----|--------------------------------|---------------------|------------|---------------------|---------------|----------------------------------|------------|----------|----------------------|---|---|
|                 |            |                              | T <sub>db</sub> (°C)                     | P <sub>a</sub> (mmHg) | T <sub>in</sub> (°C) | T <sub>out</sub> (°C) |                |         | T <sub>in</sub> (°C) | T <sub>out</sub> (°C) |                           |   | t <sub>1</sub> | t <sub>2</sub> |                      |                       |                      |                       |                                     |                     |                                     |            |                                |                |     |                                |                     |            |                     |               |                                  |            |          |                      |   |   |
| 1500            | 24         | 1.50                         | 71.84                                    | 71.90                 | 71.94                | 71.89                 | 22             | 2.53    | 30.9                 | 757.5                 | 224                       | 0.8                                       | 74             | 77             | 85                   | 27.9                  | -0.2                 | 0.38                  | 11.2                                | 1.042               | 9.5                                 | 1.50       | 218.7                          | 11.81          | 908 | 0.891                          | 0.35                | 8.7        | 2.6879              | 0.9308        | 0.9187                           |            |          |                      |   |   |
| 1500            | 25         | 2.00                         | 65.93                                    | 65.94                 | 65.87                | 65.91                 | 18             | 3.08    | 31.2                 | 757.5                 | 238                       | 1.0                                       | 73             | 77             | 87                   | 27.7                  | -0.2                 | 4.54                  | 11.8                                | 0.985               | 11.7                                | 1.83       | 268.1                          | 13.18          | 813 | 0.892                          | 0.38                | 10.7       | 2.7342              | 0.9254        | 0.9123                           |            |          |                      |   |   |
| 1500            | 26         | 2.60                         | 58.82                                    | 58.80                 | 58.88                | 58.83                 | 16             | 3.80    | 31.2                 | 757.5                 | 253                       | 1.1                                       | 76             | 81             | 89                   | 26.6                  | -0.3                 | 5.37                  | 12.5                                | 0.936               | 14.4                                | 2.26       | 330.7                          | 14.47          | 741 | 0.895                          | 0.43                | 13.1       | 2.7342              | 0.9254        | 0.9123                           |            |          |                      |   |   |
| 1500            | 27         | 3.60                         | 49.53                                    | 49.53                 | 49.47                | 49.51                 | 14             | 4.83    | 31.4                 | 757.5                 | 278                       | 1.2                                       | 76             | 78             | 90                   | 25.4                  | -0.3                 | 6.09                  | 11.8                                | 0.986               | 18.4                                | 2.89       | 422.3                          | 15.42          | 695 | 0.899                          | 0.51                | 16.7       | 2.7654              | 0.9218        | 0.9081                           |            |          |                      |   |   |
| 1500            | 28         | 5.00                         | 41.25                                    | 41.25                 | 41.34                | 41.28                 | 14             | 6.03    | 31.2                 | 757.5                 | 306                       | 1.4                                       | 71             | 77             | 89                   | 24.9                  | -0.4                 | 7.18                  | 11.6                                | 1.004               | 22.9                                | 3.59       | 524.8                          | 16.02          | 669 | 0.900                          | 0.62                | 20.9       | 2.7342              | 0.9254        | 0.9123                           |            |          |                      |   |   |
| 1500            | 29.3       | 9.00                         | 32.04                                    | 32.00                 | 32.06                | 32.03                 | 14             | 6.95    | 31.2                 | 757.5                 | 312                       | 1.8                                       | 74             | 79             | 80                   | 25.8                  | -0.4                 | 9.63                  | 12.1                                | 0.961               | 26.3                                | 4.14       | 604.9                          | 14.37          | 746 | 0.897                          | 0.79                | 24.0       | 2.7342              | 0.9254        | 0.9123                           |            |          |                      |   |   |
| 1500            | 29.2       | 8.90                         | 32.88                                    | 32.88                 | 32.88                | 32.88                 | 14             | 7.10    | 32.6                 | 757.8                 | 355                       | 1.2                                       | 78             | 85             | 99                   | 29.8                  | -0.5                 | 9.55                  | 12.4                                | 0.913               | 27.8                                | 4.36       | 637.6                          | 15.54          | 705 | 0.894                          | 0.77                | 24.6       | 2.9595              | 0.9014        | 0.8841                           |            |          |                      |   |   |
| 1800            | 24         | 2.50                         | 57.81                                    | 57.81                 | 57.78                | 57.80                 | 22             | 2.83    | 31.8                 | 757.8                 | 284                       | 1.4                                       | 73             | 77             | 90                   | 27.4                  | -0.3                 | 5.07                  | 11.6                                | 1.007               | 10.9                                | 2.05       | 249.6                          | 12.76          | 840 | 0.893                          | 0.44                | 9.8        | 2.8289              | 0.9151        | 0.9002                           |            |          |                      |   |   |
| 1800            | 25         | 3.30                         | 52.28                                    | 52.25                 | 52.29                | 52.27                 | 20             | 3.43    | 32.2                 | 757.8                 | 277                       | 1.6                                       | 71             | 75             | 92                   | 27.3                  | -0.3                 | 5.82                  | 12.0                                | 0.970               | 13.3                                | 2.51       | 305.3                          | 14.01          | 765 | 0.893                          | 0.48                | 11.9       | 2.8935              | 0.9082        | 0.8921                           |            |          |                      |   |   |
| 1800            | 26         | 4.50                         | 46.00                                    | 46.03                 | 46.10                | 46.04                 | 16             | 4.30    | 32.2                 | 757.8                 | 300                       | 2.0                                       | 74             | 79             | 94                   | 26.4                  | -0.3                 | 6.80                  | 12.3                                | 0.946               | 16.7                                | 3.14       | 382.7                          | 15.42          | 695 | 0.896                          | 0.55                | 14.9       | 2.8935              | 0.9082        | 0.8921                           |            |          |                      |   |   |
| 1800            | 27         | 5.60                         | 39.72                                    | 39.78                 | 39.81                | 39.77                 | 14             | 5.23    | 32.6                 | 757.8                 | 325                       | 2.6                                       | 73             | 79             | 93                   | 25.5                  | -0.4                 | 7.58                  | 11.8                                | 0.985               | 20.5                                | 3.86       | 469.7                          | 16.18          | 662 | 0.898                          | 0.64                | 18.1       | 2.9595              | 0.9014        | 0.8841                           |            |          |                      |   |   |
| 1800            | 28         | 6.80                         | 33.53                                    | 33.56                 | 33.63                | 33.57                 | 14             | 6.08    | 32.6                 | 757.8                 | 346                       | 3.1                                       | 71             | 78             | 90                   | 25.6                  | -0.4                 | 8.35                  | 11.0                                | 1.059               | 23.8                                | 4.48       | 546.0                          | 15.88          | 675 | 0.898                          | 0.76                | 21.0       | 2.9595              | 0.9014        | 0.8841                           |            |          |                      |   |   |
| 1800            | 29.05      | 9.00                         | 28.25                                    | 28.25                 | 28.31                | 28.27                 | 14             | 6.85    | 31.2                 | 757.8                 | 342                       | 3.1                                       | 72             | 78             | 73                   | 26.5                  | -0.5                 | 9.63                  | 10.7                                | 1.087               | 26.0                                | 4.89       | 596.0                          | 15.04          | 713 | 0.895                          | 0.90                | 23.7       | 2.7342              | 0.9257        | 0.9126                           |            |          |                      |   |   |
| 1800            | 29         | 9.40                         | 26.63                                    | 26.63                 | 26.72                | 26.66                 | 12             | 7.43    | 33.6                 | 757.3                 | 356                       | 2.8                                       | 92             | 99             | 94                   | 28.7                  | -0.2                 | 9.80                  | 10.2                                | 1.130               | 29.7                                | 5.60       | 682.6                          | 15.41          | 695 | 0.901                          | 0.96                | 25.7       | 3.1301              | 0.8845        | 0.8643                           |            |          |                      |   |   |
| 2100            | 24         | 3.90                         | 47.09                                    | 47.00                 | 47.13                | 47.07                 | 22             | 3.30    | 32.5                 | 757.4                 | 292                       | 0.8                                       | 75             | 80             | 96                   | 29.3                  | -0.4                 | 6.32                  | 11.9                                | 0.985               | 12.9                                | 2.83       | 295.8                          | 14.27          | 751 | 0.887                          | 0.53                | 11.4       | 2.9429              | 0.9027        | 0.8857                           |            |          |                      |   |   |
| 2100            | 25         | 5.40                         | 42.16                                    | 42.15                 | 42.06                | 42.12                 | 20             | 4.03    | 33.6                 | 757.4                 | 313                       | 0.9                                       | 75             | 80             | 98                   | 28.9                  | -0.5                 | 7.43                  | 12.4                                | 0.938               | 16.1                                | 3.55       | 370.2                          | 15.64          | 685 | 0.888                          | 0.60                | 13.9       | 3.1301              | 0.8846        | 0.8644                           |            |          |                      |   |   |
| 2100            | 26         | 7.20                         | 36.94                                    | 36.84                 | 36.84                | 36.87                 | 18             | 4.93    | 33.6                 | 757.5                 | 333                       | 2.7                                       | 77             | 81             | 98                   | 28.3                  | -0.5                 | 8.58                  | 12.6                                | 0.930               | 19.7                                | 4.34       | 452.8                          | 16.72          | 641 | 0.890                          | 0.68                | 17.0       | 3.1301              | 0.8847        | 0.8645                           |            |          |                      |   |   |
| 2100            | 27         | 9.00                         | 31.50                                    | 31.53                 | 31.56                | 31.53                 | 16             | 5.85    | 34.4                 | 757.5                 | 351                       | 1.6                                       | 75             | 81             | 98                   | 28                    | -0.6                 | 9.58                  | 12.0                                | 0.974               | 23.8                                | 5.24       | 546.7                          | 17.00          | 630 | 0.890                          | 0.80                | 20.2       | 3.2726              | 0.8720        | 0.8496                           |            |          |                      |   |   |
| 2100            | 28         | 10.60                        | 27.12                                    | 27.13                 | 27.15                | 27.13                 | 16             | 6.63    | 33.4                 | 757.9                 | 362                       | 2.4                                       | 74             | 80             | 95                   | 27.6                  | -0.7                 | 10.41                 | 11.2                                | 1.043               | 26.4                                | 5.80       | 605.9                          | 16.50          | 650 | 0.891                          | 0.93                | 22.9       | 3.0953              | 0.8883        | 0.8668                           |            |          |                      |   |   |
| 2100            | 28.7       | 12.00                        | 24.47                                    | 24.46                 | 24.50                | 24.48                 | 16             | 7.18    | 32.0                 | 758.0                 | 367                       | 1.7                                       | 74             | 79             | 88                   | 28.1                  | -0.8                 | 11.10                 | 10.8                                | 1.082               | 27.7                                | 6.09       | 636.0                          | 16.07          | 667 | 0.890                          | 1.03                | 24.8       | 2.8610              | 0.9119        | 0.8965                           |            |          |                      |   |   |
| 2100            | 28.6       | 12.20                        | 23.81                                    | 23.78                 | 23.78                | 23.79                 | 14             | 7.55    | 34.3                 | 757.3                 | 380                       | 4.5                                       | 79             | 83             | 101                  | 28.2                  | -0.2                 | 11.15                 | 10.4                                | 1.115               | 30.7                                | 6.75       | 704.3                          | 16.31          | 657 | 0.903                          | 1.07                | 26.1       | 3.2545              | 0.8733        | 0.8512                           |            |          |                      |   |   |



ตารางที่ ๖-5 (ต่อ) แสดงผลการทดสอบเครื่องยนต์ Daihatsu รุ่น AB 547cc ด้วย gas mixer ชนิดผสมคาร์บูเรเตอร์ที่รอบต่างๆ โดยใช้เชื้อเพลิงแก๊สผสมที่มีมีเทนและ CO<sub>2</sub> เป็นองค์ประกอบหลัก (แก๊สธรรมชาติจากชาวไทย) ปรับ Spark timing ที่ MBT เมทริกซ์ทดสอบรูปที่ 3-22

