## CONTENTS

Chapter 1  INTRODUCTION  1-62

1.1  Zeolites: Historical Development of Zeolite Chemistry.  :  1
1.2  Synthesis of Zeolites.
   1.2.1 Development of early Zeolite synthesis.  :  8
1.3  Zeolite modification.
   1.3.1 Modifications by Direct Synthesis.  :  11
   1.3.2 Modification by Post-synthesis.  :  12
1.4  Nomenclature of Zeolites.  :  15
1.5  Classification of Zeolites.  :  16
1.6  Characterization of zeolites.
   1.6.1 X-ray Diffraction.  :  17
   1.6.2 Microanalysis.
      1.6.2.1 Scanning Electron Microscopy.  :  19
      1.6.2.2 Transmission Electron Microscopy.  :  20
   1.6.3 Thermal Desorption.  :  20
   1.6.4 Vibrational Spectroscopy.  :  21
   1.6.5 Nuclear Magnetic Resonance Spectroscopy.  :  24
   1.6.6 Surface Area Measurement.
      1.6.6.1 Intracrystalline Diffusion in Zeolites.  :  26
1.7  Properties of Zeolites.  :  27
   1.7.1 Physical Properties.
      1.7.1.1 Morphology.  :  28
      1.7.1.2 Particle size of synthetic zeolites.  :  29
      1.7.1.3 Density.  :  29
1.7.2 Chemical Properties. : 29
   1.7.2.1 Brønsted and Lewis acid sites. : 29
   1.7.2.2 Basic sites. : 31
1.7.3 Stability of Zeolites. : 31
1.7.4 Shape Selectivity in Zeolites. : 31

1.8 Description of zeolites used in the present investigation. : 34
   1.8.1 Zeolite ZSM-5. : 34
      1.8.1.1 Synthesis of ZSM-5 Zeolite. : 34
      1.8.1.2 Structure of ZSM-5. : 35
      1.8.1.3 Application of ZSM-5. : 37
   1.8.2 Zeolite MCM-22. : 38
      1.8.2.1 Synthesis of MCM-22 Zeolite. : 38
      1.8.2.2 Structure of MCM-22. : 39
      1.8.2.3 Application of MCM-22. : 40

1.9 Scope of this Thesis. : 40
1.10 References. : 42

Chapter 2 SYNTHESIS OF ZEOLITES AND THEIR CHARACTERIZATION 63-102

2.1 Introduction : 63
2.2 Preparation Of Catalysts. : 64
   2.2.1 Chemicals used : 64
   2.2.2 Synthesis of ZSM-5 in different solvents. : 65
   2.2.3 Preparation of ammonium forms of the zeolite. : 67
   2.2.4 Preparation of HZSM-5. : 68
   2.2.5 Calcination. : 68
2.2.6 Synthesis of BMCM-22.

2.3 Characterization.

2.3.1 Powder X-ray Diffraction (XRD).

2.3.2 Fourier Transform Infrared Spectroscopy.

2.3.3 Temperature Programmed Desorption of Ammonia.

2.3.4 Thermogravimetric Analysis.

2.3.5 Scanning Electron Microscopy.

2.3.6 Nitrogen Adsorption Measurement.

2.4 Results and Discussions.

2.4.1 X-ray Diffraction (XRD).

2.4.2 FTIR Spectroscopy.

2.4.3 Temperature Programmed Desorption of Ammonia.

2.4.4 Thermogravimetric Analysis.

2.4.5 Scanning Electron Microscopy.

2.4.6 Nitrogen Adsorption Measurement.

2.5 Conclusion.

2.6 References.

Chapter 3 TRANSESTERIFICATION BY ZSM-5 ZEOLITE 103-150

3.1 Transesterification of Methyl Acetate.

3.2 Catalytic Reaction.

3.3 Results and Discussions.
IV

3.3.1 Effect of time on stream on Product Distribution for the Reaction. : 105
3.3.2 Effect of Temperature. : 112
3.3.3 Effect of Mole Ratio of Reactants. : 126
3.3.4 Effect of Catalyst Weight. : 143
3.3.5 Deactivation Study. : 147
3.4 Conclusion. : 149
3.5 References. : 150

Chapter 4 STUDIES ON ACIDITY OF BMCM-22 BY CHEMICAL CHARACTERIZATION 151-186

4.1 Acylation Reaction as a Tool for Characterization of Zeolites. : 151
4.2 Industrial Aspects of the Reaction. : 152
4.3 Catalytic Reaction. : 154
4.4 Results and Discussions. : 154
   4.4.1 Effect of Time on Stream on Product Distribution for the Reaction. : 154
   4.4.2 Effect of Si to (B + Al) ratio on the Product Distribution. : 159
   4.4.3 Effect of Catalyst Weight. : 161
   4.4.4 Deactivation Study. : 165
   4.4.5 Effect of Temperature. : 167
   4.4.6 Effect of Mole Ratio of Reactants. : 171
   4.4.7 Effect of acylating agent. : 174
   4.4.8 Comparison of Product Distribution of Phenol Acylation Reaction over catalysts MCM-22 and BMCM-22. : 178
4.5 Reaction Scheme. : 180
4.6 Conclusion. : 182
4.7 References. : 184