CHAPTER I

INTRODUCTION

1.1 Rationale

Light olefins have a wide variety of application in the petrochemical and chemical industries. They are important raw materials for many intermediates of commodity petrochemicals and fine chemical, such as monomer of polypropylene and polyethylene, and engineering plastics. A large increase in demand for ethylene and propylene [1, 2] has been occurred. Presently, most light olefins are obtained from thermal creaking of naptha. Indirect production of olefins from natural gas, though the production of methanol, is a possible olefin production route, which high yields are obtained.

Since its discovery by Chang and Silvestri at Mobil Oil in 1977, the conversion of methanol to olefins (MTO) on acidic zeolite catalyst has attracted significant reactions. Although methanol itself is a potential motor fuel or can be blended with gasoline, it would require large investments to overcome the technical problems connected with the direct use or methanol fuel. The methanol-to-olefin technology provides a powerful method to convert indirect synthesis gas into fuels.

The catalytic conversion of methanol to olefins, especially ethylene and propylene, is of significant industrial interest. The MTO reaction has been studied over different types of zeolites or molecular sieve. Both structural and chemical properties of them as well as various process parameters influence the product distribution in the methanol to olefins reaction. The catalyst acidity, pore size, shape, particle size, and presence of heteroatoms are among the many factors role in determining activity and selectivity. Reaction parameters such as temperature, space velocity, and feed composition also have significant effects on product distribution.
In general, reductions in contact time, weak acidity, water dilution, and modification with suitable promoters can enhance the selectivity of light olefins.

Zeolite-type catalysts are used widely in petrochemical and petroleum refining process. The pentasil-type zeolie ZSM-5 has been the candidate among the medium-pore zeolites to be investigated as catalyst for the MTO reaction. The pentasil-type zeolie ZSM-5 shows excellent catalytic performance for methanol conversion to hydrocarbons. This catalyst behavior, therefore, makes the pentasil-type zeolie ZSM-5 works as an effective catalyst for either methanol-to-gasoline and methanol-to-olefin reactions[3,4,5].

This thesis focused on investigation on characteristics catalytic properties of ZSM-5 zeolite and Co-ZSM-5 zeolite catalysts used for methanol conversion in to light olefins. The catalysts having different Si/Al ratios were prepared, characterized and test for methanol conversion. In addition, the crystallite size and reaction temperatures were also various. The suitable conditions were selected to determine the effect of cobalt loading in ZSM-5 zeolite.

1.2 Research objective

The objective of this research was to investigate the characteristics and performance of different cobalt loading and particle sizes of cobalt containing ZSM-5 catalysts on methanol conversion to light olefins.

1.3 Research scopes

1. Study of the method to synthesize and introduce the cobalt into ZSM-5 zeolite catalyst.
2. Characterization of the prepared catalysts by the following methods;
   - Identify the structure and crystallity of catalysts by X-ray diffraction (XRD).
   - Determine the amount of metal of catalysts by X-ray fluorescence (XRF).
   - Determine the shape and size of crystallites by Scanning Electron Microscope (SEM).
   - Measure the surface areas of catalysts by N_2 physisorption.
   - Measure the acidity of catalysts by NH_3-TPD

- Determine the binding energy and the composition on the surface layer of the catalysts using a Kratos Amicus X-ray photoelectron spectroscopy.

3. Investigation of the performance of the prepared catalysts for methanol conversion to light olefins under the following condition;
   - Atmospheric pressure.
   - Reaction temperature 200 - 500 ^{o}C
   - Space velocity 25,000 h^{-1}
   - Reactant feed 20% methanol and 80% nitrogen as diluents
   - The reaction products were analyzed by Gas Chromatography

This thesis is arranged as follows:

Chapter II presents the literature review of previous works related to this research.

Chapter III explains basic information about zeolite and metal containing ZSM-5 zeolite catalyst.

Chapter IV describes synthesis of various particle sizes of the MFI zeolite catalyst doped with cobalt to convert methanol into light olefin.

Chapter V presents experimental results and discussion.

Chapter VI presents overall conclusion of this research and recommendations for future research.