| speed (rev/min) | MAP (inHg) | P diff (mm H2O) | Fuel consumption 1 ft <sup>3</sup> (sec) |                       |                      |                       | θ <sub>s</sub> | T <sub>db</sub> (°C) | Ambient             |                        | T <sub>exhaust</sub> (°C) | Cooling |    | Gas cond. |      | ma (g/sec) | m <sub>corrected</sub> (g/sec) | Air/fuel ratio | φ     | T <sub>corrected</sub> (N-m) | P <sub>b</sub> (kW) | bmep (kPa) | η <sub>m</sub> (%) | bsfc (g/kWh) | gas density (kg/m <sup>3</sup> ) | mi (g/sec) | T <sub>b</sub> (N-m) | P <sub>v, intake</sub> | k      | α      |        |
|-----------------|------------|-----------------|--|-----------------------|----------------------|-----------------------|----------------|----------------------|---------------------|------------------------|---------------------------|---------|----|-----------|------|------------|--------------------------------|----------------|-------|------------------------------|---------------------|------------|--------------------|--------------|----------------------------------|------------|----------------------|------------------------|--------|--------|--------|
|                 |            |                 | T <sub>amb</sub> (°C)                    | P <sub>a</sub> (mmHg) | T <sub>in</sub> (°C) | T <sub>out</sub> (°C) |                |                      | T <sub>g</sub> (°C) | P <sub>g</sub> (inH2O) |                           |         |    |           |      |            |                                |                |       |                              |                     |            |                    |              |                                  |            |                      |                        |        |        |        |
| 2400            | 24         | 5.70            | 40.31                                    | 40.31                 | 40.25                | 40.29                 | 22             | 30.8                 | 758.7               | 350                    | 0.6                       | 75      | 97 | 26.8      | -0.4 | 7.67       | 0.69                           | 11.8           | 0.980 | 12.9                         | 3.23                | 295.3      | 13.83              | 772          | 0.921                            | 0.65       | 11.9                 | 2.6726                 | 0.9339 | 0.9223 |        |
| 2400            | 25         | 7.40            | 36.22                                    | 36.22                 | 36.21                | 36.22                 | 18             | 31.2                 | 758.7               | 367                    | 0.8                       | 77      | 81 | 26.4      | -0.4 | 8.73       | 0.78                           | 12.1           | 0.959 | 15.6                         | 3.93                | 358.8      | 14.97              | 713          | 0.922                            | 0.72       | 14.3                 | 2.7342                 | 0.9267 | 0.9139 |        |
| 2400            | 26         | 9.60            | 31.15                                    | 31.15                 | 31.16                | 31.15                 | 16             | 32.0                 | 758.8               | 397                    | 1.2                       | 79      | 84 | 25.9      | -0.5 | 9.93       | 0.92                           | 11.8           | 0.982 | 19.8                         | 4.99                | 455.6      | 16.08              | 664          | 0.924                            | 0.84       | 17.8                 | 2.8610                 | 0.9127 | 0.8975 |        |
| 2400            | 27         | 11.80           | 26.38                                    | 26.38                 | 26.40                | 26.39                 | 16             | 33.2                 | 758.8               | 412                    | 1.6                       | 75      | 80 | 24.7      | -0.6 | 10.99      | 1.11                           | 11.0           | 1.051 | 23.9                         | 6.00                | 548.0      | 15.96              | 669          | 0.927                            | 0.99       | 20.9                 | 3.0608                 | 0.8925 | 0.8737 |        |
| 2400            | 28         | 14.00           | 22.97                                    | 22.97                 | 22.94                | 22.96                 | 16             | 32.5                 | 758.8               | 423                    | 2.0                       | 75      | 81 | 25.5      | -0.7 | 11.98      | 1.26                           | 10.5           | 1.105 | 26.4                         | 6.64                | 606.6      | 15.62              | 684          | 0.924                            | 1.14       | 23.4                 | 2.9429                 | 0.9042 | 0.8874 |        |
| 2400            | 28.3       | 14.80           | 22.03                                    | 22.03                 | 22.04                | 22.03                 | 16             | 32.0                 | 758.8               | 423                    | 2.0                       | 79      | 84 | 25.5      | -0.7 | 12.33      | 1.30                           | 10.4           | 1.119 | 26.7                         | 6.71                | 613.1      | 15.29              | 698          | 0.924                            | 1.19       | 24.0                 | 2.8610                 | 0.9127 | 0.8975 |        |
| 2400            | 28.4       | 14.70           | 21.88                                    | 21.82                 | 21.87                | 21.86                 | 14             | 35.5                 | 757.3               | 399                    | 1.5                       | 75      | 80 | 27.8      | -0.3 | 12.22      | 1.37                           | 10.4           | 1.109 | 30.8                         | 7.75                | 708.3      | 16.84              | 636          | 0.904                            | 1.17       | 25.6                 | 3.4777                 | 0.8550 | 0.8296 |        |
| 2700            | 24         | 5.80            | 36.09                                    | 36.06                 | 36.10                | 36.08                 | 22             | 32.6                 | 759.3               | 350                    | 0.8                       | 75      | 79 | 102       | 24.5 | -0.5       | 7.71                           | 0.78           | 10.9  | 1.070                        | 14.2                | 4.01       | 325.3              | 15.23        | 704                              | 0.901      | 0.71                 | 12.6                   | 2.9595 | 0.9030 | 0.8861 |
| 2700            | 25         | 7.90            | 32.75                                    | 32.75                 | 32.75                | 32.75                 | 18             | 33.1                 | 759.3               | 375                    | 0.9                       | 77      | 81 | 104       | 23.1 | -0.5       | 8.99                           | 0.87           | 11.5  | 1.016                        | 17.0                | 4.80       | 389.6              | 16.33        | 656                              | 0.905      | 0.78                 | 14.9                   | 3.0437 | 0.8947 | 0.8763 |
| 2700            | 26         | 10.40           | 28.62                                    | 28.62                 | 28.66                | 28.63                 | 18             | 32.6                 | 759.1               | 395                    | 1.0                       | 79      | 84 | 105       | 22.4 | -0.6       | 10.32                          | 0.99           | 11.5  | 1.014                        | 20.3                | 5.74       | 466.1              | 17.19        | 623                              | 0.907      | 0.90                 | 18.0                   | 2.9595 | 0.9028 | 0.8858 |
| 2700            | 27         | 13.90           | 23.69                                    | 23.69                 | 23.72                | 23.70                 | 16             | 31.6                 | 759.0               | 405                    | 1.5                       | 78      | 83 | 101       | 21.9 | -0.7       | 11.96                          | 1.18           | 11.0  | 1.060                        | 23.2                | 6.56       | 532.9              | 16.56        | 647                              | 0.909      | 1.09                 | 21.0                   | 2.7970 | 0.9199 | 0.9059 |
| 2700            | 28         | 17.40           | 20.56                                    | 20.57                 | 20.53                | 20.55                 | 16             | 31.6                 | 759.0               | 406                    | 2.1                       | 77      | 81 | 90        | 23.9 | -0.8       | 13.38                          | 1.35           | 10.8  | 1.084                        | 26.3                | 7.45       | 604.8              | 16.41        | 653                              | 0.902      | 1.24                 | 23.9                   | 2.7970 | 0.9199 | 0.9059 |
| 2700            | 28         | 16.70           | 20.62                                    | 20.68                 | 20.69                | 20.66                 | 16             | 35.4                 | 757.3               | 410                    | 1.9                       | 76      | 80 | 102       | 27.6 | -0.3       | 13.02                          | 1.45           | 10.5  | 1.101                        | 29.9                | 8.47       | 687.7              | 17.41        | 615                              | 0.905      | 1.24                 | 24.9                   | 3.4586 | 0.8565 | 0.8314 |
| 3000            | 24         | 6.60            | 32.50                                    | 32.50                 | 32.50                | 32.50                 | 22             | 34.0                 | 757.9               | 373                    | 2.0                       | 75      | 80 | 105       | 25.1 | -0.5       | 8.21                           | 0.89           | 10.5  | 1.114                        | 14.3                | 4.50       | 328.7              | 15.02        | 714                              | 0.899      | 0.78                 | 12.3                   | 3.2006 | 0.8787 | 0.8574 |
| 3000            | 25         | 8.60            | 29.00                                    | 29.00                 | 29.03                | 29.01                 | 20             | 34.5                 | 757.9               | 399                    | 2.3                       | 75      | 79 | 107       | 23.8 | -0.6       | 9.36                           | 1.01           | 10.6  | 1.099                        | 17.7                | 5.57       | 407.2              | 16.39        | 654                              | 0.903      | 0.88                 | 15.0                   | 3.2908 | 0.8708 | 0.8482 |
| 3000            | 26         | 11.60           | 25.32                                    | 25.34                 | 25.38                | 25.35                 | 20             | 34.9                 | 758.0               | 419                    | 2.6                       | 77      | 82 | 108       | 22.3 | -0.7       | 10.86                          | 1.17           | 10.7  | 1.089                        | 21.8                | 6.85       | 500.3              | 17.39        | 616                              | 0.907      | 1.01                 | 18.3                   | 3.3645 | 0.8648 | 0.8411 |
| 3000            | 27         | 15.50           | 21.59                                    | 21.66                 | 21.69                | 21.65                 | 20             | 33.7                 | 758.0               | 426                    | 2.9                       | 78      | 84 | 104       | 22.3 | -0.8       | 12.58                          | 1.34           | 10.6  | 1.101                        | 24.4                | 7.68       | 561.3              | 17.02        | 630                              | 0.907      | 1.19                 | 21.1                   | 3.1829 | 0.8633 | 0.8629 |
| 3000            | 28         | 18.60           | 19.09                                    | 19.09                 | 19.09                | 19.09                 | 20             | 33.7                 | 758.0               | 430                    | 3.3                       | 79      | 83 | 96        | 24   | -0.9       | 13.78                          | 1.51           | 10.3  | 1.132                        | 26.4                | 8.28       | 605.5              | 16.29        | 658                              | 0.902      | 1.34                 | 22.8                   | 3.1829 | 0.8633 | 0.8629 |
| 3000            | 27.8       | 18.60           | 19.25                                    | 19.25                 | 19.21                | 19.24                 | 18             | 36.0                 | 757.3               | 443                    | 1.5                       | 77      | 81 | 104       | 27.7 | -0.3       | 13.73                          | 1.57           | 10.3  | 1.122                        | 29.6                | 9.30       | 680.0              | 17.63        | 608                              | 0.904      | 1.33                 | 24.3                   | 3.5746 | 0.8476 | 0.8209 |



ตารางที่ จ-5 (ต่อ) แสดงผลการทดสอบเครื่องยนต์ Daihatsu รุ่น AB 547cc ด้วย gas mixer ชนิดผสมคาร์บูเรเตอร์ carburetor ที่รอบต่าง ๆ โดยใช้เพื่อเพลิงแก๊สผสมที่มี มีมีเทนและ CO<sub>2</sub> เป็นองค์ประกอบหลัก (แก๊สธรรมชาติจากอ่าวไทย) ปรับ Spark timing ที่ MBT เมทริกซ์ทดสอบรูปที่ 3-22

| speed (rev/min) | MAP (inHg) | P diff (mm H2O) | Fuel consumption 1 ft <sup>3</sup> (sec) |                         |                      |                       | θ <sub>s</sub> | Tb (kg) | Ambient             |                        | T <sub>exhaust</sub> (°C) | P <sub>exhaust</sub> (inH2O) | Cooling             |                        | Gas cond. |      | ma (g/sec) | m <sub>l</sub> <sup>cond</sup> (g/sec) | Air/fuel ratio | φ     | Tb <sup>cond</sup> (N-m) | Pb (kW) | bmeP (kPa) | η <sub>m</sub> (%) | bsfc (g/kW-h) | gas density (kg/m <sup>3</sup> ) | m <sub>f</sub> (g/sec) | Tb (N-m) | P <sub>v,table</sub> | k      | α      |        |
|-----------------|------------|-----------------|--|-------------------------|----------------------|-----------------------|----------------|---------|---------------------|------------------------|---------------------------|------------------------------|---------------------|------------------------|-----------|------|------------|--|----------------|-------|--------------------------|---------|------------|--------------------|---------------|----------------------------------|------------------------|----------|----------------------|--------|--------|--------|
|                 |            |                 | T <sub>amb</sub> (°C)                    | P <sub>amb</sub> (mmHg) | T <sub>in</sub> (°C) | T <sub>out</sub> (°C) |                |         | T <sub>g</sub> (°C) | P <sub>g</sub> (inH2O) |                           |                              | T <sub>g</sub> (°C) | P <sub>g</sub> (inH2O) |           |      |            |  |                |       |                          |         |            |                    |               |                                  |                        |          |                      |        |        |        |
| 3300            | 24         | 7.70            | 29.72                                    | 29.72                   | 29.75                | 29.73                 | 22             | 3.63    | 30.2                | 758.9                  | 366                       | 3.4                          | 75                  | 106                    | 19.2      | -0.6 | 8.92       | 0.95                                   | 9.9            | 1.171 | 13.4                     | 4.64    | 308.1      | 14.44              | 739           | 0.945                            | 0.90                   | 12.6     | 2.5825               | 0.9452 | 0.9356 |        |
| 3300            | 25         | 9.80            | 26.59                                    | 26.59                   | 26.59                | 26.59                 | 22             | 4.43    | 30.2                | 759.0                  | 390                       | 3.8                          | 75                  | 109                    | 16.8      | -0.6 | 10.06      | 1.07                                   | 9.9            | 1.170 | 16.4                     | 5.66    | 375.9      | 15.64              | 683           | 0.952                            | 1.01                   | 15.3     | 2.5825               | 0.9453 | 0.9357 |        |
| 3300            | 26         | 13.40           | 23.09                                    | 23.09                   | 23.09                | 23.09                 | 18             | 5.43    | 31.2                | 759.0                  | 437                       | 4.4                          | 77                  | 81                     | 14.6      | -0.7 | 11.75      | 1.27                                   | 10.0           | 1.163 | 20.5                     | 7.10    | 471.6      | 16.58              | 644           | 0.959                            | 1.18                   | 18.8     | 2.7342               | 0.9270 | 0.9142 |        |
| 3300            | 27         | 17.60           | 20.94                                    | 20.97                   | 20.97                | 20.96                 | 18             | 6.23    | 30.6                | 759.0                  | 448                       | 4.9                          | 77                  | 82                     | 13.8      | -0.9 | 13.48      | 1.39                                   | 10.4           | 1.119 | 23.2                     | 8.03    | 533.6      | 17.19              | 621           | 0.962                            | 1.30                   | 21.5     | 2.6423               | 0.9379 | 0.9270 |        |
| 3300            | 27.5       | 20.00           | 18.91                                    | 18.88                   | 18.90                | 18.90                 | 18             | 6.75    | 30.2                | 759.0                  | 480                       | 4.9                          | 77                  | 81                     | 18.1      | -0.9 | 14.37      | 1.50                                   | 10.1           | 1.147 | 24.9                     | 8.62    | 572.8      | 17.02              | 627           | 0.947                            | 1.42                   | 23.3     | 2.5825               | 0.9453 | 0.9358 |        |
| 3300            | 27.6       | 20.00           | 18.18                                    | 18.18                   | 18.25                | 18.20                 | 18             | 6.80    | 36.9                | 757.5                  | 449                       | 2.6                          | 79                  | 82                     | 106       | 27.7 | -0.3       | 14.22                                  | 1.68           | 10.1  | 1.145                    | 29.2    | 10.08      | 669.9              | 17.81         | 602                              | 0.904                  | 1.41     | 23.5                 | 3.7548 | 0.8349 | 0.8060 |
| 3600            | 25         | 11.00           | 24.47                                    | 24.47                   | 24.50                | 24.48                 | 24             | 4.40    | 35.7                | 758.0                  | 420                       | 2.7                          | 75                  | 112                    | 24.6      | -0.7 | 10.57      | 1.22                                   | 10.1           | 1.150 | 18.4                     | 6.94    | 422.5      | 16.91              | 634           | 0.900                            | 1.04                   | 15.2     | 3.5162               | 0.8528 | 0.8270 |        |
| 3600            | 26         | 14.80           | 21.22                                    | 21.22                   | 21.19                | 21.21                 | 20             | 5.33    | 36.0                | 758.0                  | 456                       | 3.7                          | 77                  | 82                     | 113       | 23.3 | -0.8       | 12.25                                  | 1.42           | 10.1  | 1.150                    | 22.4    | 8.46       | 515.0              | 17.69         | 606                              | 0.904                  | 1.21     | 18.4                 | 3.5746 | 0.8483 | 0.8218 |
| 3600            | 27         | 19.60           | 18.31                                    | 18.31                   | 18.32                | 18.31                 | 20             | 6.13    | 35.8                | 758.0                  | 468                       | 4.4                          | 77                  | 82                     | 112       | 23.1 | -1         | 14.10                                  | 1.64           | 10.1  | 1.157                    | 25.7    | 9.68       | 589.8              | 17.55         | 611                              | 0.904                  | 1.40     | 21.2                 | 3.5355 | 0.8512 | 0.8252 |
| 3600            | 27.4       | 21.80           | 17.22                                    | 17.22                   | 17.19                | 17.21                 | 20             | 6.40    | 34.0                | 758.0                  | 471                       | 4.9                          | 76                  | 81                     | 102       | 24.8 | -1         | 14.91                                  | 1.68           | 10.1  | 1.157                    | 25.8    | 9.73       | 592.6              | 17.21         | 623                              | 0.899                  | 1.48     | 22.1                 | 3.2006 | 0.8788 | 0.8576 |
| 3600            | 27.45      | 22.10           | 17.31                                    | 17.34                   | 17.37                | 17.34                 | 18             | 6.63    | 36.8                | 757.5                  | 472                       | 4.5                          | 80                  | 84                     | 110       | 28.1 | -0.4       | 14.95                                  | 1.76           | 10.1  | 1.141                    | 28.4    | 10.70      | 651.8              | 18.07         | 593                              | 0.903                  | 1.47     | 22.9                 | 3.7344 | 0.8363 | 0.8076 |
| 3900            | 25         | 13.00           | 22.12                                    | 22.13                   | 22.13                | 22.13                 | 24             | 4.40    | 36.1                | 759.0                  | 445                       | 3.5                          | 75                  | 114                    | 26.2      | -0.8 | 11.48      | 1.35                                   | 10.0           | 1.165 | 18.5                     | 7.57    | 425.4      | 16.67              | 643           | 0.895                            | 1.15                   | 15.2     | 3.5942               | 0.8478 | 0.8212 |        |
| 3900            | 26         | 16.90           | 19.75                                    | 19.75                   | 19.78                | 19.76                 | 22             | 5.38    | 36.8                | 758.9                  | 472                       | 3.8                          | 76                  | 81                     | 116       | 25.1 | -1         | 13.07                                  | 1.54           | 10.2  | 1.149                    | 23.0    | 9.39       | 527.9              | 18.19         | 589                              | 0.898                  | 1.29     | 18.6                 | 3.7344 | 0.8376 | 0.8092 |
| 3900            | 27         | 21.80           | 17.44                                    | 17.44                   | 17.44                | 17.44                 | 22             | 6.10    | 36.5                | 758.6                  | 482                       | 5.1                          | 76                  | 82                     | 116       | 24.5 | -1         | 14.85                                  | 1.74           | 10.2  | 1.148                    | 25.9    | 10.58      | 595.1              | 18.15         | 590                              | 0.900                  | 1.46     | 21.1                 | 3.6737 | 0.8417 | 0.8140 |
| 3900            | 27.2       | 23.80           | 16.78                                    | 16.78                   | 16.81                | 16.79                 | 22             | 6.23    | 36.5                | 758.5                  | 473                       | 5.2                          | 77                  | 81                     | 103       | 25.6 | -1.1       | 15.52                                  | 1.79           | 10.3  | 1.137                    | 26.3    | 10.75      | 604.2              | 17.90         | 599                              | 0.896                  | 1.51     | 21.5                 | 3.1126 | 0.8457 | 0.8187 |
| 3900            | 27.3       | 23.60           | 17.00                                    | 16.94                   | 16.94                | 16.96                 | 20             | 6.40    | 38.0                | 757.5                  | 479                       | 5.0                          | 80                  | 83                     | 113       | 28.6 | -0.4       | 15.42                                  | 1.84           | 10.2  | 1.129                    | 28.1    | 11.47      | 644.9              | 18.59         | 576                              | 0.901                  | 1.50     | 22.1                 | 3.9856 | 0.8196 | 0.7880 |



