

CHAPTER 7

SUMMARY AND CONCLUSIONS

In the present day context, sources of energy appear to take the central theme of many scientific investigations. To optimize the use of available fossil fuel energy sources and also to conserve them for future generations are prime objectives of a number of research attempts. In this direction, this thesis attempts to examine the production of oxygenates which are used as petrol blends for better utilization and also for environmental concerns. Various oxygenates can be blended with petroleum, but if the blending components were to come from refinery feed stocks, they have certain clear advantages for blending in terms of production and distribution. Keeping these aspects in view, the present thesis considers the various options that are available and how each one of them can be exploited. The production of these oxygenates from refinery feed stock is the central theme of this study. Secondly refinery feed stock can also be exploited for the production of value added chemicals and one of them is the methyl isobutyl ketone which finds application in paint and other industries. In view of the importance of this value added chemical, its production is also considered mainly from the point of view of appropriate catalytic system which can promote the formation of this from refinery feedstock.

The future energy demand has also to rely on the development of fuel cells. One of the fuel cells which shows some promise is the Direct Methanol Fuel Cell (DMFC). One of the stumbling blocks in the exploitation of this fuel cell is the electrode and the support for the electrode. In this study, an alternate carbon support has been examined as candidate material for fuel applications.

All these aspects have been covered in 6 chapters in this thesis and the chapter wise contents of the thesis are:

Chapter 1: This chapter describes the need, functions, properties and types of oxygenates. The catalytic aspects and production of tertiary alkyl ether from refinery feedstock is highlighted for each of the oxygenates.

Chapter 2: The experimental procedure employed in the preparation of zeolite supported bimetallic and trimetallic catalysts and Pt/CDX-975 are described in this chapter. A brief description of the instrumental techniques used in the characterization of this material and the method of analysis of the results are described. The experimental methods used for vapor and liquid phase DIPE production are presented. The product analysis protocols are also outlined.

Chapter 3: This chapter describes the production of IPA and DIPE carried out using various solid acid catalysts such as zeolites, heteropolyacids and ion exchanged resins. H-zeolite- β catalyst was found to be more active than that of H-ZSM-5 catalyst for the production of DIPE from IPA in the vapour phase. DIPE formation increases with increase in contact time and pressure. Hydration of propylene in liquid phase over solid acids is described. Phosphotungstic acid is more active for the preparation of isopropanol compared to other zeolite and resin catalysts. In the hydration of propylene, solvent increases the solubility of propylene in the aqueous phase and hence accelerates the hydration rate. The polarity of the solvent is also found to be important for the observed hydration activity. Zeolite catalysts (H-ZSM-5 and H-zeolite- β) were found to be less active than the heteropolyacid catalysts for liquid phase DIPE production from IPA. Heteropolyacids namely, phosphotungstic, silicotungstic and phosphomolybdic acids were evaluated for DIPE production in

liquid phase from isopropanol. Phosphotungstic acid catalyst was found to be more active for DIPE formation compared to other heteropoly acid catalysts. Isopropanol containing propylene enhances the yield of DIPE compared to isopropanol without propylene over H-zeolite- β and phosphotungstic acid as catalyst.

Chapter 4: In this Chapter, an attempt has been made towards the synthesis of DIPE from acetone in a single step under liquid phase conditions for the first time. Ni-Cu bimetallic and catalysts supported on H-zeolite- β are found to be active for DIPE production. The amount of metal loading, temperature and hydrogen pressure are crucial factors influencing the yield of DIPE. Ni-Cu (25 wt %) metal supported on H-zeolite- β catalyst shows higher activity and DIPE yield compared to other metal loadings studied. The reduction temperature of the catalyst precursor is found to be less significant when it is higher than 573 K. Ni-Cu-Cr trimetallic catalysts supported on H-zeolite- β are found to be active for the production of DIPE from acetone. The effect of amount of catalyst loading, hydrogen pressure, volume of acetone and temperature on DIPE formation are studied. A moderate reaction temperature in the range of 433 K - 453 K and catalyst amount of 1 g are found to be favorable for higher DIPE yields. Hydrogen pressure (30 - 80 bar) increases the yield of DIPE. The effect of addition of a third metallic component (Mn and Fe) apart from Cr is also studied for the supported Ni-Cu system. Among Fe, Mn and Cr metals, the incorporation of Fe along with Ni-Cu exhibit better activity compared to Mn and Cr.

Chapter 5: The catalytic activity of Ni-Cu-Mg/H-zeolite and Ni-Cu-Cr/H-zeolite- β for the liquid phase production of MIBK from acetone feedstock is evaluated. The acidic functionality of the catalyst is found to be important for a higher selectivity of

MIBK. Among various catalysts screened, Ni-Cu-Cr/H-zeolite- β , Ni-Cu-Mg/H-zeolite- β and Ni-Cu-Mg/H-ZSM-5 were found to be effective in the production of MIBK. The higher selectivity in case of H-zeolite- β supported catalysts can be attributed to the moderate acidity and appropriate pore size (c.a. 6.5 Å).

Chapter 6: CDX-975 is identified to be a promising support for electrode application in DMFC. The platinum loading on CDX-975 was varied to identify the optimized catalyst for methanol oxidation. The optimum loading was found to be 10 % Pt/CDX-975. Pt/CDX-975 was characterized by means of XRD and electrochemical active surface area. Catalytic activity for the methanol oxidation was examined and influence of formaldehyde reduction method on the methanol oxidation activity is described in this chapter. The higher methanol oxidation activity of 10 % Pt/CDX-975 correlated well with smaller particle size (XRD), high electro-active surface area and sustained chronoamperometric response.