

# **Catalytic Hydroalkylation of Benzene: A Step Towards Refinery Petrochemical Integration**

## **Abstract**

Benzene is a known carcinogen and can cause serious health and environmental effects. EPA (Environmental Protection Agency) is constantly reducing the limit of benzene content in gasoline due to its health effects. To meet the EPA regulations, most refiners are saturating benzene in gasoline to cyclohexane. Benzene saturation not only consumes useful hydrogen but also leads to considerable octane loss for gasoline stream. In view of this, refiners are forced to explore alternate ways to valorize the benzene produced in the refinery. Cyclohexylbenzene (CHB) is a versatile chemical with numerous industrial applications. It is used as electrolytic additive in lithium ion batteries, liquid crystal displays and as non-carcinogenic fuel blending additive. Furthermore CHB is also excellent precursor for production of petrochemical intermediates like phenol cyclohexanone and biphenyl. Thus, converting benzene to CHB is more profitable option in view of the numerous benefits of CHB. This study reports green route for the preparation of CHB avoiding the traditional two step alkylation of benzene and cyclohexene, using hazardous acid catalysts such as sulfuric acid and aluminium chloride. This dissertation research is focused on development of a highly selective, stable and cost effective catalyst for hydroalkylation of benzene to CHB. Thus the present study is attempted to evaluate hydroalkylation activity of different metal supported zeolites and discuss the results in terms of the effect of catalyst properties like zeolite acidity, zeolite pore structure, type and amount of metal and acid to metal ratio of the catalyst on the catalytic activity and CHB selectivity. Furthermore, kinetic modelling, process development and scale up studies are discussed using the optimum catalyst formulation employing in-house designed process demonstration unit. Finally, it is discussed how hydroalkylation process will pave way for refinery petrochemical integration assisting in the production of useful petrochemicals like phenolic resins, bisphenol A, caprolactam, alkylphenols, biphenyl, adipic acid, cyclohexanone oxime, cyclohexanone resins and nylon.