

## **CHAPTER III**

### **EXPERIMENTAL**

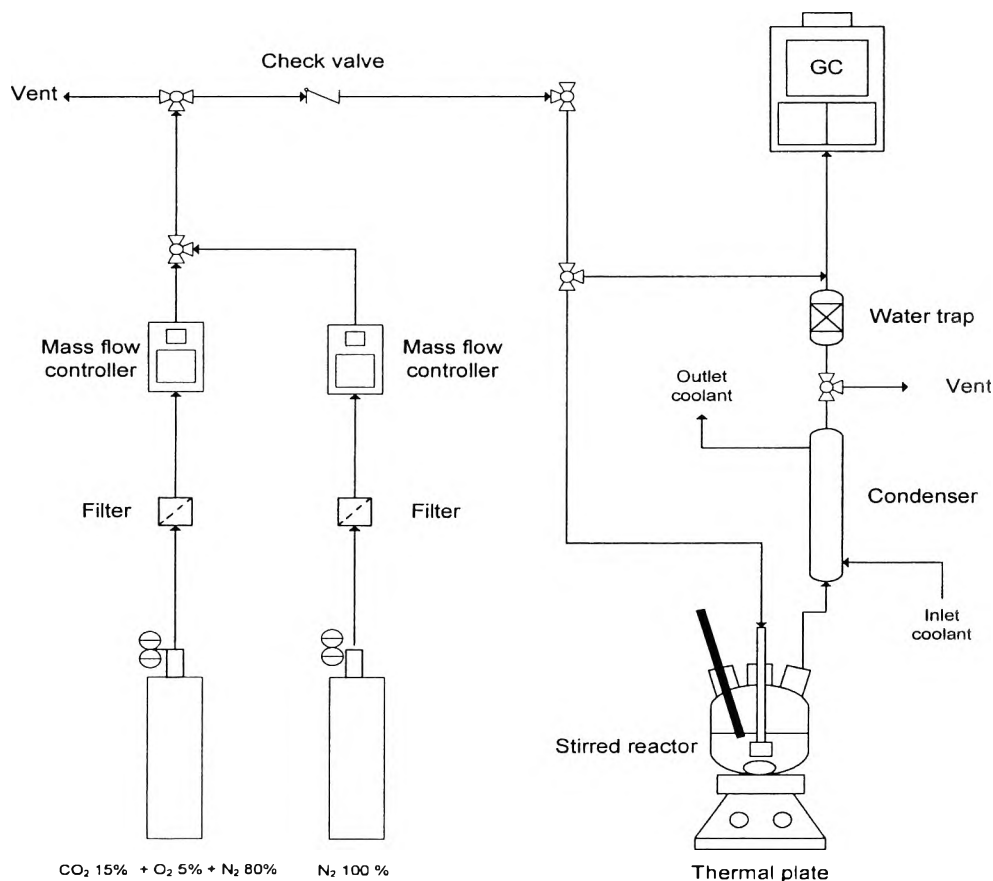
#### **3.1 Materials**

- 3.1.1 Simulated flue gas (15 % CO<sub>2</sub>, 5 % O<sub>2</sub>, and 80 % N<sub>2</sub>)
- 3.1.2 Monoethanolamine (MEA), 99.0 % purity
- 3.1.3 Diethanolamine (DEA), 99.0 % purity
- 3.1.4 Triethanolamine (TEA), 99 % purity
- 3.1.5 Diethylenediamine (PZ)

#### **3.2 Equipments**

- 3.2.1 Gas chromatography (GC)
- 3.2.2 Three-necked round-bottom Pyrex glass reactor
- 3.2.3 Mass flow controller
- 3.2.4 Stainless steel filter
- 3.2.5 Temperature-controlling bath
- 3.2.6 Cooling water bath
- 3.2.7 Magnetic stirrer

### 3.3 Methodology



**Figure 3.1** Schematic of CO<sub>2</sub> absorption system.

The schematic of CO<sub>2</sub> absorption system used in this research is shown in Figure 3.1. There are 3 main sections in this system, including feed gas section, reactor section, and analytical section.

#### 3.3.1 Feed Gas Section

A simulated flue gas, with compositions of 15 % CO<sub>2</sub>, 5 % O<sub>2</sub>, and 80 % N<sub>2</sub>, was introduced into a stirred absorption reactor. The flow rate of the simulated flue gas passing through the reactor was regulated by a mass flow controller and a transducer. A stainless steel filter was placed upstream of the mass flow controller in order to trap any foreign solid particles impure in the simulated flue gas. A check valve was also be placed downstream of the mass flow controller

to prevent any backflow. The pure N<sub>2</sub> gas was used to purge the reactor to remove air before the absorption experiments.

### 3.3.2 Reactor Section

For any studied conditions, the flue gas was introduced into the reactor through a gas dispenser connected to one neck of the reactor, where the reactor contains a studied liquid solvent. During the absorption experiments, the reactor was continuously stirred by a mechanical magnetic stirrer. The reactor was placed in a temperature-controlling bath in order to maintain the temperature of the system at a desired value. The temperature of the solvent inside the reactor was monitored using a thermometer inserted through one neck of the reactor. The gas exit at another neck of the reactor was connected to a condenser, which was connected to a cooling water bath, in order to return any vaporized solvent to the reactor for preventing the solvent loss.

The type and concentration of each studied solvent in an aqueous solution was comparatively investigated. Regeneration of each used solvent by heat treatment was performed at various temperatures. The used solvent was heated up to a desired temperature to eliminate CO<sub>2</sub> bound to the solvent molecule. The regenerated solvent was reuse for the CO<sub>2</sub> absorption to evaluate their reusability.

### 3.3.3 Analytical Section

The compositions of the feed flue gas and the outlet gas exiting the condenser was analyzed by a gas chromatograph (GC) equipped with a thermal conductivity detector (TCD). For any studied conditions, the system was operated under an atmospheric pressure. An analysis of the outlet gas compositions was taken every 10 min until reaching absorption equilibrium. The CO<sub>2</sub> absorption rate and capacity was then calculated. The experimental data taken under equilibrium conditions was used to evaluate the performance of the studied solvents. The GC was operated under the following conditions.

TCD injection temperature	60 °C
Oven temperature	60 °C

Carrier gas

High purity argon

#### 3.3.4 Studied Conditions

The conditions for all studied parameters (MEA, DEA and TEA concentration, total feed flow rate, and diamine concentrations) were shown as follows:

Alkanolamines concentration	30 wt.%
Total feed flow rate	50 cm <sup>3</sup> /min
Diamine concentration	5 wt.% of total amine