



## CHAPTER III EXPERIMENTAL

### 3.1 Materials and Chemicals

1. Fittings and valves
2. Vacuum pump
3. Data logger
4. Activated carbon (purchased from Fluka)
5. N-methylethanolamine (NMEA) (purity 99% purchased from ACROS)
6. Monoisopropanolamine (MIPA) (purity 99% purchased from ACROS)
7. Piperazine (purity 99% purchased from Sigma-Aldrich)
8. Potassium carbonate ( $K_2CO_3$ ) (purity 98-100% purchased from Sigma-Aldrich)
9. Methanol (purity 99.95% purchased from RCI Labscan)

### 3.2 Experimental Procedures

#### 3.2.1 Impregnation

- a. Activated carbon was ground and sieved to obtain a particle size of 40 mesh.
- b. Activated carbon was added to NMEA solution of desired NMEA concentration (10 and 30 wt %). The solid to liquid ratio was 1:2.
- c. Activated carbon was added to MIPA solution of desired MIPA concentration (10 and 30 wt %). The solid to liquid ratio was 1:2.
- d. Activated carbon was added to piperazine solution of desired piperazine concentration (10 and 30 wt %). The solid to liquid ratio was 1:2.
- e. Activated carbon was added to  $K_2CO_3$  solution of desired  $K_2CO_3$  concentration (10 and 30 wt %). The solid to liquid ratio was 1:2.
- f. Stirring those samples for 15 min.

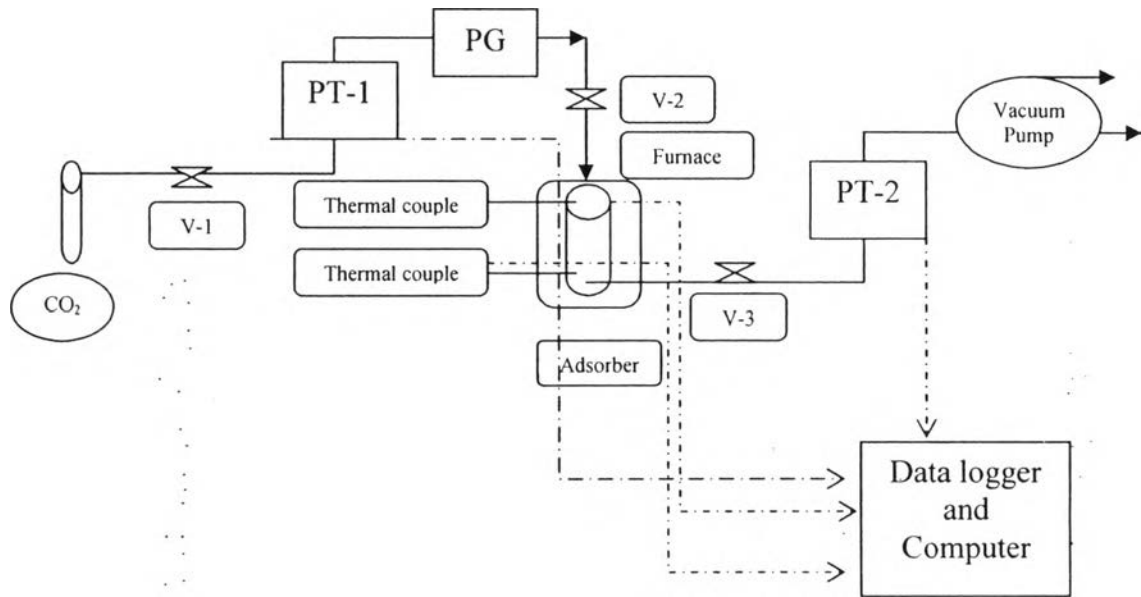
- g. The adsorbent was dried at 110 °C for 3 hrs.

### 3.2.2 Characteristics of Adsorbent

- a. BET Analysis was used to determine the surface area of adsorbents. Surface areas and pore volumes of the adsorbents were measured using BET method on a Quantachrom instrument. Each adsorbent was first outgassed to remove the humidity on its surface under vacuum at 110°C for 12 hrs prior to the analysis. After that, N<sub>2</sub> was purged to adsorb its surface. This volume-pressure data was used to calculate the BET surface area.
- b. Thermogravimetric-differential thermal analyzer (TG-DTA) was used to study thermal decomposition of adsorbents in order to evaluate the actual amount of loading. Each adsorbent was heated to 110 °C and held for 5 min in N<sub>2</sub> (100 mL/min flow-rate) in order to remove moisture content. The temperature was then increased to 800 °C with a ramping rate of 10 °C/min up to 800 °C.

### 3.2.3 Adsorption Measurement

The schematic diagram of the experimental set-up is shown in Figure 3.1. A pressure transmitter was installed to measure pressure of the system. One gram of the prepared adsorbent was loaded into the stainless steel adsorber, which was heated by the furnace in order to reach the adsorption temperatures. The effect of adsorption temperature was investigated by varying the temperature from 30 to 75 °C. Thermo couples were used to monitor the temperature during the operation.



**Figure 3.1** Schematic of the experiment.

The amount of carbon dioxide adsorption was determined by Eq. (3.1)

$$n_i = \frac{P_1(V_1+V_2)}{ZRT} - \frac{P_2(V_1+V_2)}{ZRT} \quad (3.1)$$

where,

$n_i$  = mole of adsorbed  $\text{CO}_2$ , mol

$P_1$  = pressure of the system before equilibrium, atm

$P_2$  = pressure of the system after equilibrium, atm

$V_1$  = volume of a manifold,  $\text{cm}^3$

$V_2$  = volume of a cylinder with adsorbent,  $\text{cm}^3$

$Z$  = compressibility factor

$R$  =  $82.06 \text{ cm}^3 \text{ atm/mol K}$

$T$  = temperature of the sample, K