CHAPTER I
INTRODUCTION

There are numerous drivers for every process to continue to improve energy efficiency and the operating cost. Global competition and low profit margins have led to joint ventures, mergers, and restructuring throughout the industry. Crude oil price is the most important determinant of the process margin. Thus, during the period of high and volatile crude oil prices, the industry must continue to find the ways to get the plant in more profitability. Besides the cost of crude, energy is the largest cost that can be influenced by improved operation cost and has therefore become a primary focus. To improve energy and process efficiency, the industry will aim to use cost-effective technology with lower energy-intensity. Processes in the future would be characterized by a high degree of energy optimization through more efficient heat exchanger networks and process heat integration.

A good heat exchanger network synthesis is an important part of designing any large scales industrial process. The development of a heat exchanger network is the major contributor to efficient heat recovery. Today, the most important activity in heat exchanger network synthesis is retrofitting networks. The uses of process integration techniques, such as Pinch Technology, have been widely accepted in the process industries. Pinch technology is used for heat exchanger network synthesis (HENS). It can be used to determine the minimum utilities required in the process. Even though Pinch Analysis is used routinely in a large number of industrial companies, indicating that the technology is realistic and applicable, there are a number of limitations inherent in Pinch based methods. These limitations are actually the major motivation for using Mathematical Programming in Process Integration.

Mathematical Programming is a class of methods for solving constrained Optimization Problems. These methods are perfectly suited for typical design tasks encountered in process synthesis and process integration. The formulation and solution of major types of mathematical programming problems can be effectively performed with modeling systems such as GAMS (Brooke at al., 1992). GAMS (General Algebraic Modeling System) is a modeling system for optimization that provides an interface with a variety of different algorithms. For retrofitting, GAMS can be used to optimize process to achieve both energy and cost targeting. Model is supplied by the user to GAMS in an input file in the form of algebraic equations using a higher level language. GAMS then compiles the model and interfaces automatically with a solver. The compiled model as well as the solution found by the solver is then reported back to the user through an output file. The simple diagram below illustrates this process.

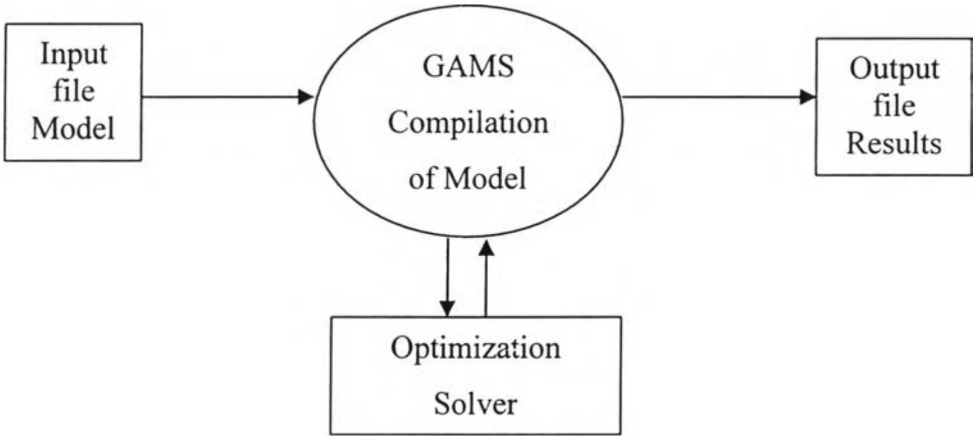

Figure 1.1 GAMS Diagram.

Over the last decade there have been considerable advances in mathematical programming techniques. The objective of this work is to develop a rigorous one-step MILP formulation (Barbaro and Bagajewicz, 2002) in mathematical programming techniques for the design and retrofit of heat exchanger network. This methodology has an ability to find the cost-optimal networks where utility cost, heat exchanger areas and selection of matches are optimized simultaneously. Extending the constraints on the network design such as stream splits and forbidden matches can be simply applied into the model. The binary variables are used to specify the heat exchanger network structure. Additionally, non-isothermal mixing assumption is useful to specify for heat transfer of stream splits. The model is applied to design and retrofit for heat exchanger network in complicated applications. The results show that the MILP model generates an economic network configuration for both new design and retrofit targets. The position of a new exchanger in the retrofit network is also considered in this work. Higher profit network structure comes from the parallel exchanger installation than providing an exchanger in series. Lastly, in special situations, further improve the model with relocation topology, the total cost would be greater reduced.