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APPENDICES

1. Calculation of Vapor Pressure of 1-Hexene[38]

$\ln (P_{vp}/P_c) \quad = \quad (1-X)^{-1} [(VPA)X + (VPB)X^{1.5} + (VPC)X^3 + (VPD)X^6]$ ..(A-1)

$X \quad = \quad 1-T/T_c$ ....(A-2)

for 1-Hexene, Pc = 31.7 bar , Tc = 504 K , VPA = -7.76467 , VPB = 2.29843,

VPC = -4.44302 and VPD = 0.89947

From equation A-2 at T = 303.15K (30°C)

$X \quad = \quad 1 - 303.15/504 = 0.3985$

By replacing the X value in Equation A-1

$\ln (P_{vp}/31.7) \quad = \quad (1-0.3985)^{-1} [(-7.76467)(0.3985) + (2.29843)(0.3985)^{1.5}+$

$(-4.44302)(0.3985)^3+(0.89947)(0.3985)^6] = -4.6445$

Thus $P_{vp} \quad = \quad 0.3045$ atm

Thus, at the atmospheric pressure of 1 atm and the temperature of 30°C, the 1-hexene partial pressure of 0.30 atm generates the mixture of 30.45% 1-hexene and the balancing gas.

2. Calculation of Feed Flow Rate

The catalyst used	=	0.3500 g
Packed catalyst into borosilicate reactor which has radius	=	0.27 cm
The average height of catalyst bed	=	3 cm.
Volume of catalyst bed	=	$\pi r^2 h$ cm^3
GHSV (Gas Hourly Space Velocity)	=	500 h^{-1} at STP

$$\text{GHSV} = \frac{\text{Volumetric flow rate at STP}}{\text{Volume of catalyst}} \qquad \text{................(A-3)}$$

Volumetric flow rate(STP) = GHSV x Volume of catalyst

$$= 500 \times \pi \times (0.27)^2 \times 3 \quad cm^3/h$$

$$= 500 \times \pi \times (0.27)^2 \times (3 / 60) \quad cm^3/min$$

Thus, volumetric flow rate = 5.72 cm^3/min

$$\text{At T °C : Volumetric flow rate} = \text{Volumetric flow rate (STP)} \times \frac{(273.15 + T)}{273.15} \qquad \text{...(A-4)}$$

$$\text{At 30°C, Volumetric fow rate} = \frac{5.72 \times (273.15 + 30)}{273.15} = 6.34 \ cm^3/min$$

3. Calculation for Weight of Reactant Feed

From ideal gas equation,

$$PV = nRT \quad \text{.......................................(A-5)}$$

Where P = Partial pressure of 1-hexene (atm)

V = Volume of gas (L)

n = mole of 1-hexene (mol)

R = Gas constant = 0.082 atm . L . mol^{-1} . K^{-1}

T = Temperature of 1-Hexene (K)

From reaction condition, P = 0.3045 atm; V = 0.191 L; T = 303.15 K (30°C)

$$n = \frac{PV}{RT}$$

$$n = \frac{0.3045 \times 0.191}{0.082 \times 303.15}$$

Thus, mol of 1-hexene = 0.0023 mol = 0.1965 g

4. Calculation of Yield to Liquid for 1-Hexene Metathesis

$$\%\text{ yield of liquid product} = \frac{W_{\text{liquid product}}}{W_{\text{1-hexene}}} \times 100 \quad \dots (A\text{-}6)$$

Where W_{liquid} = Weight of liquid product from cold trap (g)

$W_{1\text{-hexene}}$ = Weight of converted 1-hexene (g)

For example, W_{liquid} = 0.1527 g $W_{1\text{-hexene}}$ = 0.1962 g

Thus, %yield of liquid product = $\frac{0.1527}{0.1962} \times 100 = 77.82\%$

5. Calculation % Coke for 1-Hexene Metathesis

Weight of coke which means the difference between the weight of before calcination and the weight of used catalyst after calcinations compared with converted 1-hexene.

