

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE WORK

5.1 Conclusions

In this study, a lab-scale (50 kW thermal) two-stage gasification system, which consists of a feeding device, an air supplied system, a two-stage gasifier (bubbling fluidized bed pyrolysis and downdraft gasifier), an ash removal device, gas cooling and cleaning devices, was designed. It can be concluded as follows:

1. Feeding device or screw conveyor

Diameter of shaft and speed of screw were 0.020 m and 150 rpm, respectively. Diameter of screw was 0.04 m. The diameter of the inside of the screw trough was 0.067 m. The selected pipe for screw trough was NPS 2½ with SCH 5 which the outside diameter was 0.07302 m, the internal diameter was 0.0688 m, and the wall thickness was 2.108 mm.

2. Air supplied system

For primary air supplied for bubbling fluidized bed, the diameter of tuyer orifice was 0.02 m. For secondary air supplied for char gasifier, the air tuyers was designed as two layers that each layer alternates between a serration. There are 6 of tuyer orifices which was divided for two layer and there were 3 of tuyer orifices for each layer. The diameter tuyer orifice was 0.004 m.

3. Two-stage gasifier

For the first stage or bubbling fluidized bed, the internal diameter of the lower part was designed as 0.09 m, the internal diameter of the upper part was designed for 1.4 time of the lower part as 0.13 m, and the heights of lower and upper part were 0.5 m and 0.5 m, respectively. For the second stage or char gasifier, the internal diameter of char gasifier stage was 0.24 m. The internal diameter of throat was 0.10 m. The height of the char gasifier was determined as 1.4 m which was divided into two parts: 0.70 m for both of above and beneath throat.

4. Ash removal device or screw conveyor

Screw conveyor for ash removal was the same as screw conveyor for rice husk feeding but the speed of the screw was different. Diameter of shaft and speed of screw were 0.020 m and 60 rpm, respectively. Diameter of screw was 0.04 m. The diameter of the inside of the screw trough was 0.0658 m. The selected pipe for screw trough was NPS 2½

with SCH 5 which the outside diameter was 0.07302 m, the internal diameter was 0.067 m, and the wall thickness was 2.108 mm.

5. Gas cooling device or shell and tube heat exchanger

The first shell and tube heat exchanger was designed as a rectangular shape with the dimensions: 0.34 m x W 0.28 m x H 1.6 m. The outside and inside diameters of tube were 1" and 0.93", respectively. The total of used tubes was 56 tubes, which was divided into 28 tubes for each pass. Tube layout was designed as square pitch for ease of manufacture. Baffle spacing was designed as 0.1360 m with the baffle cut 25%. Pitch size was 0.0318 m.

The second shell and tube heat exchanger was designed as a rectangular shape with the dimensions: L 0.6 m x W 0.5 m x H 1.6 m. The outside and inside diameter of small tube are 1.5" and 1.334". The outside and inside diameters of big tube are 2.875" and 2.469", respectively from tube dimensional data table. The total of used small tube is 45 tubes with 0.0476 m of pitch size and 0.0095 m of clearances. The total of used big tubes was 10 tubes with 0.09128 m of pitch size and 0.01825 m of clearances.

6. Gas cleaning devices

The dimensions of design cyclone were:

D_c	0.120 m
$B_c = D_c/4$	0.030 m
$D_e = D_c/2$	0.060 m
$H_c = D_c/2$	0.060 m
$L_c = 2D_c$	0.240 m
$S_c = D_c/8$	0.015 m
$Z_c = 2D_c$	0.240 m
$J_c = D_c/4$	0.030 m

For the baghouse filter, cotton was selected for filter material. The bag's diameter and height were 15 and 50 cm, respectively, and the number of bag was designed as 4 bag.

5.2 Recommendations for Future Work

The results obtained from the design of a lab-scale two-stage gasification system were the essential parameters which can be used for the construction of a lab-scale two-stage gasification system. Therefore, the construction of a lab-scale two-stage gasification system is needed to prepare a detailed design which was not mentioned in this study.