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Nickel-Incorporated Mesostructured Cellular Foam Catalyst for Selective Conversion of Fatty Acid Distillate into Diesel-Like Hydrocarbon Fuels

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Oleochemical wastes, especially fatty acids and fatty acid distillate are seen as renewable fuel sources of the future. Owing to high molecular weight of the fatty acid feed, the catalyst materials should be designed to have high surface area, sufficient framework mesoporosity, high structural strength and narrow pore size distribution. Mesostructured cellular foam (MCF) support was synthesized using a sol gel method with tetraethyl ortho silicate (TEOS) amounts ranging from 9.2 to 16 mL and then aged for between 1 to 3 days. Nicked-incorporated MCF catalysts were subsequently prepared using a precipitation. The physicochemical properties of the MCF catalysts were then elucidated by means of N_2-adsorption, energy dispersive X-ray (EDX), transmission electron microscopy (TEM), Fourier-transformed infrared (FTIR), thermal gravimetric (TGA) and H_2-temperature programmed reduction (H_2-TPR) methods. The catalytic activity was measured based on the semi-batch conversion of palmitic acid (PA) by the catalyst (10% wcat/wPA) carried out at 300 °C for up to 6 h under nitrogen flow. The window pore size of the MCF generally increased with increasing aging time. The increase in the TEOS amount up to 12.5 mL evidently decreased the pore volume, cell size and window pore size due to the increasing thickness of the MCF mesostructure. The incorporation of nickel generally led to slight decreases in the textural parameters. NiMCF(9.2T-3D) that was prepared with 9.2 mL TEOS and aged for 3 days was the most active catalyst, attributed to its high nickel content (17.6%) with the smallest particle size. Furthermore, the yield of 1-pentadecene in the product showed corresponding increases while those of n-pentadecane remained relatively constant. This was attributed to the formation of more CO gas that could inhibit the palmitic acid decarboxylation reaction. 30.9% n-pentadecane yield and 33.7% 1-pentadecane yield were recorded.

Keywords: Palm fatty acid distillate; decarboxylation; hydrocarbon; renewable fuel; Ni-loaded MCF catalyst; synthesis conditions; physicochemical characteristics.

Biography

Prof Dr. Ahmad Zuhairi Abdullah received his PhD in 2004 in chemical engineering. His research works involve the use of functionalized nanoporous materials in generating renewable energy sources, oleochemical conversions and waste treatment. He used to be involved the environmental impact assessment of oil refinery, petrochemical complex, sanitary landfill, smelting plant, used acid lead battery, paper mill etc. Many international invitations have been received to share his research experience. He has published more than 200 refereed articles in journals. He is one of the recipients of the Top Research Scientists Malaysia 2014 award. His h-index (Scopus) currently stands at 47.