$$\% \text{ coke} = \frac{W_{coke}}{W_{1\text{-hexene}}} \times 100 \qquad \text{.......(A-7)}$$

Where W_{coke} = Weight of coke (g)

$W_{1\text{-hexene}}$ = Weight of converted 1-hexene (g)

For example, W_{coke} = 0.0098 g $\quad W_{catalyst}$ = 0.3682 g

Thus, %yield of coke $= \frac{0.0098}{0.3682} \times 100 = 2.66\%$

6. Calculation of Yield of Gas Product for 1-Hexene Metathesis

% yield of gas product = 100 – (% liquid + %coke) (A-8)

Where %liquid = %yield of liquid product

%coke = %yield of coke

For example, %liquid = 63.91, %coke = 2.66

Thus, %yield of gas product = 100-(2.66+63.91) = 33.43%

7. Calculation of Percent Conversion of 1-Hexene from Peak Area of GC

Using peak areas obtained from GC analysis,

$$\% \text{ Conversion} = \frac{\text{A in} - \text{A out}}{\text{A in}} \times 100 \quad \text{..............................(A-9)}$$

Where A in = Peak area of 1-hexene at the inlet of the catalyst reactor

A out = Peak area of 1-hexene at the outlet of the catalyst reactor

8. Calculation of Percent Selectivity to Gas Product

$$C_x = \frac{A_x \times C_{std} \times V_{std}}{A_{std} \times V_x} \qquad \text{A-10}$$

$$\%\ \text{selectivity} = \frac{C_x \times 100}{C_{total}} \qquad \text{A-11}$$

When C_{std} = Concentration of the component of interest in the standard mixture (% mol)

C_x = Concentration of the component in the sample (% mol)

C_{total} = Concentration of the total component in the sample (% mol)

A_{std} = Peak area of the component in standard mixture (au.)

A_x = Peak area of the component in the sample (au.)

V_{std} = Injected volume of the standard mixture (μl)

V_x = Injected Volume of the sample (μl)

From GC data of ethylene product,

$A_{ethylene}$ = 219681; $A_{\text{std of ethylene}}$ = 119958; Cstd = 24.88 % molar,

V_{std} = 5 μl; $V_{ethylene}$ = 200 μl, C_{total} = 3.47 % molar

$$C_{ethylene} = \frac{219681 \times 24.88 \times 5}{119958 \times 200}$$

Thus, $C_{ethylene}$ = 1.1392 % molar

$$\%\ \text{selectivity} = \frac{1.1392 \times 100}{3.4729}$$

Thus, % selectivity to ethylene = 32.80%

9. Calculation of Percent Selectivity to Liquid Product

$$C_y = \frac{A_y \times Cb_{std} \times C_{std}}{A_{std} \times Cb_y}$$

$$\% \text{ selectivity} = \frac{C_x \times 100}{C_{total}}$$

$$C_{std} = \frac{D \times V \times 1000}{MW}$$

When C_{total} = Concentration of the total component in the sample (mol)

C_y = Concentration of the component in the sample (mol)

C_{std} = Concentration of the internal the sample (mol)

Cb_{std} = Carbon effective number of the internal stadard

Cb_y = Carbon effective number of the component in the sample

A_{std} = Peak area of the internal standard mixture (au.)

A_x = Peak area of the component in the sample (au.)

D = Density of ethyl benzene (0.86 g/cm^3)

V = Volume of ethyl benzene (L)

MW = Molecular weight of ethyl benzene (106.16 g/mol)