ตารางที่ ๑-6 แสดงผลการทดสอบเครื่องยนต์ Daihatsu รุ่น AB 547cc ด้วย gas mixer ชนิดผสมคาร์บูเรเตอร์ carburetor ที่รอบต่าง ๆ โดยให้เชื้อเพลิงแก่ผสมที่มี มีเทนและ N<sub>2</sub> เป็นองค์ประกอบหลัก (แก้สูตรรวมหาได้จากแหล่งพม่า) ปรับ Spark timing ที่ MBT เมทริกซ์ทดสอบรูปที่ 3-22

| speed (rev/min) | MAP (inHg) | P diff (mm H2O) | Fuel consumption 1 ft <sup>3</sup> (sec) |                |                |                  | θ <sub>s</sub> | T <sub>amb</sub> (°C) | Ambient                   |                      | P <sub>exhaust</sub> (inH2O) | Cooling               |                      | Gas cond.             |                     | ma (g/sec) | m <sub>corrected</sub> (g/sec) | Air/Fuel ratio | φ    | T <sub>corrected</sub> (N-m) | P <sub>b</sub> (kW) | bmeP (kPa) | η <sub>s</sub> (%) | bsfc (g/kWh) | gas density (kg/m <sup>3</sup> ) | mf (g/sec) | T <sub>b</sub> (N-m) | P <sub>v,table</sub> | k      | α      |                        |
|-----------------|------------|-----------------|--|----------------|----------------|------------------|----------------|-----------------------|---------------------------|----------------------|------------------------------|-----------------------|----------------------|-----------------------|---------------------|------------|--------------------------------|----------------|------|------------------------------|---------------------|------------|--------------------|--------------|----------------------------------|------------|----------------------|----------------------|--------|--------|------------------------|
|                 |            |                 | t <sub>1</sub>                           | t <sub>2</sub> | t <sub>3</sub> | t <sub>avg</sub> |                |                       | T <sub>exhaust</sub> (°C) | T <sub>in</sub> (°C) |                              | T <sub>out</sub> (°C) | T <sub>in</sub> (°C) | T <sub>out</sub> (°C) | T <sub>g</sub> (°C) |            |                                |                |      |                              |                     |            |                    |              |                                  |            |                      |                      |        |        | P <sub>g</sub> (inH2O) |
| 1500            | 24         | 1.60            | 67.60                                    | 67.71          | 67.63          | 67.65            | 28             | 29.3                  | 760.0                     | 252                  | 0.1                          | 72                    | 74                   | 79                    | 28.6                | -0.3       | 4.07                           | 0.36           | 11.2 | 0.961                        | 5.7                 | 0.90       | 131.0              | 7.89         | 1456                             | 0.834      | 0.35                 | 5.5                  | 2.4523 | 0.9637 | 0.9573                 |
| 1500            | 25         | 2.10            | 61.25                                    | 61.16          | 61.19          | 61.20            | 28             | 29.6                  | 759.9                     | 260                  | 0.2                          | 72                    | 77                   | 84                    | 28.6                | -0.4       | 4.66                           | 0.40           | 11.6 | 0.934                        | 9.9                 | 1.56       | 228.1              | 12.35        | 930                              | 0.834      | 0.39                 | 9.4                  | 2.4951 | 0.9577 | 0.9503                 |
| 1500            | 26         | 3.00            | 54.56                                    | 54.56          | 54.53          | 54.55            | 22             | 29.6                  | 759.7                     | 276                  | 0.3                          | 76                    | 80                   | 85                    | 28.5                | -0.4       | 5.57                           | 0.45           | 12.3 | 0.877                        | 13.1                | 2.06       | 300.9              | 14.51        | 791                              | 0.835      | 0.43                 | 12.4                 | 2.4951 | 0.9575 | 0.9500                 |
| 1500            | 27         | 3.80            | 46.25                                    | 46.25          | 46.19          | 46.23            | 16             | 30.1                  | 759.7                     | 304                  | 0.7                          | 76                    | 79                   | 87                    | 28.3                | -0.4       | 6.27                           | 0.54           | 11.6 | 0.930                        | 16.9                | 2.66       | 389.1              | 15.74        | 730                              | 0.835      | 0.51                 | 15.9                 | 2.5678 | 0.9479 | 0.9388                 |
| 1500            | 28         | 5.00            | 39.75                                    | 39.75          | 39.78          | 39.76            | 16             | 30.1                  | 759.6                     | 324                  | 1.4                          | 75                    | 80                   | 87                    | 28.5                | -0.5       | 7.19                           | 0.63           | 11.5 | 0.942                        | 20.7                | 3.26       | 476.2              | 16.58        | 693                              | 0.834      | 0.59                 | 19.5                 | 2.5678 | 0.9479 | 0.9387                 |
| 1500            | 29.2       | 9.30            | 32.31                                    | 32.31          | 32.31          | 32.31            | 14             | 30.1                  | 759.6                     | 369                  | 1.8                          | 78                    | 83                   | 80                    | 28.2                | -0.6       | 9.80                           | 0.77           | 12.7 | 0.851                        | 26.6                | 4.18       | 611.5              | 17.29        | 664                              | 0.835      | 0.73                 | 25.0                 | 2.5678 | 0.9479 | 0.9387                 |
| 1800            | 24         | 2.60            | 54.85                                    | 54.87          | 54.84          | 54.85            | 28             | 29.6                  | 761.0                     | 289                  | 0.6                          | 76                    | 79                   | 88                    | 28.7                | -0.4       | 5.19                           | 0.45           | 11.6 | 0.935                        | 8.2                 | 1.54       | 187.7              | 10.95        | 1049                             | 0.834      | 0.43                 | 7.8                  | 2.4951 | 0.9590 | 0.9518                 |
| 1800            | 25         | 3.80            | 48.37                                    | 48.34          | 48.41          | 48.37            | 26             | 30.0                  | 760.9                     | 298                  | 0.7                          | 76                    | 79                   | 88                    | 28.7                | -0.4       | 6.27                           | 0.51           | 12.2 | 0.885                        | 11.4                | 2.14       | 261.1              | 13.32        | 862                              | 0.834      | 0.49                 | 10.7                 | 2.5531 | 0.9512 | 0.9426                 |
| 1800            | 26         | 5.00            | 42.60                                    | 42.63          | 42.62          | 42.62            | 20             | 31.4                  | 760.9                     | 324                  | 1.6                          | 73                    | 77                   | 91                    | 28.5                | -0.4       | 7.17                           | 0.60           | 12.0 | 0.902                        | 14.9                | 2.81       | 342.0              | 14.95        | 768                              | 0.835      | 0.55                 | 13.6                 | 2.7654 | 0.9254 | 0.9124                 |
| 1800            | 27         | 6.00            | 37.10                                    | 37.16          | 37.18          | 37.15            | 18             | 31.7                  | 760.8                     | 343                  | 2.5                          | 76                    | 80                   | 94                    | 28.5                | -0.5       | 7.85                           | 0.69           | 11.4 | 0.951                        | 18.7                | 3.52       | 429.4              | 16.27        | 706                              | 0.834      | 0.64                 | 16.9                 | 2.8129 | 0.9201 | 0.9061                 |
| 1800            | 28         | 6.90            | 32.00                                    | 32.00          | 32.10          | 32.03            | 16             | 32.3                  | 760.8                     | 372                  | 3.4                          | 73                    | 78                   | 95                    | 28.7                | -0.6       | 8.41                           | 0.81           | 10.4 | 1.040                        | 23.3                | 4.40       | 535.7              | 17.32        | 663                              | 0.834      | 0.74                 | 20.9                 | 2.9099 | 0.9097 | 0.8938                 |
| 1800            | 29         | 9.20            | 27.91                                    | 27.91          | 27.78          | 27.87            | 16             | 32.3                  | 760.8                     | 400                  | 3.6                          | 81                    | 87                   | 92                    | 28.9                | -0.6       | 9.72                           | 0.93           | 10.4 | 1.034                        | 27.8                | 5.24       | 637.8              | 17.95        | 640                              | 0.833      | 0.85                 | 24.8                 | 2.9099 | 0.9097 | 0.8938                 |
| 1800            | 29         | 9.00            | 25.50                                    | 25.40          | 25.53          | 25.48            | 14             | 33.3                  | 755.7                     | 336                  | 4.5                          | 78                    | 83                   | 101                   | 29.7                | -0.5       | 9.59                           | 1.04           | 10.4 | 1.041                        | 28.7                | 5.41       | 658.7              | 16.57        | 692                              | 0.830      | 0.92                 | 24.9                 | 3.0780 | 0.8876 | 0.8680                 |
| 2100            | 24         | 4.20            | 43.78                                    | 43.78          | 43.79          | 43.78            | 28             | 28.5                  | 760.2                     | 326                  | 0.7                          | 72                    | 75                   | 90                    | 28.8                | -0.4       | 6.58                           | 0.58           | 11.3 | 0.956                        | 10.0                | 2.21       | 230.3              | 12.09        | 950                              | 0.834      | 0.54                 | 9.2                  | 2.7498 | 0.9265 | 0.9136                 |
| 2100            | 25         | 5.90            | 38.97                                    | 38.97          | 38.94          | 38.96            | 24             | 31.8                  | 760.1                     | 341                  | 0.8                          | 72                    | 76                   | 93                    | 28.8                | -0.4       | 7.79                           | 0.66           | 11.8 | 0.916                        | 13.5                | 2.97       | 310.3              | 14.36        | 800                              | 0.834      | 0.61                 | 12.2                 | 2.8289 | 0.9176 | 0.9032                 |
| 2100            | 26         | 7.40            | 34.31                                    | 34.34          | 34.32          | 34.32            | 20             | 30.6                  | 760.0                     | 360                  | 1.2                          | 75                    | 79                   | 95                    | 28.7                | -0.5       | 8.74                           | 0.73           | 11.9 | 0.906                        | 16.1                | 3.55       | 370.4              | 15.45        | 744                              | 0.834      | 0.69                 | 15.0                 | 2.6423 | 0.9390 | 0.9283                 |
| 2100            | 27         | 8.80            | 30.03                                    | 30.03          | 30.06          | 30.04            | 18             | 31.2                  | 760.0                     | 388                  | 1.5                          | 77                    | 82                   | 96                    | 29.0                | -0.5       | 9.52                           | 0.85           | 11.2 | 0.960                        | 20.1                | 4.43       | 462.3              | 16.70        | 688                              | 0.833      | 0.79                 | 18.4                 | 2.7342 | 0.9280 | 0.9154                 |
| 2100            | 28         | 10.50           | 26.43                                    | 26.41          | 26.44          | 26.43            | 16             | 32.2                  | 760.0                     | 422                  | 2.0                          | 74                    | 79                   | 96                    | 28.3                | -0.6       | 10.38                          | 0.98           | 10.6 | 1.022                        | 24.9                | 5.48       | 572.3              | 17.80        | 645                              | 0.835      | 0.89                 | 22.3                 | 2.8935 | 0.9105 | 0.8949                 |
| 2100            | 28.7       | 12.00           | 24.12                                    | 24.13          | 24.30          | 24.18            | 16             | 32.2                  | 760.0                     | 438                  | 2.2                          | 75                    | 80                   | 90                    | 28.0                | -0.7       | 11.10                          | 1.07           | 10.3 | 1.046                        | 27.4                | 6.03       | 630.0              | 17.92        | 641                              | 0.835      | 0.98                 | 24.6                 | 2.8935 | 0.9105 | 0.8949                 |
| 2100            | 29         | 11.20           | 23.87                                    | 23.91          | 23.99          | 23.92            | 18             | 34.8                  | 756.5                     | 378                  | 3.2                          | 78                    | 84                   | 101                   | 32.1                | -0.7       | 10.68                          | 1.13           | 11.0 | 0.986                        | 29.8                | 6.55       | 684.4              | 17.47        | 619                              | 0.824      | 0.97                 | 25.1                 | 3.3459 | 0.8648 | 0.8411                 |



ตารางที่ ๖-6 (ต่อ) แสดงผลการทดสอบเครื่องยนต์ Daihatsu รุ่น AB 547cc ด้วย gas mixer ชนิดผสมคาร์บูเรเตอร์ carburetor ที่รอบต่าง ๆ โดยใช้เชื้อเพลิงแก๊สผสมที่มีมีเทนและ N<sub>2</sub> เป็นองค์ประกอบหลัก (แก๊สธรรมชาติจากแหล่งพม่า) ปรับ Spark timing ที่ MBT เมทริกซ์ทดสอบรูปที่ 3-22

