CHAPTER I
INTRODUCTION

Heat integration is one of the most important methods to efficiently utilize energy in industrial plants, especially in oil refinery processes which haves given serious and significant attention in both research and practice. The crude distillation columns are one of the most important and energy intensive processes and have been a focus to reduce energy consumption for several decades. A lot of effort has been done to figure out the way to make more profit out of the existing processes and at the same time it is practical for each cycle of crude oil. Thus, Heat Exchanger Network (HEN) has become the subject of numerous investigations. Yee and Grossmann (1990) presented a basic heat exchanger model through the use of a stage-wise superstructure which was formulated as a Mixed Integer Non-Linear Programming (MINLP) model with an objective function to minimize a number of units, utilities and capitals cost.

One of the assumptions used in the stage-wise superstructure model developed by Yee and Grossmann (1990), was the isothermal mixing. This assumption significantly simplified the model formulation and it is not practical at least in two aspects. The first aspect is due to the limitation in each stream interval that causes the overall heat balance to only be performed within each stage. The second aspect is due to the non-isothermal mixing in real industrial streams. Furthermore, stream matching configuration and the heat capacity flow rate are limited. For instance, a split stream cannot contain more than one heat exchanger (Yee *et al.*, 1990). In this regard, there is not much flexibility in selecting structure. Therefore, this limitation may cause the global optimal being excluded in HEN. These limitations have come to the formulation of this study.

The main concept of synthesizing a heat exchanger network in this study are as follows: (1) to modify the stage-wise superstructure by implementing the stream splitting, multiple matches per branch stream and non-isothermal mixing, and (2) to modify mathematical programming and provide suitable initialization strategy to reach more flexibility, efficiency, using less assumption, and to select the best HEN configuration with the fewest heat exchangers and minimum utility usage. The proposed model will be demonstrated by the best heat exchanger network for a crude distillation unit. Finally, the best grass-root model solution of the modified stage-wise superstructure will also be investigated.

Mathematical programming and algorithm are a group method for solving formulated problem models. Each method is developed to be perfectly suitable for solving large and complex mathematical programming problems and performing any synthesized models or process integration. In this work, a mathematical programming, namely the General Algebraic Modeling System or GAMS, is used to formulate the rigorous calculation of the HEN synthesis using CPLEX v.12.6 as the LP solver, CONOPT v.3.15M as the NLP solver, and DICOPT as the MINLP solver.