CHAPTER I
INTRODUCTION

Energy demand has increased continuously and becomes more important worldwide issue in the last few decades. Petroleum refinery industry encounters the similar crisis especially in crude distillation unit (CDU) which is one of the largest energy-consuming units in the refinery plant. Heat exchanger network synthesis (HENS) is a widely used method to recover excess energy from heat source (hot process streams) and transfer to heat sink (cold process streams).

For CDU, the hot process streams are generally main products from distillation column and pump-around streams between two trays, while the cold streams are mainly crude oil feed in the crude preheat train. In general, HEN is designed to serve a process which has only one set of steady state condition throughout the operational time. That means the design parameters consists of fixed temperatures and flowrate capacities. Therefore, the particular HEN can be efficiently used only for such specific condition, but it may have less efficiency to operate or even no feasibility at other conditions. In crude refinery, crude oil feeds are produced from different areas and reservoirs. It doubtlessly has different compositions due to its geological history of each area. Furthermore, refinery plants sometimes have to blend various kinds of crude before feeding into the process in a period of time as a result of economic aspects. As far as variety of crude characteristics is concerned, multiperiod HEN design is introduced to apply in refinery plants for more flexibility in each period of operation.

Many researchers have attempted to find systematic methodology for designing HENs. Floudas and Grossmann (1986) proposed a multiperiod Mixed Integer Linear Programming (MILP) model based on transshipment model developed by Papoulias and Grossmann (1983). They were able to generate HEN configurations automatically under the utilization of computer software rather than designing HEN manually. The objective is to target minimum number of heat exchangers and minimum total annualized cost (TAC) sequentially. Yee *et al.* (1990) introduced a stage-wise simplified superstructure formulation to solve HEN optimization problems and the model was later extended by Yee and Grossmann (1990). Chen and

Hung (2004) proposed a three-step sequential approach. The problem is decomposed into three main iterative steps: HEN synthesis based on stage-wise superstructure, flexibility analysis, and improvement of unqualified networks. Apart from sequential approach, Aaltola (2002) adopted the stage-wise superstructure model in order to apply with multiperiod problems without sequential decomposition. This caused the optimized solution have tendency not to stuck in local optima. Modification to Aaltola's model was done-by Verheyen and Zhang (2006) to improve performance of the model and become more practical in real problems.

The purpose of this research is to study and develop HEN formulation for multiperiod design for using mathematical programming based on stage-wise superstructure of Yee and Grossmann (1990). The model will be developed targeting minimum utility and capital costท simultaneously. Two techniques of multiperiod HEN synthesis, which are sequential and simultaneous approaches, will be proposed and compared by using adapted case study of (Verheyen and Zhang, 2006). The most effective method will be applied to an industrial case study of CDU to see the performance of the method when dealing with larger problem. Moreover, the final results will be simulated in PRO/II to ensure its operability in real process.