| speed (rev/min) | MAP (inHg) | P diff (mm H2O) | Fuel consumption 1 ft <sup>3</sup> (sec) |                |                |                  | θ <sub>s</sub> | Ambient              |                       | Cooling             |                       | Gas cond.            |                           | ma (g/sec) | m <sub>f</sub> corrected (g/sec) | Air/Fuel ratio | φ     | Tb <sub>corrected</sub> (N-m) | Pb (kW) | bmep (kPa) | η <sub>m</sub> (%) | bsfc (g/kW-h) | gas density (kg/m <sup>3</sup> ) | m (g/sec) | Tb (N-m) | P <sub>v,table</sub> | k    | α    |                              |                           |                              |
|-----------------|------------|-----------------|--|----------------|----------------|------------------|----------------|----------------------|-----------------------|---------------------|-----------------------|----------------------|---------------------------|------------|----------------------------------|----------------|-------|-------------------------------|---------|------------|--------------------|---------------|----------------------------------|-----------|----------|----------------------|------|------|------------------------------|---------------------------|------------------------------|
|                 |            |                 | l <sub>1</sub>                           | l <sub>2</sub> | l <sub>3</sub> | l <sub>avg</sub> |                | T <sub>db</sub> (°C) | P <sub>a</sub> (mmHg) | T <sub>m</sub> (°C) | T <sub>out</sub> (°C) | T <sub>in</sub> (°C) | T <sub>exhaust</sub> (°C) |            |                                  |                |       |                               |         |            |                    |               |                                  |           |          |                      |      |      | P <sub>exhaust</sub> (inH2O) | T <sub>exhaust</sub> (°C) | T <sub>exhaust</sub> (inH2O) |
| 2400            | 24         | 5.40            | 37.82                                    | 37.81          | 37.86          | 37.83            | 30             | 32.7                 | 759.0                 | 319                 | 0.4                   | 72                   | 76                        | 94         | 30.9                             | -0.5           | 7.44  | 0.69                          | 10.8    | 0.998      | 11.5               | 2.88          | 263.3                            | 13.40     | 857      | 0.825                | 0.62 | 10.1 | 2.9762                       | 0.9010                    | 0.8837                       |
| 2400            | 25         | 7.20            | 33.81                                    | 33.91          | 33.91          | 33.88            | 24             | 33.0                 | 759.0                 | 333                 | 0.5                   | 73                   | 77                        | 96         | 30.9                             | -0.5           | 8.59  | 0.77                          | 11.1    | 0.971      | 14.1               | 3.54          | 323.8                            | 14.67     | 782      | 0.825                | 0.69 | 12.4 | 3.0267                       | 0.8960                    | 0.8779                       |
| 2400            | 26         | 9.40            | 29.12                                    | 29.12          | 29.13          | 29.12            | 20             | 35.3                 | 759.0                 | 355                 | 0.5                   | 71                   | 76                        | 99         | 31.0                             | -0.6           | 9.77  | 0.93                          | 10.5    | 1.034      | 19.0               | 4.77          | 435.4                            | 16.28     | 705      | 0.825                | 0.80 | 15.8 | 3.4396                       | 0.8597                    | 0.8352                       |
| 2400            | 27         | 11.80           | 25.38                                    | 25.37          | 25.35          | 25.37            | 18             | 35.3                 | 759.0                 | 390                 | 1.3                   | 73                   | 79                        | 102        | 31.0                             | -0.6           | 10.95 | 1.07                          | 10.2    | 1.059      | 23.6               | 5.93          | 541.9                            | 17.65     | 650      | 0.825                | 0.92 | 19.7 | 3.4396                       | 0.8597                    | 0.8352                       |
| 2400            | 28         | 13.40           | 22.59                                    | 22.59          | 22.59          | 22.59            | 16             | 34.5                 | 758.5                 | 420                 | 1.3                   | 75                   | 81                        | 102        | 30.8                             | -0.7           | 11.68 | 1.19                          | 9.8     | 1.100      | 27.4               | 6.89          | 629.4                            | 18.50     | 620      | 0.825                | 1.03 | 23.3 | 3.2908                       | 0.8715                    | 0.8490                       |
| 2400            | 28.3       | 14.50           | 21.65                                    | 21.66          | 21.72          | 21.68            | 16             | 34.5                 | 758.5                 | 424                 | 1.4                   | 75                   | 81                        | 99         | 30.2                             | -0.8           | 12.15 | 1.24                          | 9.8     | 1.104      | 29.1               | 7.32          | 668.7                            | 18.83     | 610      | 0.827                | 1.08 | 24.7 | 3.2908                       | 0.8715                    | 0.8490                       |
| 2400            | 28.5       | 14.00           | 21.66                                    | 21.66          | 21.76          | 21.69            | 18             | 36.5                 | 756.7                 | 403                 | 2.5                   | 76                   | 83                        | 104        | 33                               | -0.7           | 11.90 | 1.28                          | 11.1    | 0.972      | 30.7               | 7.71          | 704.3                            | 18.15     | 596      | 0.821                | 1.07 | 24.9 | 3.6737                       | 0.8397                    | 0.8117                       |
| 2700            | 24         | 6.00            | 33.41                                    | 33.41          | 33.41          | 33.41            | 30             | 33.0                 | 758.8                 | 339                 | 1.0                   | 71                   | 75                        | 98         | 30.1                             | -0.5           | 7.84  | 0.78                          | 10.0    | 1.082      | 11.9               | 3.38          | 274.2                            | 13.74     | 835      | 0.828                | 0.70 | 10.5 | 3.0267                       | 0.8958                    | 0.8775                       |
| 2700            | 25         | 8.00            | 30.18                                    | 30.16          | 30.15          | 30.16            | 28             | 33.4                 | 758.8                 | 355                 | 1.0                   | 72                   | 76                        | 99         | 29.6                             | -0.6           | 9.04  | 0.87                          | 10.3    | 1.048      | 14.8               | 4.19          | 340.5                            | 15.27     | 751      | 0.829                | 0.78 | 12.9 | 3.0953                       | 0.8892                    | 0.8698                       |
| 2700            | 26         | 10.60           | 26.62                                    | 26.62          | 26.62          | 26.62            | 20             | 33.8                 | 758.8                 | 389                 | 1.1                   | 72                   | 76                        | 102        | 28.9                             | -0.6           | 10.40 | 1.00                          | 10.4    | 1.042      | 18.4               | 5.22          | 423.6                            | 16.61     | 691      | 0.831                | 0.88 | 15.9 | 3.1652                       | 0.8828                    | 0.8623                       |
| 2700            | 27         | 13.90           | 22.56                                    | 22.56          | 22.59          | 22.57            | 20             | 34.5                 | 758.9                 | 421                 | 1.3                   | 75                   | 81                        | 103        | 28.5                             | -0.7           | 11.90 | 1.20                          | 9.9     | 1.089      | 23.6               | 6.68          | 542.1                            | 17.79     | 645      | 0.832                | 1.04 | 20.1 | 3.2908                       | 0.8719                    | 0.8495                       |
| 2700            | 28         | 16.80           | 20.09                                    | 20.03          | 19.97          | 20.03            | 18             | 34.5                 | 758.9                 | 444                 | 1.5                   | 75                   | 81                        | 98         | 28.7                             | -1             | 13.08 | 1.35                          | 9.7     | 1.115      | 28.3               | 8.00          | 649.6                            | 18.94     | 606      | 0.830                | 1.17 | 24.0 | 3.2908                       | 0.8719                    | 0.8495                       |
| 2700            | 28.1       | 16.50           | 20.25                                    | 20.25          | 20.25          | 20.25            | 20             | 37.5                 | 756.8                 | 422                 | 2.1                   | 75                   | 80                        | 105        | 32.6                             | -0.8           | 12.90 | 1.39                          | 11.2    | 0.962      | 30.6               | 8.64          | 701.9                            | 18.66     | 580      | 0.822                | 1.15 | 24.3 | 3.8792                       | 0.8257                    | 0.7952                       |
| 3000            | 25         | 8.70            | 27.44                                    | 27.44          | 27.47          | 27.45            | 26             | 33.0                 | 759.1                 | 372                 | 1.7                   | 74                   | 78                        | 104        | 30.0                             | -0.6           | 9.44  | 0.95                          | 9.9     | 1.093      | 15.1               | 4.74          | 346.4                            | 15.86     | 724      | 0.828                | 0.85 | 13.2 | 3.0267                       | 0.8962                    | 0.8780                       |
| 3000            | 26         | 11.80           | 24.25                                    | 24.25          | 24.28          | 24.26            | 22             | 34.0                 | 758.8                 | 407                 | 2.0                   | 75                   | 80                        | 107        | 28.9                             | -0.7           | 10.97 | 1.10                          | 10.0    | 1.088      | 18.6               | 5.86          | 428.2                            | 16.95     | 677      | 0.831                | 0.97 | 16.0 | 3.2006                       | 0.8796                    | 0.8586                       |
| 3000            | 27         | 15.60           | 20.72                                    | 20.72          | 20.71          | 20.72            | 20             | 34.2                 | 758.9                 | 446                 | 2.5                   | 78                   | 83                        | 108        | 27.6                             | -0.9           | 12.61 | 1.30                          | 9.7     | 1.116      | 24.2               | 7.60          | 555.4                            | 18.63     | 616      | 0.834                | 1.14 | 20.7 | 3.2364                       | 0.8766                    | 0.8550                       |
| 3000            | 27.8       | 18.40           | 19.03                                    | 19.06          | 19.15          | 19.08            | 20             | 34.0                 | 758.9                 | 461                 | 2.8                   | 78                   | 83                        | 103        | 27.7                             | -0.9           | 13.70 | 1.41                          | 9.7     | 1.111      | 26.7               | 8.39          | 613.1                            | 19.02     | 603      | 0.833                | 1.24 | 22.9 | 3.2006                       | 0.8797                    | 0.8587                       |
| 3000            | 27.8       | 18.20           | 18.78                                    | 18.78          | 18.75          | 18.77            | 20             | 37.5                 | 756.8                 | 449                 | 3.4                   | 76                   | 81                        | 108        | 32.5                             | -0.9           | 13.55 | 1.50                          | 10.9    | 0.988      | 29.7               | 9.33          | 682.0                            | 18.67     | 579      | 0.822                | 1.24 | 23.6 | 3.8792                       | 0.8257                    | 0.7952                       |

ตารางที่ ๖-6 (ต่อ) แสดงผลการทดสอบเครื่องยนต์ Daihatsu รุ่น AB 547cc ด้วย gas mixer ชนิดผสมคาร์บอนกับ carburetor ที่รอบต่าง ๆ โดยใช้เชื้อเพลิงแก๊สผสมที่มีมีเทนและ N<sub>2</sub> เป็นองค์ประกอบหลัก (แก๊สธรรมชาติจากแหล่งพม่า) ปรับ Spark timing ที่ MBT เมทริกซ์ทดสอบรูปที่ 3-22

| speed(rev/min) | MAP(inHg) | P diff(mm H2O) | Fuel consumption 1 ft <sup>3</sup> (sec) |                       |                      |                       | θ <sub>s</sub> | T <sub>b</sub> (kg) | Ambient              |                       | T <sub>exhaust</sub> (°C) | P <sub>exhaust</sub> (inH2O) | Cooling             |                        | Gas cond. |      | ma (g/sec) | m <sub>corrected</sub> (g/sec) | Air/fuel ratio | φ     | T <sub>b corrected</sub> (N-m) | P <sub>b</sub> (kW) | bmeP (kPa) | η <sub>b</sub> (%) | bsfc (g/kW-h) | gas density(kg/m <sup>3</sup> ) | ml (g/sec) | T <sub>b</sub> (N-m) | P <sub>v, iable</sub> | k      |
|----------------|-----------|----------------|--|-----------------------|----------------------|-----------------------|----------------|---------------------|----------------------|-----------------------|---------------------------|------------------------------|---------------------|------------------------|-----------|------|------------|--------------------------------|----------------|-------|--------------------------------|---------------------|------------|--------------------|---------------|---------------------------------|------------|----------------------|-----------------------|--------|
|                |           |                | T <sub>amb</sub> (°C)                    | P <sub>a</sub> (mmHg) | T <sub>in</sub> (°C) | T <sub>out</sub> (°C) |                |                     | T <sub>in</sub> (°C) | T <sub>out</sub> (°C) |                           |                              | T <sub>g</sub> (°C) | P <sub>g</sub> (inH2O) |           |      |            |                                |                |       |                                |                     |            |                    |               |                                 |            |                      |                       |        |
| 3300           | 25        | 10.00          | 24.56                                    | 24.56                 | 24.56                | 28                    | 3.85           | 35.0                | 759.0                | 390                   | 1.3                       | 72                           | 75                  | 105                    | 31.3      | -0.7 | 10.08      | 1.10                           | 9.2            | 1.185 | 15.8                           | 5.47                | 363.7      | 15.79              | 725           | 0.826                           | 0.95       | 13.3                 | 3.3831                | 0.8643 |
| 3300           | 26        | 13.40          | 21.75                                    | 21.75                 | 21.74                | 24                    | 4.80           | 35.0                | 759.2                | 416                   | 1.7                       | 73                           | 78                  | 107                    | 31.0      | -0.8 | 11.67      | 1.25                           | 9.4            | 1.158 | 19.7                           | 6.82                | 453.3      | 17.41              | 657           | 0.826                           | 1.08       | 16.6                 | 3.3831                | 0.8645 |
| 3300           | 27        | 17.50          | 18.81                                    | 18.82                 | 18.82                | 22                    | 6.00           | 35.0                | 759.2                | 455                   | 2.4                       | 75                           | 81                  | 110                    | 30.7      | -0.9 | 13.34      | 1.44                           | 9.3            | 1.171 | 24.7                           | 8.53                | 566.6      | 18.83              | 608           | 0.827                           | 1.24       | 20.7                 | 3.3831                | 0.8645 |
| 3300           | 27.6      | 20.00          | 18.59                                    | 18.56                 | 18.58                | 22                    | 6.50           | 34.0                | 759.0                | 468                   | 2.5                       | 77                           | 83                  | 104                    | 29.9      | -1   | 14.29      | 1.44                           | 9.9            | 1.091 | 26.2                           | 9.04                | 601.0      | 20.01              | 572           | 0.829                           | 1.26       | 22.5                 | 3.2006                | 0.8798 |
| 3300           | 27.4      | 19.60          | 17.66                                    | 17.65                 | 17.66                | 22                    | 6.55           | 38.0                | 756.8                | 449                   | 2.5                       | 76                           | 81                  | 109                    | 32.8      | -0.9 | 14.05      | 1.61                           | 10.7           | 1.012 | 28.8                           | 9.94                | 660.7      | 18.58              | 582           | 0.821                           | 1.32       | 22.7                 | 3.9856                | 0.8188 |
| 3600           | 26        | 15.20          | 20.10                                    | 20.15                 | 20.00                | 24                    | 4.73           | 35.7                | 759.3                | 448                   | 2.3                       | 75                           | 80                  | 112                    | 29.5      | -0.9 | 12.42      | 1.37                           | 9.1            | 1.198 | 19.7                           | 7.44                | 453.3      | 17.25              | 663           | 0.830                           | 1.17       | 16.4                 | 3.5162                | 0.8540 |
| 3600           | 27        | 19.40          | 17.72                                    | 17.72                 | 17.72                | 24                    | 5.83           | 35.6                | 759.3                | 479                   | 2.8                       | 77                           | 82                  | 113                    | 29.2      | -1.1 | 14.03      | 1.55                           | 9.0            | 1.200 | 24.3                           | 9.15                | 557.6      | 18.74              | 610           | 0.831                           | 1.33       | 20.2                 | 3.4969                | 0.8555 |
| 3600           | 27.4      | 21.60          | 16.88                                    | 16.78                 | 16.80                | 22                    | 6.25           | 35.6                | 759.3                | 488                   | 3.4                       | 78                           | 83                  | 107                    | 29.4      | -1.1 | 14.81      | 1.63                           | 9.1            | 1.197 | 26.0                           | 9.81                | 597.7      | 19.09              | 599           | 0.830                           | 1.40       | 21.6                 | 3.4969                | 0.8556 |
| 3600           | 27.4      | 21.20          | 16.22                                    | 16.18                 | 16.22                | 22                    | 6.60           | 36.5                | 755.7                | 454                   | 4.8                       | 82                           | 85                  | 113                    | 31.8      | -1.1 | 14.65      | 1.71                           | 10.2           | 1.063 | 28.2                           | 10.61               | 646.4      | 19.72              | 582           | 0.823                           | 1.44       | 22.8                 | 3.6537                | 0.8389 |
| 3900           | 26        | 17.00          | 18.84                                    | 18.84                 | 18.82                | 24                    | 4.63           | 35.5                | 759.5                | 457                   | 3.3                       | 72                           | 77                  | 113                    | 29.5      | -0.9 | 13.14      | 1.46                           | 9.0            | 1.204 | 19.2                           | 7.86                | 441.7      | 17.13              | 668           | 0.830                           | 1.25       | 16.0                 | 3.4777                | 0.8572 |
| 3900           | 27        | 22.20          | 16.72                                    | 16.72                 | 16.78                | 24                    | 5.70           | 34.6                | 759.5                | 487                   | 4.5                       | 75                           | 79                  | 115                    | 28.6      | -1.1 | 15.04      | 1.62                           | 9.3            | 1.167 | 23.2                           | 9.49                | 533.6      | 18.65              | 613           | 0.833                           | 1.41       | 19.7                 | 3.3275                | 0.8708 |
| 3900           | 27.2      | 23.50          | 16.53                                    | 16.53                 | 16.56                | 24                    | 5.90           | 34.6                | 759.5                | 493                   | 4.7                       | 76                           | 81                  | 110                    | 28.1      | -1.1 | 15.47      | 1.64                           | 9.4            | 1.150 | 24.1                           | 9.82                | 552.3      | 19.04              | 601           | 0.834                           | 1.43       | 20.4                 | 3.3275                | 0.8708 |
| 3900           | 27.2      | 23.30          | 15.84                                    | 15.81                 | 15.81                | 24                    | 6.38           | 37.0                | 755.7                | 475                   | 4.6                       | 78                           | 82                  | 115                    | 32.0      | -1.2 | 15.34      | 1.77                           | 10.4           | 1.038 | 27.5                           | 11.23               | 631.5      | 20.21              | 567           | 0.823                           | 1.47       | 22.1                 | 3.7753                | 0.8316 |