From GC data of C_6 alkene product,

A_y = 291862; A_{std} = 44504; Cb_y = 6; Cb_{std} = 8; C_{std} = 0.0000162 mol

$$C_y = \frac{291862 \text{ x } 8 \text{ x } 0.0000162}{44504 \text{ x } 6}$$

$$= 0.000142 \text{ mol}$$

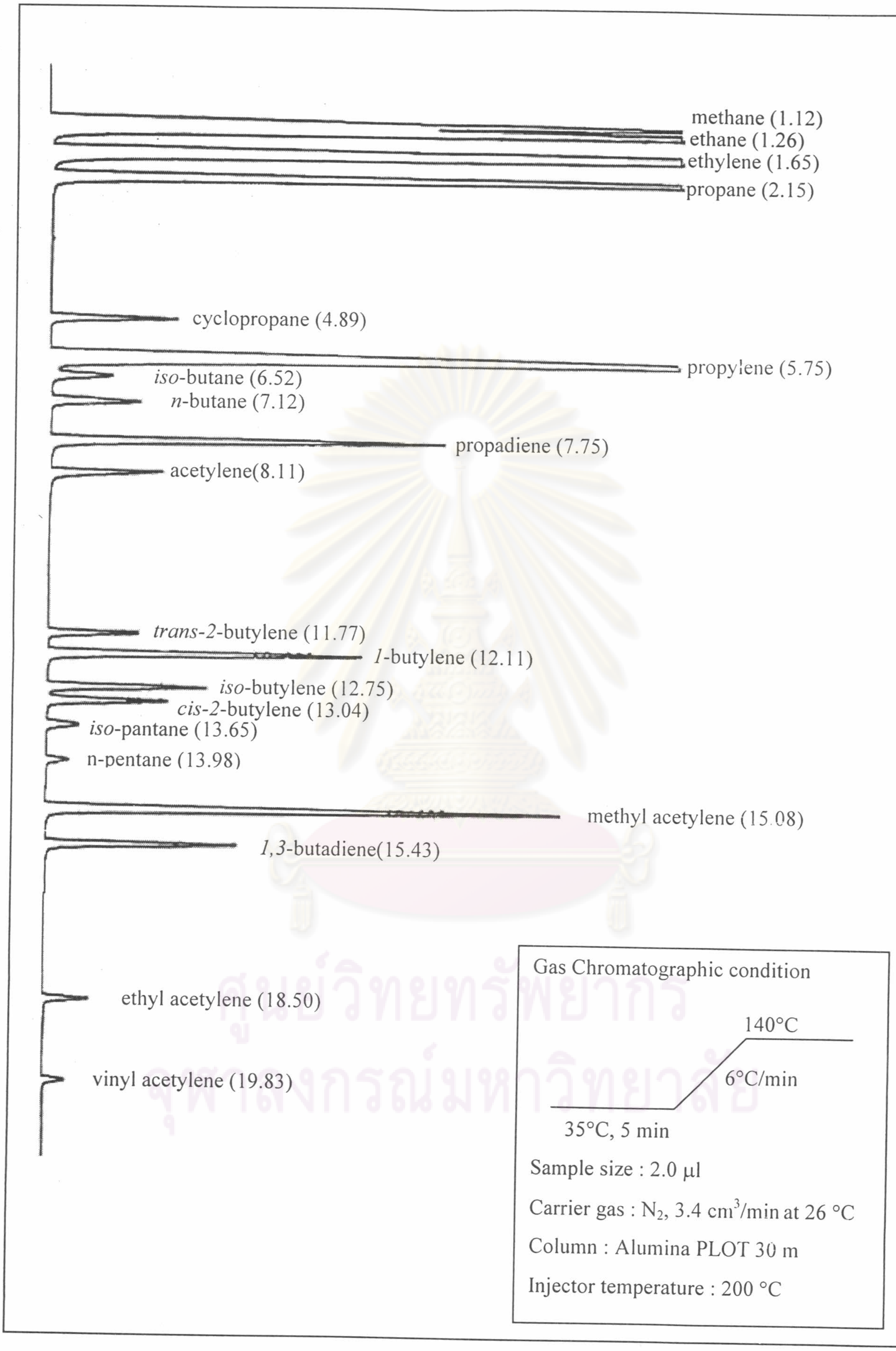

Figure A-1 Gas chromatogram of standard mixture C_4 gas.

