CHAPTER III
EXPERIMENTAL

3.1 Material Preparation

3.1.1 Air from compressor at constant pressure of 1 bar

3.1.2 Fresh tap water from water reservoir

3.1.3 Packing materials

- Ceramic balls were granted from The Petroleum Authority of Thailand.
- Plastic raschig rings

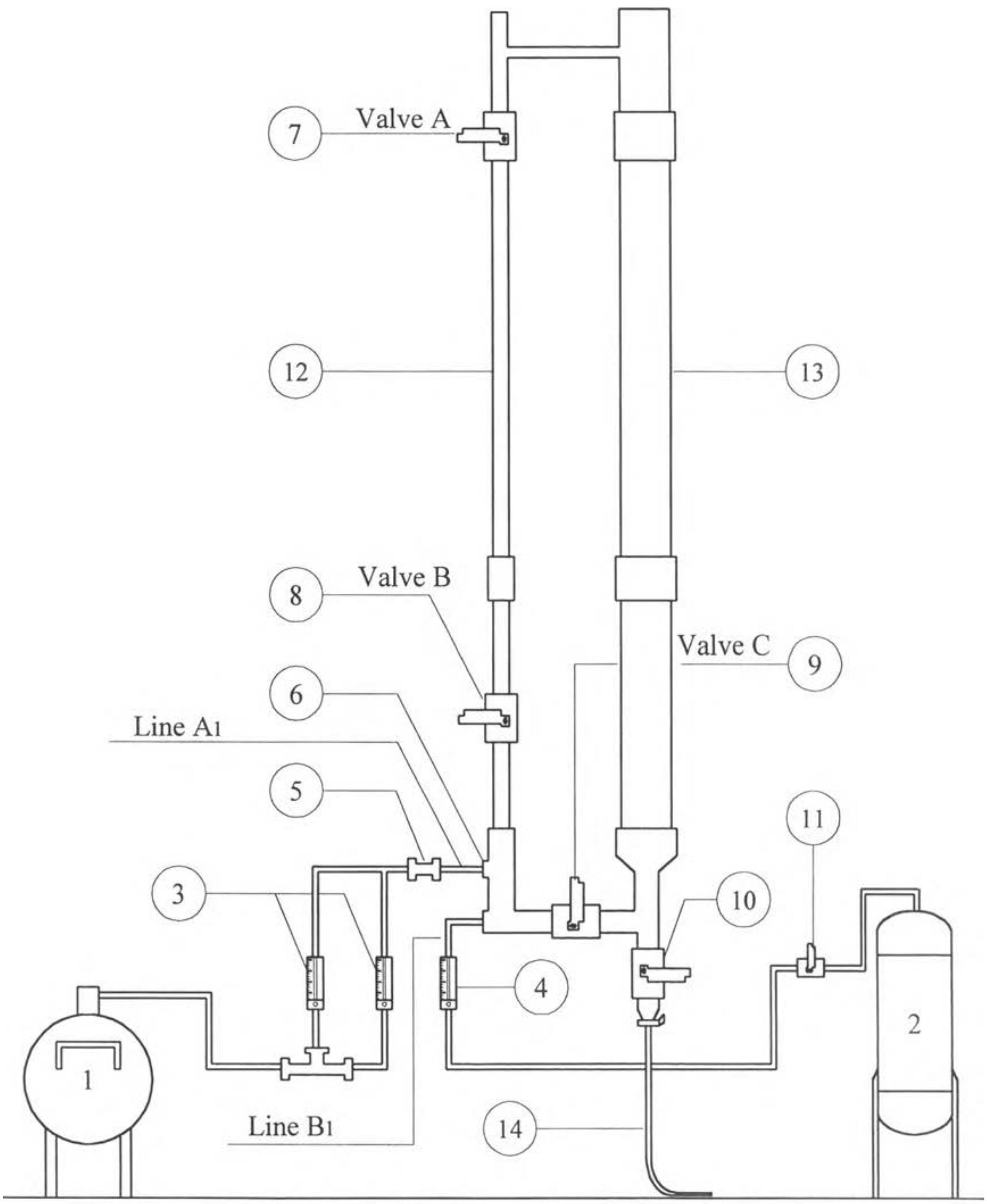
Table 3.1 Packing Materials Data.

	Plastic raschig ring	Ceramic ball
Size	Length 1.30 cm Width 1.30 cm Wall thickness 0.12 cm	Diameter 1.37 cm
Weight	0.80 g	2.98 g
Surface area of packing per packed volume	8.63 cm^2/cm^3	3.00 cm^2/cm^3
Porosity	0.841	0.421

3.2 Apparatus

3.2.1 Design and Experimental Setup of two-phase flow

The experimental setup is schematically shown in Figure 3.1. Two-phase flow part was carried out in two different sizes of transparent acrylic columns. The smaller column of 1.9 cm in diameter was used as a main column. The hydrodynamics of two-phase flow were studied in the main column which consisted of test length about 200 cm. Compressed air with constant 1 bar entered at the bottom of the main column and their flowrates were measured by a calibrated rotameter. Water entered at the bottom of the column below the air injection. Void fraction could be investigated within the length between the isolating valve A and value B. Value C was used to separate two columns while air-lift pump operation was determined.

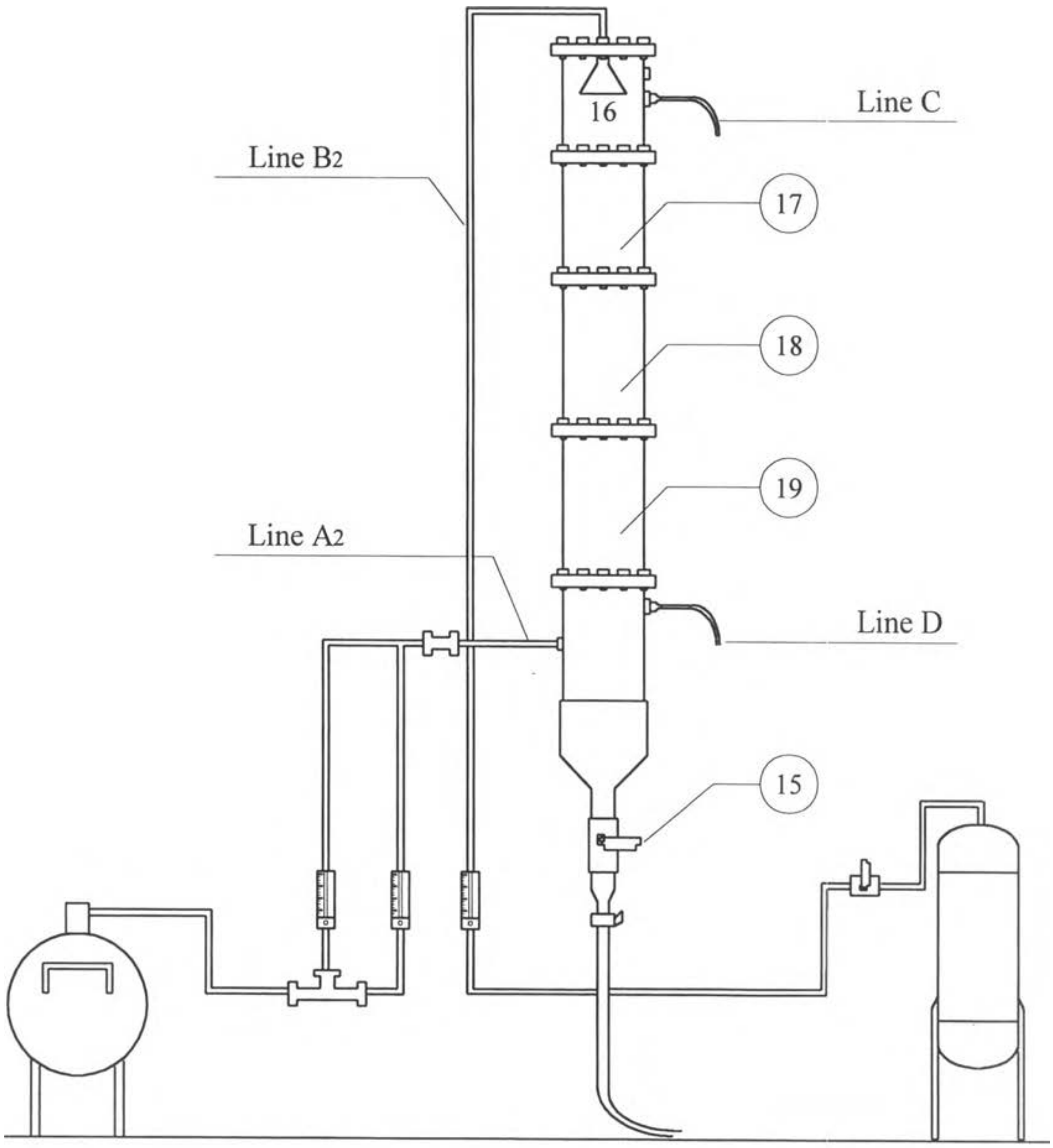


* The label numbers are described in Table 3.2

Figure 3.1 Diagram of equipment for studying the hydrodynamic of two-phase flow.

3.2.2 Design and Experimental Setup of flooding

Figure 3.2 shows the packed column which consists of a 8.4 cm inside diameter and the height of 128 cm. The column was divided into three sections for filling packing so that the height of packing can be investigated, the length of each part was 30 cm, 30 cm, and 20 cm, respectively. Plastic raschig rings with the size of 1.3 cm and ceramic balls with the diameter of 1.37 cm were used as the packing elements. Air enters at the base of the bottom of the column and their flowrates were determined by a calibrated rotameter. Water fed into the liquid distributor on top of the column to ensure uniform distribution of water and was similarly metered and fell through the packing where it was contacted with the rising air. By means of a water filled manometer, the pressure drop across the column was determined.



* The label numbers are described in Table 3.2

Figure 3.2 Diagram of equipment for studying the flooding.

Table 3.2 Label of number equipment.

1.	Air compressor maximum 10 bar
2.	Tap water reservoir
3.	Air rotameter
4.	Water rotameter
5.	Check valve
6.	Air injection tee for ¾ in schedule 80 tube
7.	Isolating ball valve A for ¾ in schedule 80 pipe
8.	Isolating ball valve B for ¾ in schedule 80 pipe
9.	Isolating ball valve C for ¾ in schedule 80 pipe
10.	Draining ball valve ¾ in
11.	Tap water valve
12.	Vertical tube with the diameter of 0.019 m and the length of 3 m
13.	Overflow tube with the diameter of 0.054 m and the length of 3 m
14.	Rubber hose for water draining
15.	Draining ball valve ¾ in
16.	Water distributor
17.	Packing test section with the length of 20 cm
18.	Packing test section with the length of 30 cm
19.	Packing test section with the length of 30 cm
Line A1	Air injection to two-phase flow section
Line A2	Air injection to flooding section
Line B1	Feed-in water to two-phase flow section
Line B2	Feed-in water to flooding section
Line C	Upper connection to the water manometer
Line D	Lower connection to the water manometer

3.3 Methodology

3.3.1 Parameters

3.3.1.1 Controlled parameters of two-phase flow

- Dimension of both columns
- Height of water in main column

3.3.1.2 Variable parameters of two-phase flow

- Volumetric flow rate of air and water
- Height of water in reservoir column
- Slug length

3.3.1.3 Measured parameters of two-phase flow

- Rise velocity
- Void fraction

3.3.1.4 Controlled parameters of flooding

- Dimension of column

3.3.1.5 Variable parameters of flooding

- Volumetric flow rate of air and water
- Type of packing material
- Height of packing material

3.3.1.6 Measured parameters of flooding

- Air flowrate at flooding
- Pressure drop across the column

3.3.2 Experimental Procedures

3.3.2.1 Determination of flow pattern map

With valve C closed, the volumetric flow rates of gas and water were varied in the range of 0.29 to 5.87 and 0 to 15.85 cm/s, respectively. The transition of bubble to slug flow was observed by a visualization or video camera.

3.3.2.2 Determination of rise of velocity of single slug and slug length

By turning the air on and off suddenly at different opening, with valve C closed, and by timing over known distances, determine the rise velocity of isolated single slugs of air was determined in otherwise stagnant water (no net water flow). The slug length was also measured by picture from a camcorder.

3.3.2.3 Determination of void fraction at a variety of air and water flow rates within slug length

Within slug flow regime, valve A and B were very quickly closed in order to isolate the water and air between them and hence the void fraction was determined.

3.3.2.4 Determination of rise velocity of continuously generated slug

Operated with a steady continuous stream of air, with valve C closed, so there was no net water flow rate. Air volumetric flow rate was varied within slug flow regime to make steady continuous stream of air and the volumetric flow rate of air, the rise velocity of slug and the void fraction were measured.

3.3.2.5 Determination of air-lift pump operation and pressure drop in main column

With the main column free to communicate with the central reservoir (valve C opened), and with the water level at height that was significant below the top, the air flow rate was determined to start pumping the water out through the top of the tube and back into the reservoir. The difference of water height in main column and water height in reservoir column was measured to calculate the void fraction at different water levels.

3.3.2.6 Determination of the onset flooding

In the case of packed column, water entering the top of the column was distributed over of packing by a distributor. The air and water feed rates were set manually and measured by rotameters. A water manometer was used to measure the pressure drop across the packing. Air flowrate at the situation which no water flow down the column was recorded.

3.3.3 Data Analysis

a. Transition of bubble flow to slug flow was calculated by Nicklin's model with the void fraction of 0.1. The flow pattern map was produced by plotting the superficial gas velocity versus the superficial water velocity.

b. The rise velocities of single slug in stagnant liquid were calculated by equation 5. The relationship between the rise velocity and slug length was determined, moreover, the valve of c from the experiments was investigated.

c. Void fraction at a variety of the superficial air velocities and the superficial water velocities were determined and compared the void fraction from the experiment with the void fraction from equation 8.

d. The rise velocity of continuously generated slug at different superficial air velocities and superficial water velocities were investigated. The validity of equation 6 was also studied for comparing the theoretical results with the experimental results.

e. The required air velocities for incipient air-lift pump operation were calculated by equation 10 and compared with the experimental values by using the void fraction calculated from equation 9.

f. The relation between the types of packing, the height of packing and the gas mass velocities in which flooding occurs were studied. The Eckert type charts were generated, furthermore, pressure drop across the packing was also investigated.