ตารางที่ ๑-6 (ต่อ) แสดงผลการทดสอบเครื่องยนต์ Daihatsu รุ่น AB 547cc ด้วย gas mixer ชนิดผสมกับ carburetor ที่รอบต่าง ๆ โดยใช้เชื้อเพลิงแก๊สผสมที่มี มีมีเทนและ N<sub>2</sub> เป็นองค์ประกอบหลัก (แก๊สธรรมชาติจากแหล่งพม่า) ปรับ Spark timing ที่ MBT เมทริกซ์ทดสอบรูปที่ 3-22

| speed (rev/min) | MAP (inHg) | P diff (mm H2O) | Fuel consumption 1 ft <sup>3</sup> (sec) |                       |                      |                       | θ <sub>s</sub> | Tb (kg) | Ambient              |                       | T <sub>exhaust</sub> (°C) | P <sub>exhaust</sub> (mmH2O) | Cooling        |                | T <sub>in</sub> (°C) | T <sub>out</sub> (°C) | T <sub>in</sub> (°C) | T <sub>out</sub> (°C) | Gas cond.      |                  | ma (g/sec) | m <sub>corrected</sub> (g/sec) | Air/fuel ratio | φ     | T <sub>corrected</sub> (N-m) | Pb (kW) | bmep (kPa) | η <sub>th</sub> (%) | bsfc (g/kW-h) | gas density (kg/m <sup>3</sup> ) | mf (g/sec) | Tb (N-m) | P <sub>viable</sub> | k | α |
|-----------------|------------|-----------------|--|-----------------------|----------------------|-----------------------|----------------|---------|----------------------|-----------------------|---------------------------|------------------------------|----------------|----------------|----------------------|-----------------------|----------------------|-----------------------|----------------|------------------|------------|--------------------------------|----------------|-------|------------------------------|---------|------------|---------------------|---------------|----------------------------------|------------|----------|---------------------|---|---|
|                 |            |                 | T <sub>amb</sub> (°C)                    | P <sub>a</sub> (mmHg) | T <sub>in</sub> (°C) | T <sub>out</sub> (°C) |                |         | T <sub>in</sub> (°C) | T <sub>out</sub> (°C) |                           |                              | t <sub>1</sub> | t <sub>2</sub> |                      |                       |                      |                       | t <sub>3</sub> | t <sub>avg</sub> |            |                                |                |       |                              |         |            |                     |               |                                  |            |          |                     |   |   |
| 1500            | 25         | 2.00            | 61.91                                    | 61.98                 | 61.96                | 61.95                 | 28             | 2.13    | 31.4                 | 756.5                 | 225                       | 1.0                          | 71             | 74             | 93                   | 30.8                  | -0.3                 | 4.54                  | 0.41           | 12.0             | 0.905      | 8.1                            | 1.28           | 186.5 | 9.87                         | 1158    | 0.827      | 0.38                | 7.4           | 2.7654                           | 0.9207     | 0.9068   |                     |   |   |
| 1500            | 26         | 2.60            | 54.81                                    | 54.85                 | 54.78                | 54.81                 | 24             | 3.28    | 31.8                 | 756.5                 | 233                       | 1.0                          | 74             | 77             | 82                   | 31.0                  | -0.3                 | 5.17                  | 0.47           | 12.1             | 0.897      | 12.6                           | 1.98           | 289.8 | 13.47                        | 848     | 0.826      | 0.43                | 11.3          | 2.8289                           | 0.9137     | 0.8986   |                     |   |   |
| 1500            | 27         | 3.60            | 47.88                                    | 47.78                 | 47.84                | 47.83                 | 20             | 4.28    | 31.5                 | 756.8                 | 246                       | 1.5                          | 76             | 79             | 78                   | 30.6                  | -0.3                 | 6.09                  | 0.53           | 12.4             | 0.874      | 16.4                           | 2.57           | 375.5 | 15.30                        | 747     | 0.827      | 0.49                | 14.8          | 2.7812                           | 0.9193     | 0.9051   |                     |   |   |
| 1500            | 28         | 4.60            | 40.50                                    | 40.53                 | 40.50                | 40.51                 | 20             | 5.33    | 32.3                 | 756.7                 | 271                       | 2.0                          | 71             | 77             | 88                   | 31.0                  | -0.4                 | 6.87                  | 0.64           | 11.9             | 0.913      | 20.7                           | 3.26           | 476.2 | 16.21                        | 705     | 0.826      | 0.58                | 18.4          | 2.9099                           | 0.9054     | 0.8888   |                     |   |   |
| 1500            | 29.3       | 8.60            | 32.84                                    | 32.85                 | 32.84                | 32.84                 | 14             | 7.18    | 31.5                 | 756.6                 | 308                       | 2.7                          | 78             | 84             | 81                   | 30.9                  | -0.5                 | 9.41                  | 0.77           | 13.2             | 0.822      | 27.4                           | 4.31           | 630.0 | 17.65                        | 647     | 0.826      | 0.71                | 24.8          | 2.7812                           | 0.9191     | 0.9049   |                     |   |   |
| 1800            | 24         | 2.60            | 54.30                                    | 54.56                 | 54.40                | 54.42                 | 28             | 1.98    | 32.9                 | 756.8                 | 258                       | 1.7                          | 75             | 77             | 89                   | 31.8                  | -0.4                 | 5.16                  | 0.48           | 12.0             | 0.905      | 7.8                            | 1.47           | 179.3 | 9.71                         | 1174    | 0.826      | 0.43                | 6.8           | 3.0098                           | 0.8953     | 0.8770   |                     |   |   |
| 1800            | 25         | 3.50            | 48.56                                    | 48.56                 | 48.59                | 48.57                 | 28             | 3.05    | 32.9                 | 756.8                 | 263                       | 1.8                          | 77             | 80             | 91                   | 31.9                  | -0.4                 | 5.99                  | 0.54           | 12.4             | 0.874      | 12.0                           | 2.27           | 276.1 | 13.36                        | 854     | 0.826      | 0.48                | 10.5          | 3.0098                           | 0.8953     | 0.8770   |                     |   |   |
| 1800            | 26         | 4.50            | 43.62                                    | 43.72                 | 43.69                | 43.68                 | 22             | 3.80    | 33.9                 | 756.8                 | 275                       | 1.9                          | 73             | 77             | 93                   | 32.1                  | -0.4                 | 6.78                  | 0.61           | 12.7             | 0.858      | 15.3                           | 2.89           | 351.7 | 15.03                        | 759     | 0.825      | 0.53                | 13.1          | 3.1829                           | 0.8791     | 0.8580   |                     |   |   |
| 1800            | 27         | 5.60            | 38.03                                    | 37.94                 | 37.97                | 37.98                 | 22             | 4.63    | 34.0                 | 756.7                 | 292                       | 2.4                          | 76             | 79             | 93                   | 32.0                  | -0.5                 | 7.56                  | 0.70           | 12.3             | 0.885      | 18.7                           | 3.53           | 429.5 | 15.93                        | 716     | 0.825      | 0.62                | 16.0          | 3.2006                           | 0.8774     | 0.8560   |                     |   |   |
| 1800            | 28         | 7.40            | 30.84                                    | 30.85                 | 30.87                | 30.85                 | 20             | 6.05    | 34.8                 | 756.5                 | 329                       | 3.2                          | 73             | 79             | 96                   | 32.0                  | -0.6                 | 8.68                  | 0.88           | 11.5             | 0.948      | 24.9                           | 4.69           | 571.1 | 16.97                        | 672     | 0.825      | 0.76                | 20.9          | 3.3459                           | 0.8648     | 0.8411   |                     |   |   |
| 1800            | 29         | 8.60            | 27.94                                    | 27.97                 | 28.00                | 27.97                 | 16             | 7.08    | 34.0                 | 756.5                 | 357                       | 4.2                          | 81             | 87             | 95                   | 31.5                  | -0.6                 | 9.37                  | 0.95           | 11.2             | 0.971      | 28.6                           | 5.39           | 656.9 | 17.92                        | 637     | 0.826      | 0.84                | 24.5          | 3.2006                           | 0.8772     | 0.8557   |                     |   |   |
| 2100            | 24         | 4.10            | 43.33                                    | 43.37                 | 43.41                | 43.37                 | 28             | 2.48    | 33.6                 | 756.3                 | 286                       | 1.0                          | 72             | 75             | 9                    | 32.2                  | -0.4                 | 6.47                  | 0.61           | 12.0             | 0.904      | 9.9                            | 2.19           | 228.2 | 11.36                        | 1004    | 0.825      | 0.54                | 8.6           | 3.1301                           | 0.8834     | 0.8630   |                     |   |   |
| 2100            | 25         | 5.50            | 38.85                                    | 38.81                 | 38.72                | 38.79                 | 24             | 3.33    | 34.0                 | 756.3                 | 294                       | 1.2                          | 71             | 75             | 91                   | 31.9                  | -0.4                 | 7.49                  | 0.69           | 12.4             | 0.874      | 13.5                           | 2.96           | 309.1 | 13.65                        | 836     | 0.826      | 0.60                | 11.5          | 3.2006                           | 0.8770     | 0.8555   |                     |   |   |
| 2100            | 26         | 7.20            | 34.59                                    | 34.59                 | 34.58                | 34.58                 | 22             | 4.28    | 33.9                 | 756.0                 | 305                       | 1.4                          | 75             | 79             | 95                   | 31.6                  | -0.5                 | 8.57                  | 0.77           | 12.7             | 0.858      | 17.3                           | 3.80           | 396.5 | 15.62                        | 730     | 0.826      | 0.68                | 14.8          | 3.1829                           | 0.8783     | 0.8571   |                     |   |   |
| 2100            | 27         | 8.80            | 30.47                                    | 30.41                 | 30.44                | 30.44                 | 20             | 5.25    | 33.9                 | 755.9                 | 330                       | 1.9                          | 76             | 81             | 95                   | 31.5                  | -0.6                 | 9.48                  | 0.88           | 12.3             | 0.882      | 21.2                           | 4.66           | 486.5 | 16.87                        | 676     | 0.826      | 0.77                | 18.2          | 3.1829                           | 0.8782     | 0.8569   |                     |   |   |
| 2100            | 28         | 10.00           | 26.53                                    | 26.56                 | 26.50                | 26.53                 | 18             | 6.38    | 34.5                 | 755.9                 | 359                       | 2.2                          | 73             | 78             | 93                   | 31.1                  | -0.7                 | 10.09                 | 1.02           | 11.4             | 0.951      | 26.1                           | 5.74           | 598.9 | 17.88                        | 638     | 0.827      | 0.88                | 22.1          | 3.2908                           | 0.8688     | 0.8459   |                     |   |   |
| 2100            | 29         | 11.40           | 23.97                                    | 23.91                 | 24.00                | 23.96                 | 18             | 7.05    | 33.2                 | 755.9                 | 366                       | 2.1                          | 75             | 80             | 82                   | 30.7                  | -0.7                 | 10.80                 | 1.10           | 11.0             | 0.985      | 28.0                           | 6.16           | 643.3 | 17.74                        | 643     | 0.828      | 0.98                | 24.4          | 3.0608                           | 0.8895     | 0.8702   |                     |   |   |

ตารางที่ ๑-6 (ต่อ) แสดงผลการทดสอบเครื่องยนต์ Daihatsu รุ่น AB 547cc ด้วย gas mixer ชนิดผสมคาร์บูเรเตอร์ที่รอบต่าง ๆ โดยใช้เชื้อเพลิงแก๊สผสมที่มีมีเทนและ N<sub>2</sub> เป็นองค์ประกอบหลัก (แก้จรรยาบรรณชาติจากแหล่งพม่า) ปรับ Spark timing ที่ MBT เมทริกซ์ทดสอบรูปที่ 3-22

| speed (rev/min) | MAP (inHg) | P diff (mm H2O) | Fuel consumption 1 ft <sup>3</sup> (sec) |                |                |                  | θ <sub>s</sub> | T <sub>b</sub> (kg) | Ambient              |                       | P <sub>exhaust</sub> (inH2O) | Cooling              |                       | Gas cond.            |                     | ma (g/sec) | m <sub>corrected</sub> (g/sec) | Air/Fuel ratio | φ    | T <sub>bcorrected</sub> (N-m) | Pd (kW) | bmep (kPa) | η <sub>br</sub> (%) | bsfc (g/kW-h) | gas density (kg/m <sup>3</sup> ) | mf (g/sec) | T <sub>b</sub> (N-m) | P <sub>v,table</sub> | k    | α      |                        |        |
|-----------------|------------|-----------------|--|----------------|----------------|------------------|----------------|---------------------|----------------------|-----------------------|------------------------------|----------------------|-----------------------|----------------------|---------------------|------------|--------------------------------|----------------|------|-------------------------------|---------|------------|---------------------|---------------|----------------------------------|------------|----------------------|----------------------|------|--------|------------------------|--------|
|                 |            |                 | t <sub>1</sub>                           | t <sub>2</sub> | t <sub>3</sub> | t <sub>avg</sub> |                |                     | T <sub>db</sub> (°C) | P <sub>a</sub> (mmHg) |                              | T <sub>in</sub> (°C) | T <sub>out</sub> (°C) | T <sub>in</sub> (°C) | T <sub>g</sub> (°C) |            |                                |                |      |                               |         |            |                     |               |                                  |            |                      |                      |      |        | P <sub>g</sub> (inH2O) |        |
| 2400            | 24         | 5.00            | 43.12                                    | 43.03          | 42.97          | 43.04            | 30             | 2.78                | 34.0                 | 757.2                 | 309                          | 0.7                  | 72                    | 75                   | 95                  | 31.4       | -0.4                           | 7.14           | 0.62 | 13.1                          | 0.823   | 11.2       | 2.82                | 257.7         | 14.52                            | 791        | 0.827                | 0.54                 | 9.6  | 3.2006 | 0.8779                 | 0.8566 |
| 2400            | 25         | 6.80            | 36.00                                    | 36.03          | 36.03          | 36.02            | 24             | 3.48                | 33.6                 | 757.2                 | 315                          | 0.9                  | 78                    | 81                   | 96                  | 31.6       | -0.4                           | 8.34           | 0.73 | 12.8                          | 0.843   | 13.9       | 3.50                | 319.8         | 15.20                            | 756        | 0.826                | 0.65                 | 12.0 | 3.1301 | 0.8843                 | 0.8641 |
| 2400            | 26         | 9.00            | 30.88                                    | 30.81          | 30.85          | 30.85            | 20             | 4.43                | 34.8                 | 757.2                 | 339                          | 1.2                  | 75                    | 80                   | 99                  | 32.3       | -0.5                           | 9.57           | 0.87 | 12.6                          | 0.855   | 18.2       | 4.57                | 417.8         | 16.69                            | 688        | 0.824                | 0.76                 | 15.3 | 3.3459 | 0.8655                 | 0.8419 |
| 2400            | 27         | 11.40           | 26.50                                    | 26.56          | 26.59          | 26.55            | 18             | 5.58                | 35.3                 | 757.2                 | 372                          | 1.5                  | 74                    | 79                   | 101                 | 31.6       | -0.6                           | 10.76          | 1.03 | 12.2                          | 0.885   | 23.2       | 5.82                | 531.9         | 18.09                            | 635        | 0.826                | 0.88                 | 19.3 | 3.4396 | 0.8579                 | 0.8330 |
| 2400            | 28         | 13.00           | 23.09                                    | 23.10          | 23.09          | 23.09            | 18             | 6.73                | 35.2                 | 757.2                 | 400                          | 2.1                  | 75                    | 81                   | 101                 | 30.7       | -0.6                           | 11.49          | 1.18 | 11.3                          | 0.955   | 27.9       | 7.01                | 640.3         | 18.91                            | 607        | 0.828                | 1.02                 | 23.3 | 3.4396 | 0.8592                 | 0.8346 |
| 2400            | 28.5       | 13.60           | 22.09                                    | 22.09          | 22.06          | 22.08            | 18             | 7.18                | 33.6                 | 757.2                 | 413                          | 2.7                  | 76                    | 81                   | 98                  | 30.2       | -0.7                           | 11.79          | 1.20 | 11.1                          | 0.976   | 28.7       | 7.22                | 659.7         | 19.15                            | 600        | 0.830                | 1.06                 | 24.8 | 3.1301 | 0.8844                 | 0.8641 |
| 2700            | 24         | 5.60            | 34.84                                    | 34.84          | 34.85          | 34.84            | 30             | 2.70                | 34.0                 | 755.9                 | 329                          | 1.0                  | 78                    | 81                   | 99                  | 32.5       | -0.5                           | 7.56           | 0.76 | 11.3                          | 0.958   | 10.9       | 3.09                | 250.7         | 12.88                            | 890        | 0.823                | 0.67                 | 9.3  | 3.2006 | 0.8767                 | 0.8551 |
| 2700            | 25         | 7.70            | 30.94                                    | 30.94          | 30.97          | 30.95            | 28             | 3.58                | 34.7                 | 755.8                 | 337                          | 1.1                  | 76                    | 80                   | 101                 | 32.8       | -0.5                           | 8.85           | 0.87 | 11.8                          | 0.920   | 14.7       | 4.16                | 337.6         | 15.22                            | 753        | 0.822                | 0.75                 | 12.4 | 3.3275 | 0.8656                 | 0.8421 |
| 2700            | 26         | 10.30           | 27.43                                    | 27.53          | 27.60          | 27.52            | 22             | 4.38                | 34.1                 | 758.0                 | 367                          | 1.3                  | 76                    | 80                   | 102                 | 32.0       | -0.6                           | 10.25          | 0.97 | 12.1                          | 0.894   | 17.7       | 5.00                | 406.4         | 16.53                            | 695        | 0.824                | 0.85                 | 15.1 | 3.2185 | 0.8772                 | 0.8558 |
| 2700            | 27         | 13.40           | 23.34                                    | 23.35          | 23.35          | 23.35            | 20             | 5.68                | 33.8                 | 758.0                 | 394                          | 1.7                  | 78                    | 83                   | 100                 | 31.5       | -0.7                           | 11.70          | 1.13 | 11.7                          | 0.925   | 22.8       | 6.45                | 523.6         | 18.13                            | 633        | 0.825                | 1.00                 | 19.6 | 3.1652 | 0.8820                 | 0.8614 |
| 2700            | 28         | 16.60           | 20.25                                    | 20.25          | 20.25          | 20.25            | 18             | 6.80                | 32.3                 | 758.0                 | 419                          | 2.3                  | 77                    | 82                   | 91                  | 30.5       | -0.8                           | 13.05          | 1.28 | 11.3                          | 0.959   | 26.4       | 7.47                | 606.4         | 18.67                            | 615        | 0.828                | 1.16                 | 23.5 | 2.9099 | 0.9067                 | 0.8904 |
| 3000            | 25         | 8.40            | 28.15                                    | 28.16          | 28.16          | 28.16            | 26             | 3.50                | 35.6                 | 757.0                 | 367                          | 2.2                  | 71                    | 74                   | 100                 | 32.5       | -0.6                           | 9.23           | 0.97 | 11.1                          | 0.968   | 14.6       | 4.59                | 335.8         | 15.12                            | 761        | 0.824                | 0.83                 | 12.1 | 3.4969 | 0.8532                 | 0.8276 |
| 3000            | 26         | 11.40           | 24.59                                    | 24.59          | 24.59          | 24.59            | 22             | 4.43                | 35.3                 | 757.0                 | 392                          | 4.1                  | 71                    | 76                   | 102                 | 31.6       | -0.7                           | 10.76          | 1.11 | 11.3                          | 0.954   | 18.4       | 5.78                | 422.4         | 16.64                            | 691        | 0.826                | 0.95                 | 15.3 | 3.4396 | 0.8577                 | 0.8328 |
| 3000            | 27         | 14.80           | 21.28                                    | 21.28          | 21.28          | 21.28            | 18             | 5.60                | 34.4                 | 757.0                 | 432                          | 3.9                  | 71                    | 76                   | 103                 | 31.0       | -0.8                           | 12.28          | 1.26 | 11.2                          | 0.967   | 22.8       | 7.17                | 523.7         | 18.12                            | 635        | 0.827                | 1.10                 | 19.4 | 3.2726 | 0.8715                 | 0.8490 |
| 3000            | 27.8       | 18.00           | 18.91                                    | 18.91          | 18.91          | 18.91            | 18             | 6.58                | 32.8                 | 757.0                 | 444                          | 4.3                  | 78                    | 82                   | 91                  | 30.5       | -0.9                           | 13.58          | 1.38 | 10.9                          | 0.986   | 25.9       | 8.13                | 594.2         | 18.78                            | 612        | 0.829                | 1.24                 | 22.8 | 2.9929 | 0.8973                 | 0.8793 |



