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Titanium Modified USY Zeolite-based Catalysts for Hydrocracking of Residual Oil (Part 2) Development of Catalysts for Fixed Bed Reactors

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The present study tried to develop hydrocracking catalysts for commercial hydrotreating plants to treat residual oil based on the molybdenum-supported Ti-modified zeolite (MTZ) described in Part 1 of this study. Preparation methods of MTZ were investigated for application to large-scale manufacturing. The resultant MTZ had similar catalytic properties to the MTZ prepared in Part 1. After molding into cylindrical extrudates using an alumina binder, nickel (4 wt% as NiO) and molybdenum (16 wt% as MoO_3) were loaded by the incipient wetness impregnation method. The catalytic performances of the extrudate-type hydrocracking catalysts (NiMo/ MTZ) were tested using a bench-scale continuous flow type reactor with a catalyst volume of 80 m*l* and atmospheric residue of Arabian Light and Kuwait crude oils as feedstocks. The catalytic activity was found to be stable for more than 800 h. The selectivity for middle distillates of the NiMo/MTZ catalysts was superior to that of the reference NiMo zeolite catalyst (NiMo/USY1) prepared using a commercially available USY zeolite. The high selectivity for middle distillates was ascribed to the increased mesopore volume and controlled acidity of the MTZ zeolites. The NiMo/MTZ catalysts also showed higher hydrocracking activity of residual fractions than NiMo catalysts prepared using H_2SO_4-treated zeolites with increased mesopore volume and controlled acidity. The higher hydrocracking activity of the NiMo/MTZ catalysts was assumed to arise from the synergy between the solid acid sites on the zeolites and the

hydrogenation active sites on the MoS_2 clusters loaded on dispersed TiO_2 particles. The synergy prevented the formation of inert coke on the catalyst at the early stage prior to reaching steady catalytic activity in the bench-scale reactor experiment.

Keywords: Hydrocracking, Titanium modification, USY zeolite, Residual oil, Mesopore, Nickel molybdenum catalyst

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