ETHANOL CONVERSION TO TOLUENE OVER HZSM-5

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Introduction:

The instability in crude oil prices and uncertainty in supply are once again refueling the need to find alternatives to crude oil as sources of fuel and feed stock for the petrochemical and allied industries. Furthermore the need to tackle the damage done by green house gases calls for all hands on deck in finding alternatives to crude oil. The possible alternatives to crude oil should be able to meet present day ecological standards among others. One of the immediate necessary steps towards curbing the damage done by green gases is ensuring that there is a net balance in the amount of carbon given off as exhausts and that taken in as fuels.

Bioethanol produced from plants and other organic matter has been used as a fuel and a fuel additive [1]. Carbon is taking in by plants during photosynthesis in the form of carbon dioxide, hence ensuring the recycling of the carbon given off as exhaust from vehicles and industries. A proper utilistaion of bioethanol could be a possible solution to the the inevitable depletion of crude oil and the effect of green house gases.

Zeolites have been used in the conversion of ethanol to other hydrocarbons, the composition of which is affected by the types of zeolites, SiO_2/Al_2O_3 and reaction variables such as temperature and LHSV. In order to ensure the production of combustible hydrocarbons that reflect the composition of gasoline and other crude oil refining fractions, there is need to have a clear understanding of the mechanism of ethanol conversion. One of the important aromatic components of gasoline; toluene and other aromatic compounds are formed during ethanol conversion. Possible routes (figure 1) of toluene formation were investigated and it has been observed that, benzene does not play a significant role in toluene formation. It is suggested that toluene is formed via dehydrocycling of oligomers (> C_7) formed from the dehydration of ethanol.

Materials and Methods

The ethanol conversion was carried out in a fixed bed continuous flow reactor. It comprises a reactive block, made from stainless steel and heated electrically. The reagent was charged from the top using a pump, after which it was evaporated and the vapour was passed to the catalyst layer. An automatic thermoregulator was used to control the temperature.

The products of the reaction passed into the condenser where they were cooled by running water. The products were separated into liquid and gaseous phases in a separator. The liquid phase consisting of water and hydrocarbon fractions was collected in a collector. After which a separating funnel was used to separate the hydrocarbon from the water product. The gas fraction passed through a scrubber, a flow meter (soap bubble meter, with a relative accuracy of 0.5-1%) and was then collected. The gases were analyzed using a chromatograph that was directly connected to the experimental setup.Ethanol conversion was carried out at a temperature of 623K and atmospheric pressue. LHVS= $2h^{-1}$ -$10h^{-1}$for a period of 2-4 hours. The gas fraction was analyzed at intervals of about 40 minutes and the liquid fraction was analyzed at the end of the experiment.

The conversion products (both gaseous and liquid) were analyzed using gas chromatograph with helium (99.98%) as the carrier gas.

Results and Discussion

It is observed that, water to ethanol ratio and LHVS affect the catalysts selectivity for liquid hydrocarbons. In studying the possible mechanism of toluene formation, it was observed that toluene is not a product of benzene alkylation. It is suggested that Toluene is formed from the dehydrocycling of oligomers larger than C_7

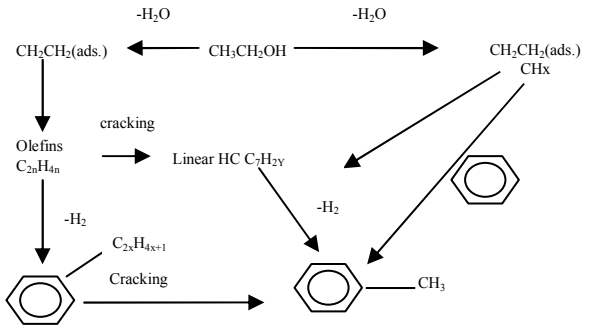

Figure1. Possible routes of Toluene formation from the conversion of ethanol over HZSM-5

References:

1. S.A Karpov, V.M. Kapustin and A.K. Starkov. Automobile fuels with bioethanol