ตารางที่ ๖-6 (ต่อ) แสดงผลการทดสอบเครื่องยนต์ Daihatsu รุ่น AB 547cc ด้วย gas mixer ชนิดผสมคาร์บูเรเตอร์ที่รอบต่าง ๆ โดยใช้เชื้อเพลิงแก๊สผสมที่มีไนโตรเจนและ N<sub>2</sub> เป็นองค์ประกอบหลัก (แก้ธรรมชาติจากแหล่งพม่า) ปรับ Spark timing ที่ MBT เมทริกซ์ทดสอบรูปที่ 3-22

| speed (rev/min) | MAP (inHg) | P diff (mm H <sub>2</sub> O) | Fuel consumption 1 ft <sup>3</sup> (sec) |                       |                      |                       | θ <sub>s</sub> | Tb (kg) | Ambient              |                       | T <sub>exhaust</sub> (°C) | P <sub>exhaust</sub> (inH2O) | Cooling             |                        | T <sub>in</sub> (°C) | T <sub>out</sub> (°C) | T <sub>in</sub> (°C) | T <sub>exhaust</sub> (°C) | Gas cond. | ma (g/sec) | m <sub>corrected</sub> (g/sec) | Air/fuel ratio | φ     | Tb <sub>corrected</sub> (N-m) | Pd (kW) | bmep (kPa) | η <sub>m</sub> (%) | bsfc (g/kW-h) | gas density (kg/m <sup>3</sup> ) | mf (g/sec) | Tb (N-m) | P <sub>v,table</sub> | k | α |
|-----------------|------------|------------------------------|--|-----------------------|----------------------|-----------------------|----------------|---------|----------------------|-----------------------|---------------------------|------------------------------|---------------------|------------------------|----------------------|-----------------------|----------------------|---------------------------|-----------|------------|--------------------------------|----------------|-------|-------------------------------|---------|------------|--------------------|---------------|----------------------------------|------------|----------|----------------------|---|---|
|                 |            |                              | T <sub>amb</sub> (°C)                    | P <sub>a</sub> (mmHg) | T <sub>in</sub> (°C) | T <sub>out</sub> (°C) |                |         | T <sub>in</sub> (°C) | T <sub>out</sub> (°C) |                           |                              | T <sub>g</sub> (°C) | P <sub>g</sub> (inH2O) |                      |                       |                      |                           |           |            |                                |                |       |                               |         |            |                    |               |                                  |            |          |                      |   |   |
| 3300            | 25         | 9.80                         | 27.75                                    | 27.75                 | 27.75                | 28                    | 3.53           | 36.0    | 758.5                | 374                   | 1.7                       | 71                           | 74                  | 102                    | 33.6                 | -0.7                  | 9.97                 | 0.99                      | 11.9      | 0.906      | 14.8                           | 5.13           | 340.8 | 16.61                         | 692     | 0.821      | 0.84               | 12.2          | 3.5746                           | 0.8488     | 0.8224   |                      |   |   |
| 3300            | 26         | 13.00                        | 22.75                                    | 22.68                 | 22.72                | 24                    | 4.53           | 35.3    | 758.5                | 401                   | 2.0                       | 72                           | 76                  | 105                    | 32.5                 | -0.8                  | 11.49                | 1.19                      | 11.2      | 0.964      | 18.8                           | 6.49           | 431.0 | 17.34                         | 663     | 0.823      | 1.03               | 15.7          | 3.4396                           | 0.8592     | 0.8346   |                      |   |   |
| 3300            | 27         | 17.20                        | 19.44                                    | 19.44                 | 19.45                | 22                    | 5.80           | 34.2    | 758.5                | 436                   | 2.6                       | 75                           | 80                  | 106                    | 31.3                 | -0.9                  | 13.24                | 1.37                      | 11.0      | 0.980      | 23.5                           | 8.11           | 538.9 | 18.87                         | 609     | 0.826      | 1.20               | 20.1          | 3.2364                           | 0.8762     | 0.8545   |                      |   |   |
| 3300            | 27.6       | 19.80                        | 18.13                                    | 18.09                 | 18.12                | 22                    | 6.60           | 32.0    | 758.5                | 444                   | 2.8                       | 76                           | 80                  | 90                     | 29.9                 | -0.6                  | 14.26                | 1.42                      | 11.0      | 0.983      | 25.4                           | 8.79           | 584.2 | 19.73                         | 583     | 0.831      | 1.30               | 22.8          | 2.8610                           | 0.9124     | 0.8971   |                      |   |   |
| 3600            | 26         | 14.70                        | 20.54                                    | 20.53                 | 20.53                | 26                    | 4.70           | 33.9    | 759.3                | 418                   | 3.2                       | 75                           | 78                  | 109                    | 32.4                 | -0.9                  | 12.25                | 1.29                      | 10.8      | 1.002      | 18.9                           | 7.12           | 433.4 | 17.63                         | 651     | 0.823      | 1.14               | 16.3          | 3.1829                           | 0.8817     | 0.8610   |                      |   |   |
| 3600            | 27         | 19.20                        | 17.97                                    | 17.94                 | 17.97                | 24                    | 5.78           | 33.4    | 759.5                | 449                   | 4.2                       | 77                           | 81                  | 108                    | 30.6                 | -1                    | 14.01                | 1.47                      | 10.7      | 1.007      | 23.0                           | 8.65           | 527.1 | 18.83                         | 610     | 0.828      | 1.31               | 20.0          | 3.0953                           | 0.8900     | 0.8707   |                      |   |   |
| 3600            | 27.4       | 21.60                        | 16.97                                    | 16.97                 | 16.97                | 24                    | 6.28           | 31.6    | 759.5                | 456                   | 5.2                       | 77                           | 81                  | 99                     | 28.7                 | -1.1                  | 14.90                | 1.51                      | 10.7      | 1.008      | 24.0                           | 9.03           | 550.1 | 19.08                         | 602     | 0.833      | 1.39               | 21.7          | 2.7970                           | 0.9204     | 0.9065   |                      |   |   |
| 3900            | 26         | 16.60                        | 19.15                                    | 19.15                 | 19.16                | 26                    | 4.43           | 34.2    | 758.5                | 431                   | 3.8                       | 72                           | 76                  | 109                    | 31.5                 | -0.9                  | 13.01                | 1.39                      | 10.7      | 1.013      | 17.9                           | 7.32           | 411.6 | 16.77                         | 685     | 0.826      | 1.22               | 15.3          | 3.2364                           | 0.8762     | 0.8545   |                      |   |   |
| 3900            | 27         | 22.00                        | 17.25                                    | 17.22                 | 17.25                | 24                    | 5.48           | 33.9    | 758.7                | 457                   | 4.7                       | 72                           | 76                  | 109                    | 30.3                 | -1.1                  | 14.98                | 1.55                      | 11.0      | 0.981      | 22.0                           | 9.00           | 505.8 | 18.58                         | 619     | 0.829      | 1.36               | 18.9          | 3.1829                           | 0.8811     | 0.8603   |                      |   |   |
| 3900            | 27.3       | 24.00                        | 16.47                                    | 16.44                 | 16.46                | 22                    | 5.68           | 32.7    | 758.7                | 458                   | 5.3                       | 75                           | 79                  | 102                    | 29.4                 | -1.1                  | 15.68                | 1.59                      | 11.0      | 0.985      | 22.2                           | 9.08           | 510.6 | 18.25                         | 630     | 0.832      | 1.43               | 19.6          | 2.9762                           | 0.9007     | 0.8833   |                      |   |   |

ตารางที่ ๑-7 แสดงผลการทดสอบผลกระทบบนเครื่องยนต์แบบการปฏิบัติงานต่อสมรรถนะของเครื่องยนต์ Daihatsu รุ่น AB 547cc ด้วย gas mixer ชนิดผสมครบ  
 กับ carburetor เมื่อใช้เพื่อเพลิงแก๊สผสมที่มีองค์ประกอบของมีเทนและแก๊สเฉื่อยที่ WOT

