CHEPTER I

INTRODUCTION

1.1 Importance and reason for research

Optimization is the use of specific methods to determine the most promising solution to a problem or design for a process. This technique is one of the major quantitative tools in industrial decision making. A wide variety of problems in the design, construction, operation, and analysis of chemical plants (as well as many other industrial processes) can be resolved by optimization.

Optimization had been involved in chemical industrial problem. It is used to find the maximizing of productivity and safety while minimizing operating costs. In a fully optimized plant, efficiency and productivity are continuously maximized while levels, temperatures, pressures, or, flows rate are kept within their allowable limits. Many real-world chemical industrial problems involve two types of problem difficulty: i) multiple conflicting objectives (Multi-objective optimization) and ii) a highly complex search space. Multi-objective optimization which instead of a single optimal solution competing goals, give rise to a set of compromise solutions, generally denoted as Pareto-optimal. In the absence of preference information, none of the corresponding trade-offs can be said to be better than the others. Moreover, the search space can be too large and too complex to be solved by exact methods. Thus, efficient optimization strategies are required to solve problems with both types of problem difficulty.

Evolutionary algorithm (EA) is one of the most popular techniques to solve multi-objective optimization problem. This technique provides some important advantages in solving multi-objective optimization over other techniques because it can simultaneously deals with a set of possible solutions and find several members of the Pareto solutions in a single run of the algorithm. Additionally, evolutionary algorithms are less susceptible to the shape or continuity of the Pareto front, and also have an ability to handle complex problems, involving features such as discontinuities, multimodality, disjoint feasible spaces and noisy function evaluations.

Unfortunately, evolutionary algorithm involves using many parameters. Consequently, the selection of the parameters value is important, and has an effect on accuracy and convergence of the solution.

Various studies have been on the analysis of the effect of various parameters and on the development of generic guideline for selecting suitable parameters. Leboreiro and Acevedo (2004) analyzed the effect of the parameters of the EA for single objective optimization in its performance by solving a series of process engineering problems. The authors concluded the best value of mutation and crossover probability. However, only a few studies have been on the development of generic guideline for selecting suitable parameters of the evolutionary algorithm for multi-objective optimization problems.

In this work, we study the effect of various parameters used in evolutionary algorithm for multi-objective optimization problem for instance mutation and crossover probability. Furthermore, the generic guideline for selecting suitable parameters values of the evolutionary algorithm for multi-objective optimization problems is developed.

1.2 Research objectives

The objectives of our research are to analyze the effect of the parameters of evolutionary algorithm for multi-objective optimization problems, and to find suitable value of parameters for evolutionary algorithm. Furthermore, the proposed guideline is applied for problem of synthesis phenol recovery process.

1.3 Scope of research

Our research focuses on the analyzing the effect of genetic parameters (mutation and crossover probability) in evolutionary algorithm for multi-objective optimization problems. In this work we analyze the effect of genetic parameters used in Multiple Objective Genetic Algorithm (MOGA) (Fonseca and Fleming 1993), Niched-Pareto Genetic Algorithm (NPGA) (Horn, Nafpliotis and Goldberg 1994), Non-dominated Sorting Genetic Algorithm (NSGA) (Srinivas and

Deb, 1994), Elitish non-dominated Sorting Genetic Algorithm (NSGA-II) (Deb, Agrawal, Pratap and Meyarivan, 2000) and Strength Pareto Evolutionary Algorithm (SPEA) (Zitzler and Thiele, 2000). In addition, we develop generic guideline for selecting appropriate genetic parameters in each algorithm. The developed guideline is applied in a case study. The case study involves the problem of synthesis of phenol recovery process used in phenolic-resin manufacturing. The formulated problem is multi-objective optimization which two objectives in the global problem are economic and environmental performances.

1.4 Contribution of research

This research provides an insight on the effect of genetic parameters and a guideline for selecting suitable value parameters in various evolutionary algorithms for multi-objective optimization problems.

1.5 Structure of Thesis

The thesis can be divided into six chapters. In the first chapter, "Introduction", we discuss importance and reasons of this thesis. The objectives and scopes of this work are also clarified.

Chapter II, "Literature review", review of the development of many successful multi-objective evolutionary algorithms over the past decade and applications of EA are also presented at the end of this chapter.

Chapter III, "Multi-objective optimization problem", highlights the basic concepts of multi-objective optimization problem, the Classical methods to solve multi-objective optimization problem, review of Evolutionary algorithms and two steps to solve multi-objective optimization problem.

Chapter IV, "Evolutionary algorithms", describes the theory of Evolutionary algorithm (EA). The principle steps of EA, such as assign fitness, selection, crossover, and mutation step are explained. And brief overview of Evolutionary Techniques, such as MOGA, NSGA, NPGA, NSGA-II and SPEA

Chapter V, "Analyze the Effect of Genetic Parameters", In this chapter we analyze effect of genetic parameters on five multi-objective optimization problems Finally, the results concerning the effect of these algorithms are discussed and summarized the suitable value of genetic parameters is used in Evolutionary algorithms .

Chapter VI, "Synthesis phenol recovery process", the developed guideline is applied in a case study, synthesis of phenol recovery process used in phenolic-resin manufacturing. The formulated problem is multi-objective optimization which two objectives in the global problem are economic and environmental performances.

Chapter VII, "Conclusion" concludes the thesis by summarizing the main results of each chapter, and discussing the new contributions.