CHAPTER I
INTRODUCTION

Low temperature processes in many chemical processes are energy demanding parts which consume a large amount of energy to drive refrigeration compressor units. It is important to design refrigeration system due to save energy consumption. Pinch analysis (PA) is a general methodology for design of thermal and chemical processes by applying exchanger-matching between hot and cold streams. The PA method has two graphical representations; Composite Curves (CCs) and Grand Composite Curves (GCCs) which represent the minimum energy requirement. However it has the limitation where only temperature is the main design variable. In the case of operating below ambient temperature where expansion and compression of stream are required and pressure becomes the variable for design. Linnhoff et al. (1982) proposed the onion diagram which indicates the sequence of design that includes compressors and expanders inside the heat recovery system. If pressure of stream is manipulated, the utility requirement and energy consumption may be reduced, therefore, pressure should be included in the stream data like temperature. Exergy analysis (EA) is a tool to utilize power or shaft work where temperature, pressure and composition are the process variables used to calculate exergy content in the process. Linnhoff and Dhole (1992) combined PA and EA methods which are represented in graphical method called Exergy Composite Curves (ECCs) and Exergy Grand Composite Curves (EGCCs) based on Carnot factor. The ECCs shows the area of hot and cold composites curves which provides the exergy losses due to heat transfer and EGCCs shows the exergy losses related to heat transfer between the process and utilities system. They help find appropriate placement of load, level and number of refrigeration cycles. However, exergy targeting is not explicit because it is not linear relation. Aspelund (2007) proposed the Extened Pinch Analysis and Design (ExPAnD) to utilize heating and cooling obtained by pressure changes to minimize work consumption by utilizing ten heuristic rules to accomplish the target. Gundersen (2012) proposed the new graphical method that for exergy targeting explicitly where the axes of diagram are exergetic temperature and temperature based exergy which are linear relation. The goal of this research is to reduce the energy and power consumption with considering exergy targeting in early stage of design. By applying these graphical methodologies such as shaftwork targeting by Linnhoff and Dhole (1992), ExPAnD method by Aspelund (2007) and novel exergy diagram by Gundersen (2012) for minimizing exergy requirement, it helps obtain the improved process with minimum work required. In addition, this methodology is applied to case study of complex LNG (multistage cascade cycle) under subambient temperature. Furthermore, the cascade refrigeration system is designed by mathematical programming for restructure of exchangers in order to improve the process with minimum energy and work required.