| speed (rev/min) | MAP (inHg) | P diff (mm H <sub>2</sub> O) | Fuel consumption 1 ft <sup>3</sup> (sec) |                |                |                 | θ    | T <sub>b</sub> (kg) | Ambient               |                         | T <sub>exhaust</sub> (°C) | Cooling              |                       | Gas cond.            |                       | m <sup>l</sup> correct (N-m) | φ     | T <sub>b</sub> correct (N-m) | P <sub>b</sub> (kW) | bmep (Kpa) | η <sub>e</sub> (%) | bsfc (g/kWh) | gas density (g/m <sup>3</sup> ) | m <sup>l</sup> (N-m) | P <sub>variable</sub> | k     | α     | Test date |                                     |                     |        |          |          |
|-----------------|------------|------------------------------|--|----------------|----------------|-----------------|------|---------------------|-----------------------|-------------------------|---------------------------|----------------------|-----------------------|----------------------|-----------------------|------------------------------|-------|------------------------------|---------------------|------------|--------------------|--------------|---------------------------------|----------------------|-----------------------|-------|-------|-----------|-------------------------------------|---------------------|--------|----------|----------|
|                 |            |                              | t <sub>1</sub>                           | t <sub>2</sub> | t <sub>3</sub> | t <sub>no</sub> |      |                     | T <sub>amb</sub> (°C) | P <sub>amb</sub> (mmHg) |                           | T <sub>in</sub> (°C) | T <sub>out</sub> (°C) | T <sub>in</sub> (°C) | T <sub>out</sub> (°C) |                              |       |                              |                     |            |                    |              |                                 |                      |                       |       |       |           | P <sub>g</sub> (inH <sub>2</sub> O) | T <sub>g</sub> (°C) |        |          |          |
| 3900            | 27.2       | 23.70                        | 16.59                                    | 16.66          | 16.60          | 22              | 5.88 | 35.8                | 759.2                 | 537                     | 0.9                       | 79                   | 85                    | 116                  | 29.5                  | -1.2                         | 15.51 | 1.66                         | 11.0                | 0.986      | 24.6               | 10.05        | 564.8                           | 19.30                | 595                   | 0.830 | 1.42  | 20.3      | 3.5355                              | 0.8524              | 0.8266 | 05/01/04 |          |
| 3600            | 27.4       | 21.20                        | 17.18                                    | 17.22          | 17.28          | 22              | 6.25 | 36.3                | 759.2                 | 535                     | 0.3                       | 79                   | 85                    | 119                  | 30.2                  | -1.1                         | 14.65 | 1.61                         | 10.8                | 1.004      | 26.4               | 9.96         | 606.6                           | 19.72                | 582                   | 0.828 | 1.36  | 21.6      | 3.6338                              | 0.8452              | 0.8181 | 05/01/04 |          |
| 3600            | 27.4       | 21.40                        | 17.16                                    | 17.19          | 17.17          | 20              | 6.23 | 36.3                | 759.2                 | 541                     | 0.1                       | 78                   | 84                    | 118                  | 30.4                  | -1.1                         | 14.72 | 1.62                         | 10.8                | 1.002      | 26.3               | 9.93         | 604.7                           | 19.61                | 586                   | 0.828 | 1.37  | 21.5      | 3.6338                              | 0.8451              | 0.8180 | 05/01/04 |          |
| 3300            | 27.6       | 19.80                        | 17.87                                    | 17.88          | 17.87          | 22              | 6.53 | 36.8                | 759.2                 | 519                     | 0.3                       | 79                   | 84                    | 116                  | 30.7                  | -1                           | 14.15 | 1.56                         | 10.8                | 1.001      | 27.9               | 9.64         | 640.5                           | 19.66                | 584                   | 0.827 | 1.31  | 22.6      | 3.7344                              | 0.8379              | 0.8095 | 05/01/04 |          |
| 3300            | 27.6       | 19.70                        | 17.84                                    | 17.85          | 17.84          | 20              | 6.50 | 36.8                | 759.2                 | 525                     | 0.2                       | 78                   | 84                    | 115                  | 31                    | -1                           | 14.11 | 1.57                         | 10.8                | 1.004      | 27.8               | 9.59         | 637.5                           | 19.55                | 588                   | 0.827 | 1.31  | 22.5      | 3.7344                              | 0.8379              | 0.8095 | 05/01/04 |          |
| 3000            | 27.8       | 18.30                        | 18.87                                    | 18.88          | 18.88          | 20              | 6.80 | 37.2                | 759.2                 | 509                     | 0.3                       | 78                   | 85                    | 114                  | 31.7                  | -0.9                         | 13.59 | 1.49                         | 11.0                | 0.983      | 29.3               | 9.20         | 672.3                           | 19.75                | 581                   | 0.825 | 1.24  | 23.5      | 3.7959                              | 0.8324              | 0.8031 | 05/01/04 |          |
| 3000            | 27.8       | 18.30                        | 18.90                                    | 18.85          | 18.88          | 18              | 6.75 | 37.0                | 759.2                 | 523                     | 0.2                       | 78                   | 84                    | 114                  | 32.1                  | -0.9                         | 13.60 | 1.48                         | 11.0                | 0.981      | 29.0               | 9.10         | 664.8                           | 19.62                | 585                   | 0.824 | 1.24  | 23.3      | 3.7753                              | 0.8351              | 0.8062 | 05/01/04 |          |
| 2700            | 28         | 16.60                        | 20.19                                    | 20.15          | 20.28          | 20.21           | 18   | 7.03                | 37.1                  | 759.2                   | 492                       | 0.2                  | 76                    | 82                   | 110                   | 32.1                         | -0.8  | 12.95                        | 1.38                | 11.2       | 0.963              | 30.2         | 8.54                            | 693.8                | 19.68                 | 584   | 0.824 | 1.15      | 24.3                                | 3.7959              | 0.8337 | 0.8045   | 05/01/04 |
| 2700            | 28         | 16.70                        | 20.16                                    | 20.09          | 20.13          | 16              | 6.95 | 37.2                | 759.2                 | 54                      | 0.2                       | 75                   | 82                    | 109                  | 32.2                  | -0.8                         | 12.99 | 1.39                         | 11.2                | 0.964      | 29.9               | 8.46         | 687.2                           | 19.39                | 592                   | 0.824 | 1.16  | 24.0      | 3.7959                              | 0.8324              | 0.8031 | 05/01/04 |          |
| 2400            | 28.3       | 14.20                        | 21.59                                    | 21.66          | 21.61          | 18              | 7.20 | 36.5                | 759.2                 | 467                     | 0.2                       | 78                   | 84                    | 117                  | 32.4                  | -0.8                         | 11.99 | 1.28                         | 11.1                | 0.972      | 30.6               | 7.68         | 701.8                           | 19.14                | 600                   | 0.823 | 1.08  | 24.9      | 3.6737                              | 0.8422              | 0.8146 | 05/01/04 |          |
| 2400            | 28.3       | 14.20                        | 21.72                                    | 21.75          | 21.73          | 16              | 7.15 | 36.5                | 759.2                 | 473                     | 0.2                       | 79                   | 85                    | 107                  | 32.3                  | -0.8                         | 11.99 | 1.27                         | 11.2                | 0.967      | 30.4               | 7.63         | 696.9                           | 19.10                | 601                   | 0.823 | 1.07  | 24.7      | 3.6737                              | 0.8422              | 0.8146 | 05/01/04 |          |
| 3900            | 27.2       | 23.90                        | 17.00                                    | 17.03          | 16.97          | 17.00           | 24   | 5.70                | 33.0                  | 759.7                   | 519                       | 4.2                  | 79                    | 84                   | 103                   | 29.8                         | -1.1  | 15.64                        | 1.54                | 11.3       | 0.954              | 22.4         | 9.16                            | 515.1                | 18.97                 | 606   | 0.830 | 1.38      | 19.7                                | 3.0267              | 0.8968 | 0.8787   | 06/01/04 |
| 3900            | 27.2       | 23.40                        | 16.94                                    | 16.93          | 17.06          | 16.98           | 22   | 5.80                | 35.3                  | 759.7                   | 535                       | 4.6                  | 79                    | 84                   | 116                   | 30                           | -1.1  | 15.42                        | 1.61                | 11.1       | 0.969              | 24.0         | 9.80                            | 550.9                | 19.45                 | 591   | 0.829 | 1.38      | 20.1                                | 3.4396              | 0.8605 | 0.8360   | 06/01/04 |
| 3600            | 27.4       | 21.40                        | 17.35                                    | 17.31          | 17.28          | 17.31           | 22   | 6.20                | 36.4                  | 759.6                   | 537                       | 4.1                  | 78                    | 84                   | 117                   | 30.9                         | -1    | 14.72                        | 1.60                | 10.9       | 0.992              | 26.2         | 9.90                            | 602.7                | 19.71                 | 583   | 0.827 | 1.35      | 21.4                                | 3.6537              | 0.8441 | 0.8168   | 06/01/04 |
| 3600            | 27.4       | 21.40                        | 17.34                                    | 17.31          | 17.33          | 20              | 6.18 | 36.4                | 759.5                 | 542                     | 4.0                       | 78                   | 84                    | 117                  | 31.2                  | -1                           | 14.72 | 1.60                         | 10.9                | 0.990      | 26.2               | 9.86         | 600.8                           | 19.69                | 584                   | 0.826 | 1.35  | 21.4      | 3.6537                              | 0.8440              | 0.8167 | 06/01/04 |          |
| 3300            | 27.6       | 19.90                        | 18.25                                    | 18.19          | 18.21          | 22              | 6.43 | 36.9                | 759.0                 | 520                     | 3.2                       | 78                   | 84                    | 116                  | 31.2                  | -1                           | 14.18 | 1.54                         | 11.0                | 0.978      | 27.5               | 9.51         | 632.1                           | 19.76                | 581                   | 0.826 | 1.28  | 22.2      | 3.7548                              | 0.8363              | 0.8077 | 06/01/04 |          |
| 3300            | 27.6       | 19.60                        | 18.25                                    | 18.18          | 18.23          | 20              | 6.40 | 36.9                | 759.0                 | 525                     | 3.2                       | 78                   | 84                    | 114                  | 31.6                  | -1                           | 14.08 | 1.53                         | 11.0                | 0.983      | 27.4               | 9.47         | 629.2                           | 19.72                | 583                   | 0.825 | 1.28  | 22.1      | 3.7548                              | 0.8363              | 0.8077 | 06/01/04 |          |
| 3000            | 27.7       | 18.00                        | 19.21                                    | 19.15          | 19.21          | 19.19           | 20   | 6.73                | 35.3                  | 759.2                   | 515                       | 2.8                  | 78                    | 84                   | 113                   | 32.2                         | -0.9  | 13.52                        | 1.41                | 11.1       | 0.970              | 27.9         | 8.75                            | 639.6                | 19.76                 | 581   | 0.824 | 1.22      | 23.3                                | 3.4396              | 0.8599 | 0.8354   | 06/01/04 |
| 3000            | 27.7       | 18.00                        | 19.22                                    | 19.15          | 19.25          | 19.21           | 18   | 6.68                | 35.3                  | 759.2                   | 521                       | 2.8                  | 78                    | 84                   | 113                   | 32.4                         | -0.9  | 13.52                        | 1.41                | 11.1       | 0.969              | 27.6         | 8.69                            | 634.9                | 19.64                 | 585   | 0.823 | 1.21      | 23.1                                | 3.4396              | 0.8599 | 0.8354   | 06/01/04 |
| 2700            | 28         | 16.40                        | 20.28                                    | 20.25          | 20.34          | 20.29           | 18   | 6.90                | 36.4                  | 759.2                   | 497                       | 1.3                  | 76                    | 82                   | 110                   | 32.6                         | -0.8  | 12.89                        | 1.36                | 11.2       | 0.962              | 29.2         | 8.26                            | 671.1                | 19.38                 | 593   | 0.823 | 1.15      | 23.9                                | 3.6537              | 0.8437 | 0.8164   | 06/01/04 |
| 2700            | 28         | 16.40                        | 20.31                                    | 20.31          | 20.37          | 20.33           | 16   | 6.83                | 36.0                  | 759.0                   | 503                       | 1.3                  | 76                    | 83                   | 109                   | 32.5                         | -0.8  | 12.89                        | 1.35                | 11.3       | 0.960              | 28.7         | 8.11                            | 659.0                | 19.19                 | 599   | 0.823 | 1.15      | 23.6                                | 3.5746              | 0.8493 | 0.8230   | 06/01/04 |
| 2400            | 28.3       | 14.40                        | 21.94                                    | 21.94          | 21.94          | 21.94           | 18   | 7.08                | 35.4                  | 759.0                   | 469                       | 1.0                  | 78                    | 84                   | 108                   | 32.8                         | -0.8  | 12.09                        | 1.24                | 11.4       | 0.948              | 29.4         | 7.38                            | 674.5                | 19.06                 | 603   | 0.822 | 1.06      | 24.5                                | 3.4586              | 0.8582 | 0.8334   | 06/01/04 |
| 2400            | 28.4       | 14.40                        | 21.94                                    | 21.94          | 21.90          | 21.93           | 16   | 7.05                | 35.4                  | 759.0                   | 469                       | 1.2                  | 78                    | 84                   | 108                   | 32.8                         | -0.8  | 12.09                        | 1.24                | 11.4       | 0.948              | 29.3         | 7.35                            | 671.7                | 18.96                 | 606   | 0.822 | 1.06      | 24.4                                | 3.4586              | 0.8582 | 0.8334   | 06/01/04 |



ตารางที่ ๑-7 (ต่อ) แสดงผลการทดสอบสมรรถนะจากการทำงานของเครื่องยนต์ Daihatsu รุ่น AB 547cc ด้วย gas mixer ชนิดผสม

ครอปกับ carburetor เมื่อใช้เพื่อเพลิงแก๊สผสมที่มีองค์ประกอบของมีเทนและแก๊สเฉื่อยที่ WOT

| speed (rev/min) | MAP (mhg) | P diff (mm H2O) | Fuel consumption 1 ft <sup>3</sup> (sec) |                       |                     |                        | $\theta_s$ | T <sub>amb</sub> (°C) | P <sub>a</sub> (mmHg) | Ambient |    | T <sub>exhaust</sub> (°C) | P <sub>exhaust</sub> (mmH2O) | T <sub>in</sub> (°C) | T <sub>out</sub> (°C) | T <sub>oil</sub> (°C) | Gas cond. |      | ma (g/sec) | m <sub>corrected</sub> (g/sec) | Air/fuel ratio | $\phi$ | T <sub>b corrected</sub> (N-m) | P <sub>b</sub> (kW) | b <sub>mep</sub> (kPa) | $\eta_{th}$ (%) | b <sub>stc</sub> (g/kWh) | gas density (kg/m <sup>3</sup> ) | m <sub>f</sub> (g/sec) | T <sub>b</sub> (N-m) | P <sub>v</sub> (table) | k | $\alpha$ | Test date |
|-----------------|-----------|-----------------|--|-----------------------|---------------------|------------------------|------------|-----------------------|-----------------------|---------|----|---------------------------|------------------------------|----------------------|-----------------------|-----------------------|-----------|------|------------|--------------------------------|----------------|--------|--------------------------------|---------------------|------------------------|-----------------|--------------------------|----------------------------------|------------------------|----------------------|------------------------|---|----------|-----------|
|                 |           |                 | T <sub>amb</sub> (°C)                    | P <sub>a</sub> (mmHg) | T <sub>g</sub> (°C) | P <sub>g</sub> (mmH2O) |            |                       |                       |         |    |                           |                              |                      |                       |                       |           |      |            |                                |                |        |                                |                     |                        |                 |                          |                                  |                        |                      |                        |   |          |           |
| 3900            | 27.2      | 23.90           | 16.53                                    | 16.59                 | 16.55               | 22                     | 36.5       | 759.5                 | 529                   | 4.7     | 79 | 84                        | 111                          | 29.4                 | -1.1                  | 15.55                 | 1.69      | 10.9 | 0.987      | 24.5                           | 10.02          | 563.1  | 18.97                          | 607                 | 0.831                  | 1.42            | 20.0                     | 3.6737                           | 0.8426                 | 0.8150               | 07/01/04               |   |          |           |
| 3600            | 27.4      | 21.40           | 16.91                                    | 16.93                 | 16.92               | 22                     | 36.5       | 759.5                 | 530                   | 4.0     | 78 | 84                        | 116                          | 29.6                 | -1                    | 14.72                 | 1.65      | 10.6 | 1.020      | 26.3                           | 9.92           | 604.0  | 19.21                          | 599                 | 0.831                  | 1.39            | 21.4                     | 3.6737                           | 0.8426                 | 0.8150               | 07/01/04               |   |          |           |
| 3600            | 27.4      | 21.40           | 16.88                                    | 16.88                 | 16.88               | 20                     | 36.5       | 759.5                 | 536                   | 4.0     | 78 | 84                        | 117                          | 30.3                 | -1                    | 14.72                 | 1.65      | 10.6 | 1.020      | 26.2                           | 9.89           | 602.1  | 19.15                          | 601                 | 0.829                  | 1.39            | 21.4                     | 3.6737                           | 0.8426                 | 0.8150               | 07/01/04               |   |          |           |
| 3300            | 27.6      | 19.90           | 17.91                                    | 17.94                 | 17.90               | 22                     | 36.0       | 759.5                 | 511                   | 3.4     | 78 | 84                        | 115                          | 30.9                 | -1                    | 14.20                 | 1.54      | 10.9 | 0.995      | 27.2                           | 9.40           | 624.8  | 19.51                          | 590                 | 0.827                  | 1.31            | 22.4                     | 3.5746                           | 0.8498                 | 0.8236               | 07/01/04               |   |          |           |
| 3300            | 27.6      | 19.90           | 17.78                                    | 17.79                 | 17.81               | 20                     | 36.0       | 759.5                 | 515                   | 3.5     | 78 | 84                        | 115                          | 31.7                 | -1                    | 14.20                 | 1.54      | 10.8 | 0.998      | 27.1                           | 9.36           | 621.9  | 19.38                          | 594                 | 0.825                  | 1.31            | 22.3                     | 3.5746                           | 0.8498                 | 0.8236               | 07/01/04               |   |          |           |
| 3000            | 27.7      | 18.20           | 18.69                                    | 18.72                 | 18.70               | 20                     | 35.1       | 759.5                 | 506                   | 2.8     | 78 | 84                        | 113                          | 32                   | -0.9                  | 13.60                 | 1.45      | 10.9 | 0.991      | 27.7                           | 8.71           | 636.7  | 19.25                          | 598                 | 0.824                  | 1.25            | 23.3                     | 3.4019                           | 0.8633                 | 0.8394               | 07/01/04               |   |          |           |
| 3000            | 27.7      | 18.40           | 18.59                                    | 18.60                 | 18.59               | 18                     | 35.1       | 759.7                 | 517                   | 3.0     | 78 | 85                        | 113                          | 32.4                 | -0.9                  | 13.68                 | 1.45      | 10.9 | 0.990      | 27.5                           | 8.64           | 631.7  | 19.02                          | 605                 | 0.823                  | 1.25            | 23.1                     | 3.4019                           | 0.8635                 | 0.8396               | 07/01/04               |   |          |           |
| 2700            | 28        | 16.70           | 19.94                                    | 19.94                 | 19.94               | 18                     | 35.6       | 759.7                 | 491                   | 2.0     | 76 | 82                        | 111                          | 32.7                 | -0.8                  | 13.02                 | 1.36      | 11.1 | 0.969      | 29.1                           | 8.22           | 667.1  | 19.24                          | 598                 | 0.823                  | 1.17            | 24.1                     | 3.4969                           | 0.8560                 | 0.8307               | 07/01/04               |   |          |           |
| 2700            | 28        | 16.70           | 20.22                                    | 20.13                 | 19.94               | 16                     | 35.6       | 759.7                 | 492                   | 1.9     | 76 | 83                        | 109                          | 32.8                 | -0.8                  | 13.02                 | 1.35      | 11.2 | 0.961      | 28.8                           | 8.16           | 662.4  | 19.25                          | 598                 | 0.822                  | 1.16            | 24.0                     | 3.4969                           | 0.8560                 | 0.8307               | 07/01/04               |   |          |           |
| 3000            | 27.7      | 18.30           | 18.94                                    | 18.94                 | 18.94               | 20                     | 35.4       | 759.1                 | 510                   | 2.9     | 78 | 84                        | 109                          | 30.2                 | -0.9                  | 13.63                 | 1.44      | 11.0 | 0.982      | 27.4                           | 8.60           | 628.7  | 19.00                          | 604                 | 0.829                  | 1.24            | 22.8                     | 3.4586                           | 0.8583                 | 0.8335               | 08/01/04               |   |          |           |
| 3000            | 27.7      | 18.30           | 18.94                                    | 18.91                 | 18.94               | 18                     | 35.4       | 759.1                 | 505                   | 2.9     | 78 | 85                        | 111                          | 30.5                 | -0.9                  | 13.63                 | 1.44      | 11.0 | 0.981      | 27.2                           | 8.54           | 623.9  | 18.87                          | 609                 | 0.828                  | 1.24            | 22.7                     | 3.4586                           | 0.8583                 | 0.8336               | 08/01/04               |   |          |           |
| 2700            | 28        | 17.00           | 20.15                                    | 20.19                 | 20.18               | 18                     | 35.3       | 759.1                 | 487                   | 1.8     | 76 | 83                        | 109                          | 30.9                 | -0.8                  | 13.14                 | 1.35      | 11.3 | 0.954      | 28.4                           | 8.02           | 651.1  | 18.94                          | 606                 | 0.827                  | 1.16            | 23.7                     | 3.4396                           | 0.8598                 | 0.8353               | 08/01/04               |   |          |           |
| 2700            | 28        | 17.00           | 20.16                                    | 20.16                 | 20.09               | 16                     | 35.8       | 759.1                 | 499                   | 1.8     | 76 | 82                        | 108                          | 31                   | -0.8                  | 13.13                 | 1.36      | 11.3 | 0.956      | 28.0                           | 7.93           | 643.6  | 18.53                          | 620                 | 0.827                  | 1.16            | 23.2                     | 3.5355                           | 0.8524                 | 0.8285               | 08/01/04               |   |          |           |
| 2400            | 28.4      | 14.40           | 21.78                                    | 21.81                 | 21.79               | 18                     | 36.5       | 759.3                 | 467                   | 2.3     | 78 | 84                        | 107                          | 31.3                 | -0.7                  | 12.07                 | 1.27      | 11.2 | 0.961      | 29.8                           | 7.50           | 685.1  | 18.77                          | 612                 | 0.826                  | 1.07            | 24.3                     | 3.6737                           | 0.8423                 | 0.8147               | 08/01/04               |   |          |           |
| 2400            | 28.4      | 14.40           | 21.75                                    | 21.75                 | 21.76               | 16                     | 36.5       | 759.3                 | 467                   | 2.2     | 78 | 85                        | 107                          | 31.6                 | -0.7                  | 12.09                 | 1.26      | 11.3 | 0.960      | 29.2                           | 7.34           | 670.8  | 18.62                          | 617                 | 0.825                  | 1.07            | 24.2                     | 3.5162                           | 0.8541                 | 0.8285               | 08/01/04               |   |          |           |
| 2100            | 28.7      | 11.60           | 24.28                                    | 24.31                 | 24.29               | 18                     | 35.5       | 759.3                 | 427                   | 2.8     | 78 | 85                        | 106                          | 31.5                 | -0.7                  | 10.85                 | 1.12      | 11.3 | 0.958      | 29.5                           | 6.49           | 677.6  | 18.43                          | 623                 | 0.826                  | 0.96            | 24.6                     | 3.4777                           | 0.8570                 | 0.8320               | 08/01/04               |   |          |           |
| 2100            | 28.7      | 11.50           | 24.31                                    | 24.31                 | 24.28               | 16                     | 35.7       | 759.3                 | 424                   | 2.5     | 78 | 85                        | 105                          | 31.7                 | -0.7                  | 10.80                 | 1.13      | 11.2 | 0.961      | 29.5                           | 6.50           | 678.5  | 18.41                          | 624                 | 0.825                  | 0.96            | 24.5                     | 3.5162                           | 0.8541                 | 0.8285               | 08/01/04               |   |          |           |
| 1800            | 29        | 9.00            | 27.90                                    | 27.90                 | 27.91               | 16                     | 35.3       | 759.5                 | 391                   | 3.0     | 78 | 86                        | 103                          | 31.7                 | -0.6                  | 9.56                  | 0.97      | 11.4 | 0.946      | 29.1                           | 5.48           | 667.9  | 17.96                          | 639                 | 0.825                  | 0.84            | 24.3                     | 3.4396                           | 0.8602                 | 0.8358               | 08/01/04               |   |          |           |
| 1800            | 29        | 9.00            | 27.87                                    | 27.87                 | 27.87               | 14                     | 34.7       | 759.5                 | 395                   | 3.0     | 78 | 85                        | 102                          | 31.8                 | -0.6                  | 9.57                  | 0.96      | 11.4 | 0.946      | 28.7                           | 5.41           | 659.4  | 17.90                          | 641                 | 0.825                  | 0.84            | 24.3                     | 3.3275                           | 0.8694                 | 0.8465               | 08/01/04               |   |          |           |
| 1500            | 29.3      | 9.10            | 32.59                                    | 32.59                 | 32.54               | 14                     | 34.4       | 759.5                 | 362                   | 1.1     | 78 | 85                        | 99                           | 31.5                 | -0.5                  | 9.63                  | 0.82      | 13.4 | 0.805      | 28.3                           | 4.45           | 649.9  | 17.27                          | 665                 | 0.826                  | 0.72            | 24.1                     | 3.1829                           | 0.8748                 | 0.8528               | 08/01/04               |   |          |           |



