Selective conversion of guaiacol to value added chemical over $NiCo/\gamma\text{-}Al_2O_3$ Catalysts

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RESEARCH WORK

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Abstract:

Diminishing fossil fuel reserve, fluctuations in their costs and its associated environmental impact upon utilization as a fuel are some of the serious problems which should be encountered as soon as possible. Petroleum reserved still hold a major share in providing energy from crude oil for transportation as well as platform chemicals. Dependence of our society on fossil derived crude oil is such that we cannot switch over to a different energy source at an instant. To encounter this problem various research has been carried out in the past few years to valorise lignocellulosic biomass mainly because it can provide us both transportation fuel and commodity chemicals similar to petroleum crude oil without harming to the environment. Deep insight of lignocellulosic biomass suggests it is made up of three main components i.e. cellulose, hemicellulose and lignin. Cellulose and hemicellulose can be valorised to bioethanol/bio-butanol which can be utilized as a transportation fuel using the current infrastructure. The last component, lignin, which is most abundant aromatic polymer in nature can provide commodity chemicals such as benzene, xylene and toluene onto which various industries relies. The various strategies adopted in past years to valorise lignin mainly gives oxygenated aromatics in the product stream. The presence of oxygen in the product stream imparts various undesirable properties such as high viscosity, thermal and chemical instability and proneness to polymerization during transportation and storage. To eliminate these undesirable properties of the product stream, further upgrading via hydro-deoxygenation (HDO) is required whose key step is to remove oxygen functionality and produce deoxygenated hydrocarbons.

In this particular study, we are studying the HDO of guaiacol (a lignin model compound) over alumina supported nickel catalyst modified with different promoters (Co, Cu and MoP) to produce valuable chemicals. Alumina supported nickel catalyst modified with different promoters were prepared using co-impregnation method. The total metal loading of the catalyst was tuned from (0-35%) and were evaluated in the HDO of guaiacol at 300 ºC and 20 bar H_2 pressure for 4h in a high temperature and pressure batch ractor (Parr). Among the different promoters used in combination with nickel, 15%NiCo/Al was found to more effective in the HDO of guaiacol which achieved complete conversion of guaiacol with benzene (20%) and cyclohexane (72%) as major product (Fig 1). The effect of total metal loading which till now studied in the range of (5-25%) represents that the conversion of guaiacol reached 100% after 4h of reaction with all the total metal loadings (Fig 2). However, as the total metal loading was increased from 5-25%, the time required to reach the 100% conversion reduced (Fig 2). The other major objectives of this study will be: (i) Effect of Ni-Co mole ratio (ii) Effect of reaction temperature (iii) Effect of initial hydrogen pressure (iv)

Effect of reduction and calcination temperature (iv) Establishing a mechanistic pathway for the conversion of guaiacol to various products.

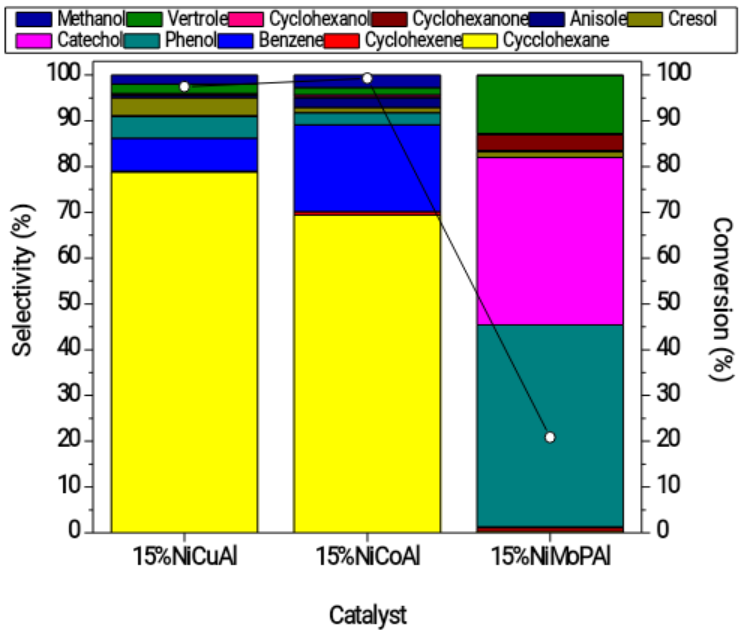

Fig 1. Effect of promoter

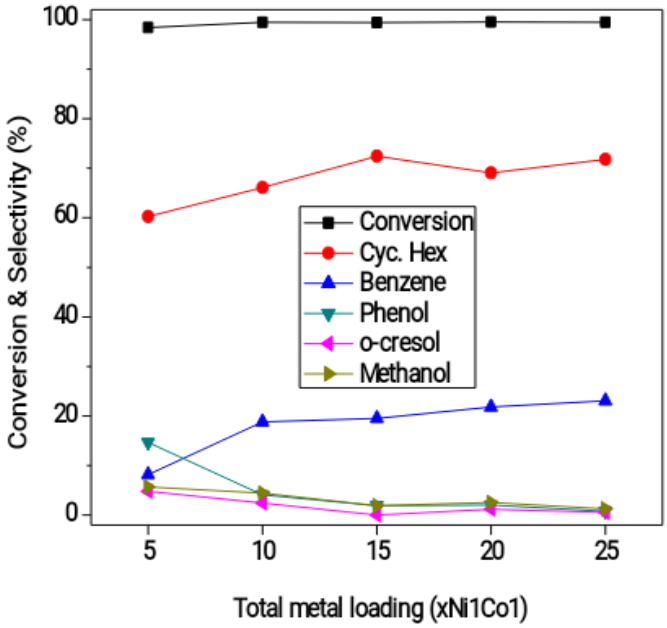

Fig 2. Effect of total metal loading on guaiacol conversion

Reaction conditions:

Temp= 300ºC, Catalyst Amount= 1g, Guaiacol Amount = 5% in tetralin, Reaction Time= 4h

Initial Hydrogen Pressure= 20bar, Stirrer Speed = 1000 rpm