# CHAPTER I
# INTRODUCTION

Ethylbenzene (EB) is important in the petrochemical industry as an intermediate in the production of styrene, which in turn is used for making polystyrene, a commonly used plastic material (Cejka *et al.*, 2002). The most important conventional process for manufacturing EB is the alkylation of benzene with ethylene on Friedel–Crafts catalysts, but these catalysts have induced many problems such as handling, safety, waste disposal and corrosion (Sridevi *et al.*, 2001). However, the direct use of ethylene as an alkylating agent with benzene for this reaction has a drawback in which a short stable catalyst life is observed.

Some investigations have observed other alternative catalyst systems as a substitute for Friedel–Crafts catalysts. Recently, zeolite-based catalysts have gained attention as a substitute for conventional catalysts because of the popularity of alternative environment-friendly chemical processes. Moreover, other alternative alkylating agents as a substitute for ethylene have gained attention as well. The alkylation of benzene with ethanol in a fixed-bed reactor in the vapor phase using a ZSM-5 based catalyst is known as the famous Mobil-Badger process. A long stable catalyst life and a higher yield of alkylbenzene products are observed when alcohol is used, rather than ethylene. The direct use of ethanol in the manufacture of ethylbenzene is also economical significance to many countries where biomass derived alcohol is an additional raw material for the manufacture of chemicals (Sridevi *et al.*, 2001). In addition, among the zeolite catalysts, ZSM-5 zeolite may be most suitable for the alkylation of benzene with ethanol because of its special structure and its surface acidity (Li *et al.*, 2009).

The global demand for EB in 2011 was forecast to approach 35.5 million metric tons (ICB America Chemical Profile. 2007. www.icis.com). In the past decades, zeolite-based processes have been introduced and licensed by several manufacturers such as Mobil–Badger, Lummus–UOP, CD Tech and Dow Chemical (Degnan *et al.*, 2001). The competing technologies for EB production among those companies based on zeolite catalysts processes in the petrochemical industry. So

using HZSM-5 zeolites is one of the interesting options that the group is looking forward to studying.

Previous studies demonstrated that a commercial HZSM-5 catalyst with $SiO_2/Al_2O_3$ ratio of ca. 195 gave somewhat high selectivity to EB. In this research, the purpose of this work was to study the effects of textural properties and acid-base properties of synthesized HZSM-5 on the selectivity to EB. The HZSM-5 catalysts were synthesized at a desired $SiO_2/Al_2O_3$ ratio of ca. 195 with different textural properties and Brönsted acid sites via hydrothermal synthesis. Their catalytic activity was tested via ethylation reaction of benzene with ethanol at different reaction conditions; temperature (300–600 °C), weight hourly space velocity (10-20 $h^{-1}$), and benzene to ethanol ratio (1-4). Finally, the comparison on both catalytic activity and selectivity to ethylbenzene for the catalysts investigated were performed.