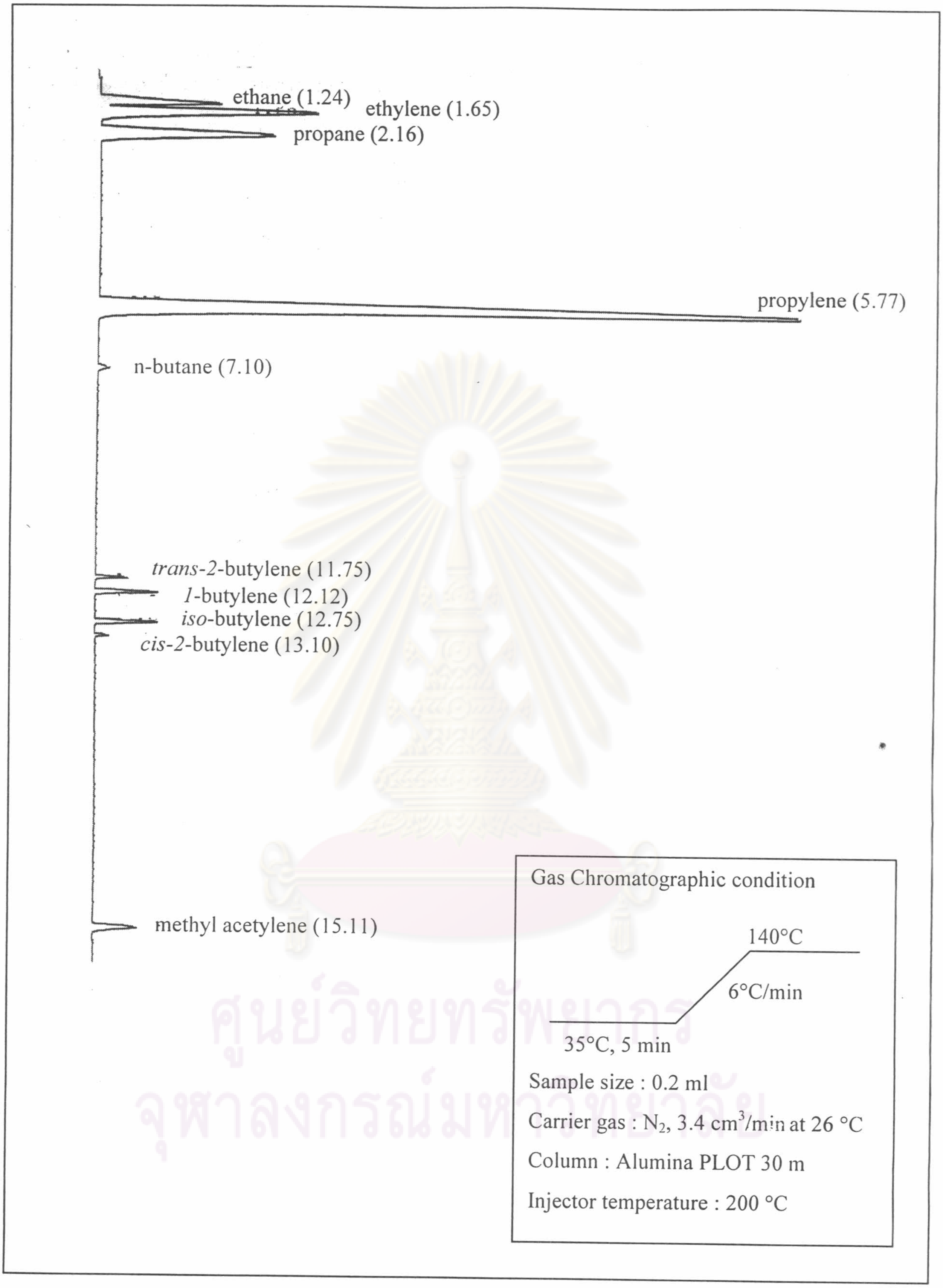

Figure A-2 Gas chromatogram of gas product from 1-hexene on 5%WO_3/SBA-15 at 500°C (condition: 0.35 g of catalyst, feed at GHSV of 500 h^{-1}, time on stream 30 min.).

VITAE

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