

CHAPTER 7 CONCLUSIONS AND FUTURE WORK

Numerical studies a new concept of high efficiency non-sprayed porous burner (NSPB) have been conducted and discussed in this thesis. The advantages of NSPB are to reduce complexity of atomization process by using a porous evaporator (FP). Beside homogeneous combustion within a porous combustor (PC) is used instead of a heterogeneous combustion in a free space of conventional sprayed burner. In additions, the combustion occurs in NSPB is late mixing combustion hence, fuel and air can be preheated without auto-ignition outside the porous combustion. Moreover, the numerical modeling of a late mixing porous burner (LMPB) for liquefied petroleum gas (LPG) is also performed.

The numerical modeling was developed in order of increasing complexity. Firstly, the numerical modeling of LMPB for to investigate the non-preheated air. Second is the numerical modeling of LMPB for preheated air. Finally, the numerical for NSPB in case of preheated air is performed. A characteristic of the burner and effect of important parameters on burner performance are also presented. In addition, the numerical results are validated with the experimental results. The main findings of the research are summarized in the sections that follow and also proposed is future work, to further extend on the subject areas covered in this thesis.

7.1 Major conclusions

1. The numerical modeling can be used to predict necessary information for characteristics both of LMPB and NSPB, e.g., solid and gas phase temperature, evaporation front, flame position, and the burner performance.
2. The numerical results of LMPB and NSPB show the same trend as experimental study in term of the temperature profile and radiant output efficiency. The predicted

temperature and η_{rad} are greater than the experimental one due to the heat lost from system to the surrounding.

3. LMPB, the equivalence ratio Φ and firing rate FR are the main parameters affecting on thermal performance. At lean condition ($\Phi < 0.8$), the radiant output efficiency η_{rad} is strongly dependent on the equivalence ratio Φ and the firing rate FR. The lower the equivalence ratio results the lowering the radiant output efficiency. The higher firing rate leads to decreasing in the radiant output efficiency. On the other hand, at a relatively high equivalence ratio ($\Phi > 0.8$) or near stoichiometric condition, the radiant output efficiency η_{rad} is almost constant irrespective of the equivalence ratio and the FR.

4. The firing rate (FR) has significant affects on the NSPB performance during the movement of the evaporation front zone within the FP and the temperature profiles within the PC. The equivalence ratio Φ has significantly affects on temperature profiles within the PC with a lesser degree on the evaporation front zone within the FP.

5. The benefit of LMPB is an alternative porous burner to replace the conventional premixed porous burner in the future due to the LMPB can yield relatively high η_{rad} and η_{rec} . The LMPB application can be extended to liquid fuels combustion requirement in order to its relatively high heat recirculation efficiency, η_{rec} . The amount of heat recirculated can be utilize to vaporize the liquid fuels flowing through the FP before mixing and combustion in the same manner as that of the LMPB as mentioned above.

6. The NSPB is one possible technology which will be able to replace a conventional sprayed burner due to many advantages compared with conventional sprayed burner. First, the complexity of the liquid fuel atomization is eliminated by porous evaporator (FP). Second, the homogeneous combustion within the PC is used instead of a heterogeneous combustion in a free space. Finally, the NSPB has a compact designed compared to the conventional sprayed burner hence, the volume to support spray distribution is undesirable. Moreover, the NSPB provide the high η_{rad} in the same range of conventional premixed porous burner with low emission.

7. The results indicate that the new concept of modulating dual fuel porous burner have two major porous media which are mixing chamber can be one of the future combustion technologies which respond variety countries and various industrials demands.

8. The suitable material to use as PC should have porosity between 0.3-0.5 and the optical thickness in the range of 10-15.

7.2 Recommendations for future work

All along this thesis, the role played by numerical modeling in the development of NSPB has been reinforced with some significant information having been given of how numerical modeling can provide guidance in the improvement and conception of burner designs. Recommendations for future work to extend the knowledge of NSPB are outlined as follows.

1. NSPB, the complete evaporation of fuel within a small volume is impossible at FR higher than 20 kW, in order to a self-sustained evaporation and combustion cannot be achieved and this becomes a limitation of the model. The fuels require more space for evaporation. Thus, the more realistic assumption of various boiling points of complex hydrocarbon compositions of kerosene should be considered in this model.

2. The difference fuel such as bio-fuel, gasohol, synthesis gas from gasification process, and landfill gas will be used.

3. The evaporation phenomena in FP section need to be explored and utilized in single boiling point liquid i.e. water.