# CHAPTER 1 INTRODUCTION

In the present thesis, the study of a non-sprayed porous burner (NSPB) for liquid kerosene is studied by mean of numerical modeling. The mathematical modeling of liquefied petroleum gas (LPG) is developed at first step after that this model is adjusted for liquid kerosene by addition evaporation model part. Seven major chapters are subdivided into suitable sections are consisted in this thesis. The seven chapters are introduction, literature reviews, theory, numerical modeling of a late mixing porous burner (LMPB) for gaseous fuel, numerical modeling of a non-sprayed porous burner (NSPB), experiment, and finally conclusions and recommendations for future work. The specific outline of the thesis is as follows.

Chapter 1 explains the motivation, objectives of the thesis, and the scope of the work. The thesis outline is also presented in this chapter.

Chapter 2 presents the necessary background to the problem. Brief information about porous materials type and physical properties are summarized. Moreover, the previous researches of combustion within porous inert media of gaseous and liquid fuel are reviewed.

Chapter 3 deals with important theories regarding the thesis. There are theory of heat recirculation combustion, internal heat recirculation combustion by porous burner, boiling theory, and evaporation within porous medium.

Chapter 4 presents the numerical modeling of a new concept of late mixing porous burner for gaseous fuel. The main governing equations used in the model are presented and described. The numerical modeling was developed in order of increasing complexity. First is the numerical modeling in case of non-preheated air. Second is the numerical modeling in case of preheated air. A characteristic of the burner and effect of important parameters on burner performance are described. The summary results of this chapter are presented in the last topic.

Chapter 5 describes a modeling of a non-sprayed porous burner (NSPB). The evaporation and combustion process, which are clarified by numerical results, are presented. Parametric studies are also consisted in this chapter. The last topic in this chapter is conclusions, which summarizes the results of a study.

Chapter 6 presents the experimental study. This chapter is subdivided into three sections, i.e., experimental apparatus, experimental results, and conclusion. In the sections of experimental apparatus, the details about the experimental set-up, fuel and air supply systems, temperature and emissions analyzer measurement are described.

In chapter 7, the results from chapter 4, chapter 5, and chapter 6 are finally concluded. The final section of this chapter discusses future directions of the work presented in this thesis.

## 1.1 Motivation of the present study

To date, many countries including Thailand have problems about dramatic increase in energy consumption and emission. Energy demand has increased while fossil fuel resources are limited. Moreover, worldwide environmental problem is rapid grown. Combustion is a major source of heat for direct using and conversion to mechanical work. Thus, many researchers try to develop new combustion technology, which increase in energy efficiency and decrease in emission issue.

A porous burner is seen as the main candidate for this technology because it provide higher thermal efficiency and lower emission (e.g. NO and CO) than a conventional burner. The porous burner achieves excess enthalpy combustion because it provides a means of internal heat recirculating without external heat exchanger surrounding the combustion chamber (i.e. the porous medium acts as a heat exchanger). The combine of conduction, convection and radiation heat transfer cause to heat recirculation in a porous medium. In a porous burner, at post-flame zone, heat is transferred from the burned gases to the solid matrix by convection. Immediately, heat is recirculated by solid to solid conduction and radiation from the post-flame zone to the pre-flame zone. Thus, heat is transferred convectively from the hot solid to the incoming gas mixture at the pre-flame zone. This results to increasing flame temperature and burning velocity.

Many studies indicate that the porous burner can unlock the limitation of a general burner due to its providing a high radiant output with low hazardous emission (e.g. NO and CO). However, all most all of the studies have been focused on premixed gaseous fuel. A few study of liquid fuel combustion within porous media has been reported. Moreover, the earlier studies were focused on spray porous burners, which are complicated for operating and maintenance.

In this thesis, focuses in a numerical model of a non-sprayed porous burner (NSPB). The numerical model solves liquid, gas and solid phase energy equation for analyzing evaporation and combustion process. A one-dimension, single-step global reaction model and steady state approach are considered in this work. The influence of heat transfer between fluid and solid phase, fluid and solid conduction, and solid radiation are also considered. The reported studies are effect of operating conditions and porous material types on thermal structures and radiant output efficiency. In addition, the numerical results are validated by the experimental ones to confirmed the model accuracy

## 1.2 Objectives of the study

The objectives of this present work are as follows:

1. To develop the mathematical model of porous burner using liquid kerosene to determine temperature profile and radiant output efficiency.

2. To investigate and identify main parameters that influences the temperature profile and radiant output efficiency:
    2.1 equivalence ratio
    2.2 firing rate
    2.3 porous material types

3. To utilize the preliminary data of this research to improve the burner performance.

## 1.3 Scopes of the work

1. This research using kerosene as fuel combustion.

2. To study influence of main parameters (i.e. equivalence ratio, firing rate, and porous material types) on temperature profile and burner performance.

3. To validate the numerical results with experimental results for confirmed model accuracy.