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Performance of nickel supported catalysts in steam reforming of toluene as a tar model compound for use in hot-syngas clean-up

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Syngas which is the product of biomass gasification is generally used in power production and in Fischer Tropsch (FT) synthesis process. The production of syngas is generally accompanied with several impurities. These impurities are mainly chlorine, sulfur, nitrogen and tar. For advanced applications such as FT synthesis, tar should be extensively removed to obtain a clean syngas for FT process. In power production application, the tar in the syngas will condense at low temperatures and cause blocking and fouling of engines. Tar removal can be done through condensation or catalytic cracking. Catalytic thermal cracking of toluene was achieved in this research. Different nickel and iron based catalysts were synthesized using the incipient impregnation method to obtain the desired catalysts. Several characterization techniques were used to investigate these catalysts. The measurement of total surface area and pore volume of the catalysts were conducted in a BET analyzer. The physiothermal behavior of the catalysts was investigated using TGA. The crystallographic analysis of the synthesized catalysts was carried out using XRD to characterize the metallic distribution on the support. The temperature programmed reduction analysis detected the reduction behavior of iron and nickel to be around 400°C and 600°C, respectively. The TGA results showed that the optimum synthesis conditions of these catalysts were around 450°C. The catalytic activity of these catalysts was investigated in a fixed bed reactor. Results of these investigations showed that addition of iron to nickel increased the catalytic resistance to sintering, however the conversion rate of tar compounds was 60%. We also learned that the addition of magnesium as a promoter to bimetallic catalyst increased the conversion rate to 74%. These results showed that the above catalysts are able to convert toluene and ammonia to hydrogen, hence producing a high-quality syngas for advanced FT applications.

Biography

Abolghasem Shahbazi uses low value agricultural waste materials to produce value-added biofuels and bioproducts, including the production of ethanol through fermentation of various food processing wastes, and advanced biofuels from woody biomass. In the past four years, he has been working on gasification of woody biomass funded by the NSF (CREST Center for bioenergy) that uses woody biomass and herbaceous grass to produce syngas and subsequently advance biofuels through catalytic reactions. He has authored/co-authored more than 60 peer reviewed research publications. He was the recipient of Senior Research award from NCA&T in 2006 and an interdisciplinary research award in 2014. He has served as a convening board member for a legislature authorized Biofuel Center of NC in 2006-2008. He is now serving as a member of Technical Advisory Committee for Biomass Research and Development Initiative (BRDI), Department of Energy.

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