ตารางที่ จ-7 (ต่อ) แสดงผลการทดสอบผลกระทบจากการเปลี่ยนตัวแปรการทำงานของเครื่องยนต์ Daihatsu รุ่น AB 547cc ด้วย gas mixer ชนิดตาม

ควบคุมกับ carburetor เมื่อใช้เชื้อเพลิงแก๊สผสมที่มีองค์ประกอบของมีเทนและแก๊สเฉื่อย ที่ WOT

| speed (rev/min) | MAP (inHg) | P diff (mm H2O) | Fuel consumption 1 ft <sup>3</sup> (sec) |                       |                     |                       | $\theta_s$ | Tb (kg) | Ambient              |                     | T <sub>exhaust</sub> (°C) | P <sub>exhaust</sub> (mmH2O) | Cooling                |     | Gas cond. |      | ma (g/sec) | m <sub>corrected</sub> (g/sec) | $\phi$ | Tb <sub>corrected</sub> (N-m) | Pd (kW) | bmeq (kPa) | $\eta_{th}$ (%) | bsfc (g/kW-h) | gas density (kg/m <sup>3</sup> ) | mf (g/sec) | Tb (N-m) | P <sub>variable</sub> | k      | $\alpha$ | Test date |          |
|-----------------|------------|-----------------|--|-----------------------|---------------------|-----------------------|------------|---------|----------------------|---------------------|---------------------------|------------------------------|------------------------|-----|-----------|------|------------|--------------------------------|--------|-------------------------------|---------|------------|-----------------|---------------|----------------------------------|------------|----------|-----------------------|--------|----------|-----------|----------|
|                 |            |                 | T <sub>dc</sub> (°C)                     | P <sub>a</sub> (mmHg) | T <sub>m</sub> (°C) | T <sub>out</sub> (°C) |            |         | T <sub>in</sub> (°C) | T <sub>g</sub> (°C) |                           |                              | P <sub>g</sub> (mmH2O) |     |           |      |            |                                |        |                               |         |            |                 |               |                                  |            |          |                       |        |          |           |          |
| 3000            | 27.7       | 18.70           | 19.06                                    | 19.03                 | 19.00               | 19.03                 | 20         | 6.50    | 34.8                 | 758.8               | 511                       | 2.9                          | 84                     | 104 | 30.4      | -0.9 | 13.80      | 1.42                           | 11.2   | 0.965                         | 26.6    | 8.37       | 611.6           | 18.78         | 612                              | 0.828      | 1.23     | 22.5                  | 3.3459 | 0.8672   | 0.8439    | 09/01/04 |
| 3000            | 27.7       | 18.70           | 19.06                                    | 19.06                 | 19.03               | 19.05                 | 18         | 6.43    | 34.7                 | 758.8               | 515                       | 3.0                          | 84                     | 109 | 30.2      | -0.9 | 13.80      | 1.42                           | 11.2   | 0.964                         | 26.3    | 8.26       | 603.7           | 18.57         | 618                              | 0.829      | 1.23     | 22.2                  | 3.3275 | 0.8687   | 0.8457    | 09/01/04 |
| 2700            | 28         | 16.90           | 20.12                                    | 20.13                 | 20.09               | 20.11                 | 18         | 6.80    | 35.3                 | 758.8               | 495                       | 2.1                          | 76                     | 82  | 30.9      | -0.8 | 13.10      | 1.35                           | 11.3   | 0.960                         | 28.2    | 7.96       | 646.7           | 18.75         | 613                              | 0.827      | 1.16     | 23.5                  | 3.4396 | 0.8595   | 0.8350    | 09/01/04 |
| 2700            | 28         | 16.80           | 20.19                                    | 20.22                 | 20.25               | 20.22                 | 16         | 6.73    | 35.5                 | 758.9               | 500                       | 2.1                          | 76                     | 82  | 30.9      | -0.8 | 13.06      | 1.35                           | 11.3   | 0.958                         | 28.0    | 7.91       | 642.7           | 18.67         | 615                              | 0.827      | 1.16     | 23.3                  | 3.4777 | 0.8566   | 0.8315    | 09/01/04 |
| 2400            | 28.4       | 14.50           | 21.75                                    | 21.66                 | 21.69               | 21.70                 | 18         | 7.00    | 35.5                 | 758.9               | 465                       | 2.4                          | 78                     | 84  | 31.1      | -0.8 | 12.13      | 1.26                           | 11.2   | 0.960                         | 29.1    | 7.32       | 668.4           | 18.53         | 620                              | 0.827      | 1.08     | 24.2                  | 3.4777 | 0.8566   | 0.8315    | 09/01/04 |
| 2400            | 28.4       | 14.50           | 21.69                                    | 21.72                 | 21.75               | 21.72                 | 16         | 6.93    | 35.3                 | 758.9               | 471                       | 2.4                          | 78                     | 84  | 31.1      | -0.8 | 12.14      | 1.25                           | 11.3   | 0.959                         | 28.7    | 7.21       | 658.9           | 18.35         | 626                              | 0.827      | 1.08     | 24.0                  | 3.4396 | 0.8596   | 0.8351    | 09/01/04 |
| 1800            | 29         | 9.00            | 27.94                                    | 27.90                 | 27.88               | 27.91                 | 16         | 7.03    | 34.4                 | 758.9               | 390                       | 2.8                          | 78                     | 85  | 31.8      | -0.6 | 9.58       | 0.96                           | 11.4   | 0.944                         | 28.6    | 5.38       | 655.7           | 17.91         | 641                              | 0.825      | 0.84     | 24.3                  | 3.2726 | 0.8734   | 0.8512    | 09/01/04 |
| 1800            | 29         | 9.00            | 27.97                                    | 27.82                 | 27.90               | 27.90                 | 14         | 7.00    | 34.4                 | 758.9               | 397                       | 3.1                          | 78                     | 85  | 31.7      | -0.6 | 9.58       | 0.96                           | 11.4   | 0.945                         | 28.4    | 5.36       | 652.9           | 17.82         | 644                              | 0.825      | 0.84     | 24.2                  | 3.2726 | 0.8734   | 0.8512    | 09/01/04 |
| 1500            | 29.3       | 9.00            | 32.53                                    | 32.56                 | 32.54               | 32.54                 | 14         | 6.98    | 34.4                 | 758.9               | 357                       | 1.2                          | 78                     | 85  | 31.8      | -0.5 | 9.58       | 0.82                           | 13.3   | 0.810                         | 28.4    | 4.45       | 651.0           | 17.28         | 665                              | 0.825      | 0.72     | 24.1                  | 3.2726 | 0.8734   | 0.8513    | 09/01/04 |
| 3900            | 27.2       | 23.20           | 17.37                                    | 17.40                 | 17.35               | 17.37                 | 22         | 5.75    | 34.1                 | 758.4               | 57                        | 3.6                          | 79                     | 84  | 27.3      | -1.2 | 15.38      | 1.55                           | 11.3   | 0.959                         | 23.2    | 9.49       | 533.3           | 19.46         | 589                              | 0.836      | 1.36     | 19.9                  | 3.2364 | 0.8775   | 0.8561    | 13/01/04 |
| 3600            | 27.4       | 21.40           | 17.60                                    | 17.59                 | 17.56               | 17.58                 | 22         | 6.13    | 34.5                 | 758.6               | 528                       | 3.1                          | 78                     | 83  | 28.7      | -1.1 | 14.76      | 1.54                           | 11.0   | 0.983                         | 25.0    | 9.41       | 573.2           | 19.49         | 588                              | 0.832      | 1.34     | 21.2                  | 3.2908 | 0.8716   | 0.8491    | 13/01/04 |
| 3600            | 27.4       | 21.20           | 17.50                                    | 17.47                 | 17.49               | 17.49                 | 20         | 6.08    | 34.5                 | 758.4               | 532                       | 3.4                          | 78                     | 84  | 29.3      | -1.1 | 14.70      | 1.54                           | 10.9   | 0.991                         | 24.8    | 9.34       | 568.7           | 19.27         | 595                              | 0.831      | 1.34     | 21.0                  | 3.2908 | 0.8714   | 0.8489    | 13/01/04 |
| 3300            | 27.6       | 19.60           | 18.38                                    | 18.38                 | 18.31               | 18.36                 | 22         | 6.40    | 34.5                 | 758.3               | 511                       | 3.3                          | 78                     | 84  | 29.6      | -1   | 14.13      | 1.47                           | 11.0   | 0.981                         | 26.1    | 9.01       | 598.7           | 19.53         | 587                              | 0.830      | 1.28     | 22.1                  | 3.2908 | 0.8713   | 0.8488    | 13/01/04 |
| 3300            | 27.6       | 19.50           | 18.41                                    | 18.40                 | 18.35               | 18.39                 | 20         | 6.38    | 34.7                 | 758.3               | 516                       | 3.3                          | 78                     | 84  | 30        | -1   | 14.13      | 1.47                           | 11.1   | 0.979                         | 26.1    | 9.02       | 599.4           | 19.54         | 587                              | 0.829      | 1.28     | 22.1                  | 3.3275 | 0.8682   | 0.8451    | 13/01/04 |
| 3000            | 27.7       | 18.30           | 19.41                                    | 19.41                 | 19.37               | 19.40                 | 20         | 6.68    | 34.5                 | 758.3               | 506                       | 2.8                          | 78                     | 84  | 30.2      | -1   | 13.65      | 1.39                           | 11.3   | 0.959                         | 27.2    | 8.55       | 624.9           | 19.62         | 584                              | 0.828      | 1.21     | 23.1                  | 3.2908 | 0.8713   | 0.8488    | 13/01/04 |
| 3000            | 27.7       | 18.20           | 19.19                                    | 19.19                 | 19.15               | 19.18                 | 18         | 6.63    | 34.3                 | 758.3               | 511                       | 2.6                          | 78                     | 84  | 30.7      | -1   | 13.62      | 1.40                           | 11.2   | 0.971                         | 26.9    | 8.45       | 617.6           | 19.27         | 595                              | 0.827      | 1.22     | 22.9                  | 3.2545 | 0.8744   | 0.8524    | 13/01/04 |
| 2700            | 28         | 16.60           | 20.41                                    | 20.41                 | 20.44               | 20.42                 | 18         | 6.90    | 34.3                 | 758.3               | 492                       | 1.4                          | 76                     | 82  | 31.1      | -0.8 | 13.01      | 1.31                           | 11.4   | 0.954                         | 28.0    | 7.91       | 642.7           | 19.24         | 596                              | 0.826      | 1.15     | 23.9                  | 3.2545 | 0.8744   | 0.8524    | 13/01/04 |
| 2700            | 28         | 16.60           | 20.40                                    | 20.40                 | 20.34               | 20.38                 | 16         | 6.78    | 34.3                 | 758.3               | 503                       | 1.3                          | 76                     | 82  | 31.3      | -0.8 | 13.01      | 1.31                           | 11.3   | 0.955                         | 27.5    | 7.78       | 631.5           | 18.88         | 607                              | 0.826      | 1.15     | 23.4                  | 3.2545 | 0.8744   | 0.8524    | 13/01/04 |
| 2400            | 28.3       | 14.30           | 22.16                                    | 22.06                 | 22.00               | 22.07                 | 18         | 7.08    | 34.1                 | 758.3               | 463                       | 1.5                          | 78                     | 84  | 31.2      | -0.8 | 12.08      | 1.21                           | 11.4   | 0.950                         | 28.6    | 7.19       | 656.8           | 18.96         | 605                              | 0.826      | 1.06     | 24.5                  | 3.2364 | 0.8774   | 0.8560    | 13/01/04 |
| 2400            | 28.4       | 14.20           | 22.06                                    | 22.06                 | 22.09               | 22.07                 | 16         | 7.03    | 33.2                 | 758.3               | 466                       | 1.4                          | 75                     | 84  | 31.5      | -0.8 | 12.05      | 1.19                           | 11.4   | 0.951                         | 27.8    | 7.00       | 639.3           | 18.78         | 611                              | 0.825      | 1.06     | 24.3                  | 3.0608 | 0.8920   | 0.8731    | 13/01/04 |

## ประวัติผู้เขียนวิทยานิพนธ์

นายวิสุทธิ กวยรักษา เกิดเมื่อวันที่ 24 เดือนกุมภาพันธ์ พุทธศักราช 2523 ที่จังหวัด นครปฐม สำเร็จการศึกษาปริญญาวิศวกรรมศาสตรบัณฑิต ภาควิชาวิศวกรรมเครื่องกล คณะ วิศวกรรมศาสตร์ จากมหาวิทยาลัยมหิดล เมื่อปีการศึกษา 2542 เข้าศึกษาในหลักสูตรวิศวกรรม ศาสตร์มหาบัณฑิต ภาควิชาวิศวกรรมเครื่องกล คณะวิศวกรรมศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย เมื่อปีการศึกษา 2543



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย