CHAPTER IV

EXPERIMENTAL CONSIDERATIONS

The experiment involved two sets of equipment; the fluidized-bed combustor and the fluidized-bed dryer. The experimental program was separated into three parts; one for the combustor, one for the dryer and the third one for the combined combustor and dryer. The details of each part were described as follows:

4.1 The Experimental Program of Rice Hull Fluidized-Bed Combustor

4.1.1 Experimental Procedures

The column was warmed up by the LPG burner and the dry air from the compressor was fed into the column. The air flow rate was adjusted by the ball valve until the pre-set condition was met as indicated by the flow cell, and the temperature was above 350 °C, rice hull was fed into the combustor through the screw feeder. The temperature, then, increased rapidly and was controlled by the temperature controller which would switch off the feeder motor. The burner was turned off after combustion was started. The combustion was continued and the combustion rate was controlled by the temperature controller that switch the motor of the rice hull feeder on/off. The steady-state desired condition was observed from the level of the temperature of the flue gas outlet.

The rice hull feed rate was the rate of rice hull consumption per unit time (hr). The rice hull consumption was

determined by the reduced level of the surface of the rice hull in the hopper. The level was calibrated against the weight of rice hull.

Flue gas was sampled from the sampling hole at the outlet of the cyclone by a 50 cc syringe. The gas sample was analyzed by the gas chromatrography, to yield, the flue gas compositions and the rate of solid residue from the cyclone was determined by weighting.

4.1.2 The Experimental Conditions

The experimental conditions were conducted as in the following Table 4.1.

Table 4.1 The Experimental Conditions of the Fluidized-Bed Combustor

Run No.	Controlled Temperature, (°C)	Air Flow Rate (Nm^3/hr)	M/M_{mf}
1.	400	20	1.32
2.	400	25	1.66
3.	400	30	1.99
4.	500	20	1.32
5.	500	25	1.66
6.	500	30	1.99
7.	600	20	1.32
8.	600	25	1.66
9.	600	30	1.99
10.	700	20	1.32
11.	700	25	1.66
12.	700	30	1.99

4.1.3 The Data Collected

The following data were collected during the experiment.

1. Temperature of the combustor column
2. Temperature of flue gas
3. Air feed rate
4. Rice hull feed rate
5. Rate of residue from cyclone
6. Wet bulb + dry bulb temperatures
7. Flue gas analysis

4.2 The Experimental Program of Rice Hull Fluidized-Bed Dryer

4.2.1 Parboiled Rice Preparation

The raw paddy was first precleaned to remove all impurities which would cause fermentation while soaking. It was then soaked in tap water at room temperature for a period of 48 hours (2 days) which was found adequate for absorbing a uniform distribution of soaking water. The paddy was cleaned again to remove the remaining impurities and fermentation products which had accumulated during the soaking period. It was drained and steamed for about 10 minutes and the cooled to room temperature to prevent excessive water absorption which would the caused spiltting of the hull.

4.2.2 The Experimental Procedure

The column was first warmed up by hot air from the electric heater. The controlled value was opened and adjusted so that the manometer pitot-tube indicated the desired hot air flow

rate. The temperature sensor at the air inlet of the drying chamber was used to control the electric heater to heat the air to the pre-set temperature. The steady-state was reached when the temperature controller showed "on" and "off" signals alternatively.

The parboiled paddy, which was prepared as explained in 4.2.1, was continuously fed into the column by the screw feeder. The height of bed was controlled by the overflow baffle at the outlet end of the column.

The parboiled paddy feed rate was indicated by the rate of parboiled paddy consumption per unit time. It was determined by the reduced level of parboiled paddy in the hopper that was calibrated to give the weight of parboiled paddy. The rate of outlet parboiled paddy was determined by collecting it per unit time. The inlet and outlet parboiled paddy were sampled to measure its moisture content by drying in an oven at 130 °C for about two hours.

4.2.3 The Experimental Conditions

The experimental conditions were conducted as in Table 4.2.

Table 4.2 The Experimental Conditions of the Fluidized-Bed Dryer

Run No.	Air Feed Rate (Nm^3/hr)	Parboiled Paddy Feed Rate (kg/hr)	Air Inlet Temperature (°C)	Height of Bed (mm)	M/M_{mf}
1.	200	6.5	120	30	1.33
2.	200	6.5	120	35	1.33
3.	200	6.5	120	40	1.33
4.	200	6.5	120	45	1.33
5.	200	6.5	130	30	1.33
6.	200	6.5	130	35	1.33
7.	200	6.5	130	40	1.33
8.	200	6.5	130	45	1.33
9.	200	6.5	140	30	1.33
10.	200	6.5	140	35	1.33
11.	200	6.5	140	40	1.33
12.	200	6.5	140	45	1.33
13.	200	6.5	150	30	1.33
14.	200	6.5	150	35	1.33
15.	200	6.5	150	40	1.33
16.	200	6.5	150	45	1.33

4.2.4 The Data Collected

1. Temperature of the inlet air and outlet air
2. Temperature of outlet parboiled paddy
3. Parboiled paddy feed rate
4. Rate of parboiled paddy outlet
5. Moisture contents of inlet and outlet parboiled paddy
6. Wet bulb + dry bulb temperature of the ambient air temperature

4.3 The Experimental Program of the Combined Rice Hull Fluidized-Bed Combustor and Parboiled Paddy Fluidized-Bed Dryer

4.3.1 The Experimental Procedures

Parboiled paddy was prepared as in 4.2.1. The combustor and the dryer were started up by the same procedures presented in 4.1.1 and 4.2.2 respectively. When they were operated in the steady state, the connecting valve between the two sections was partly opened. The exhaust flue gas valve was immediately closed as soon as the hot air from the electric heater was reduced from 200 Nm^3/hr to 170 Nm^3/hr. The pressure in the combustor was balanced by adjusting the by-pass valve to maintain the difference of water level in the manometer to be nearly zero.

Drying was carried out in two stages. The parboiled paddy from the first stage drying was refed into the dryer as a second stage drying (tempering step). Data was collected for both stages.

After drying the parboiled paddy would have 18-25 % moisture content, and would be cooled down during storage causing a moisture content decreased to about 14-16 % only.

4.3.2 The Experimental Conditions

The experimental conditions were conducted as in Table 4.3 and the tempering condition was the same as the condition in Run No.12 of Table 4.3.

Table 4.3 The Experimental Conditions of the Fluidized-Bed Combustor and Dryer in the First Stage Drying

Run No.	Combustor			Air from heater	Dryer		
	Temperature (°C)	Air Flow Rate (Nm^3/hr)	M/M_{mf}	(Nm^3/hr)	Temperature (°C)	Height of Bed (mm)	M/M_{mf}
1.	600	30	1.99	170	120	30	1.33
2.	600	30	1.99	170	120	35	1.33
3.	600	30	1.99	170	120	40	1.33
4.	600	30	1.99	170	120	45	1.33
5.	600	30	1.99	170	130	30	1.33
6.	600	30	1.99	170	130	35	1.33
7.	600	30	1.99	170	130	40	1.33
8.	600	30	1.99	170	130	45	1.33
9.	600	30	1.99	170	140	30	1.33
10.	600	30	1.99	170	140	35	1.33
11.	600	30	1.99	170	140	40	1.33
12.	600	30	1.99	170	140	45	1.33
13.	600	30	1.99	170	150	30	1.33
14.	600	30	1.99	170	150	35	1.33
15.	600	30	1.99	170	150	40	1.33
16.	600	30	1.99	170	150	45	1.33

4.3.3 The Data Collected

Data collected were the same as those described in 4.1.3 and 4.2.4.