CHAPTER 1

INTRODUCTION

1.1 Background

Typical chemical process industries like oil refineries and petrochemical plants have one common feature, i.e. they all use large amount of energy. Reducing energy consumption leads to large cost savings and consequently the search for this reduction attracts the attention of engineers throughout the world. Heat exchanger networks have been used for decades to recover sensible heat from process streams.

There are two fundamentally different approaches for heat exchanger network synthesis based on levels of problem description. They are optimization and heuristics.

A large number of HEN design papers have been published in the past two decades. Good reviews covering HEN design are found in Nishida (1981), and recently in Gunderson and Naess (1988). Interestingly enough, the problem is not completely solved (Westerberg, 1989). The existing HEN design approaches use heuristics and optimization. Several computer programmed HEN design systems using optimization techniques have been developed, e.g. MAGNETS by Floudas et al. (1986) and RESHEX by Saboo et al. (1987). But this approach does not utilize domain-specific problem-solving knowledge. In optimization, the problem data and design constrains are translated into a mathematical model. Some design requirements and constraints are difficult to express mathematically, if not impossible. Furthermore, there is no insight on how the solutions are obtained. It is also difficult to make the system interact with the designer during a problem solving process, e.g. the designer may want to match particular streams during a design session or want to see what decision have been made.

For a heuristic approach, there have been few attempts to develop a computer programmed HEN design system by using a heuristic model. To automate the synthesis we can use a rule-based system. A rule-based system offers an attractive feature that the knowledge in the rules can be built incrementally. The heuristics knowledge about HEN synthesis are formulated in the form of "situations...actions" rules. Mehta and Fan (1986) use a rule-based program on the Xerox LOOP system to synthesize a HEN, but with few rules and therefore, a limited scope of problem can be solved. Rules in their system do not distinguish a match or do not prefer one over another. A more extensive use of the accumulated HEN synthesis heuristic knowledge in knowledge-based systems will make a rule-based HENS system more powerful, and broaden the scope of problems that can be solved. Grimes el. (1982), employ two match types to find a network with the aid of the search matrix for bookkeeping. Their method and heuristics used is written in OPS3RX, and early rule-based language. However, the disadvantage of a rule-based program is that it quite takes much time to find more than one solutions.

It is quite appropiate to mention that there were two HEN research works done earlier at Chulalongkorn University. Boonliang Simsrisakul (1989) developed software whose the design procedure is based on the pinch design method and some heuristic rules. The initial network structure is further evolved based on the algorithmic evolutionary approach in order to minimize the number of exchanger unit and also to carry out economic analysis of the generated network. Chaiyot Worravitudomsuk (1989) presents a case study of HEN design using pinch and exergy concepts. The proposed design approach is applied to a selected large-scale process, the refinery plant of Bangchak Petroleum Industry. The results indicate that the design approach is able to save 15.5% and 13.4% of hot and cold utility requirements, respectively, while the exergy losses are reduced by 16.73% compared to the existing plant.

In this thesis, a procedural computer program, which is in constrast to the rule-based approach, for heat exchanger network design using match patterns invented for the rule-based program by Wongsri (1990) is developed.

1.2 Objectives

1. To systematically study heat exchanger network design procedures by using the heuristic method.
2. To study heuristic rules used in HEN design.
3. To develop a computer program for HEN design using a conventional procedural programming technique.

1.3 Scopes of work

This work focus on developing a procedural computer program using the match pattern concept (Wongsri, 1990) to find all or many optimal or near optimal (maximum energy recovery (MER) and minimum number of units (MNU)) heat exchanger network configurations.

1.4 Assumptions

1. All exchangers are counter-current type.
2. Availability of hot and cold utilities are unlimitted.
3. No phase change and constant heat capacities