CHAPTER I
INTRODUCTION

The environmental concerns and regulations have been increased in the public, political and economical world over the last two decades because the quality of life is strongly connected to a clean environment. The impulse for new development, more efficient and selective catalysts and the realization of new process technology is strongly related to environmental compatibility.

An excellent example is the alkylation of aromatics. In former days such processes have been mainly carried out in the presence of homogeneous Lewis acid catalysts such as $AlCl_3$, $FeCl_3$, HF, BF_3, etc. The well-known drawbacks of such homogeneously catalyzed processes have to be overcome by applying heterogeneous catalysis.

Cumene (isopropylbenzene) is an important raw material for the production of phenol and acetone. It can be produced from the alkylation of benzene with propylene or isopropanol. In conventional processes are usually catalyzed by either solid phosphoric acid (SPA) or $AlCl_3$, which both of catalysts give rise to many problems concerning handling, safety, corrosion and waste disposal. The total worldwide production capacity of cumene is about 6 million ton/year; the SPA is still heavily predominant. Much effort has been put into developing alternative catalyst systems such as zeolite-based catalysts.

In 1993, the Mobil-Badger/Raytheon cumene process [1] by using zeolite ZSM-5 is offered for license by Mobil-Badger that can give high purity and yield. After that, several company have been involved in development of cumene process by using other zeolites as shown in table 1. The suitable zeolite catalyst is essentially inactive for oligomerization but active for the alkylation and transalkylation. Beta zeolite is reported that has the good efficiency for cumene production.

Beta zeolite is a 12-member ring (12 MR) tridirectional zeolite, with two different type of channel having about 7.0 and 5.5 Å [2] that can be synthesized within a large range of silica-to-alumina ratio (12-200) [3]. This zeolite may offer interesting opportunities as a catalyst, since it combines three important characteristics: large pores, high silica-to-alumina ratio, and a tridirectional network of pores [4]. High silica zeolites are known to be important potential catalysts on account of their high thermal, hydrothermal and acid stabilities, and good resistance to aging and hydrophobicity [3]. In additions of one type of pores (5.5 Å) can give a certain level of shape selectivity [5].

Therefore, this work aims to study cumene synthesis from benzene and isopropanol over Beta zeolite. This present work is arranged as follows:

Chapter II presents the literature reviews of investigation the alkylation of benzene with isopropanol for synthesis cumene.

The theory of this research, the theoretical consideration on Beta zeolite and mechanism of alkylation of benzene with isopropanol are presented in chapter III.

Following by the description of the experimental systems and the operational procedures in chapter IV.

The experimental results obtained from a laboratory scale reactor and standard measurement are reported and discussed in chapter V.

Chapter VI gives overall conclusions emerged from this work and present some recommendations for any future works.

Finally, the sample of calculation of catalyst preparation, the calibration, and data of experiments are including in appendix at end of this thesis.

Table 1. Cumene process [1]

Feed	Catalyst	Company	Year, scale
Benzene + Propylene	Solid phosphoric acid (SPA)	Most of the cumene producer	
	High silica zeolite	Mobil-Badger/ Raytheon	Ten licenses 1.5 bil lb/y, Georgia Gulf at Pasadena, Texas 1996, 1.5 bil lb/y Citgo Petroleum 1998, 1 bil lb/y, Sun at Philadelphia, PA 1995, 25000 t/y, Ertisa at Huebla, Spain
	β-zeolite	Enichem	1996, 265000 t/y
	Acid zeolite catalytic distillation	CDTECH	170000 t/y, GP-Orgetelko-Dzeryinsk at Nizhny Novgorod, Russia
	Mordenite	DOW Chemicals	1994 (p)
	Y-zeolite	Lummus	1994 (p)
	Acid zeolite catalytic distillation	CDTECH Catstill-technology	
	Three-dimensional dealuminated mordenite	DOW/Kellog 3-DDM technology	1994, 200000 t/y at Terneuzen, Belgium Five projects
Diisopropyl benzene + Benzene	Dealuminated mordenite	DOW/Kellog UOP Q-Max technology	1992, at Terneuzen, Belgium 1996, 145 mil lb/y, BTL Speciality Resins at Blue Island, IL 45000 t/y, Chevron Chemicals at Port Arthur, TX

*(p) denotes "under pilot plant"

The Objective of This Study

To study cumene synthesis from benzene and isopropanol over Beta zeolite

The Scope of This study

1. To study the synthesis of Beta zeolite
2. Characterize the prepared catalyst by following method:
    2.1. Analyzing the structure of catalyst by X-Ray Diffraction (XRD)
    2.2. Analyzing shape and size of crystallites by Scanning Electron Microscope (SEM)
    2.3. Analyzing surface areas of the catalysts by BET Surface Area Measurement
    2.4. Analyzing the acidity of catalysts by Infrared Spectroscopy (IR)
3. To investigate the performance of the prepared catalysts on cumene synthesis from vapor of benzene and vapor of isopropanol by using N_2 for carrier gas under the following conditions:
    3.1. Atmospheric pressure
    3.2. Ratio of SiO_2/Al_2O_3 in gel 30-80
    3.3. Reaction temperature 100-300 °C
    3.4. Space velocity 1000-5000 h^{-1}
    3.5. Ratio of benzene/isopropanol 2.8

The reaction products were analyzed by gas chromatographs.