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Comparison between Ni/ZSM-5 and NiMo/Al_2O_3 Catalysts in the Hydrocracking of Fischer–Tropsch Wax – Reflected in the Properties of Middle Distillates

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The harmful emissions caused by fossil fuels have long been recognized as a major issue. Various actions have been implemented worldwide to mitigate these negative effects. In the European Union, the ReFuel EU regulation and the RED III directive have been introduced. Both regulations promote the use of so-called e-fuels. This fuel category includes gasoline and middle distillates produced by Fischer-Tropsch synthesis from hydrogen generated using renewable electricity and carbon monoxide derived from renewable sources. In the low-temperature variant of the synthesis, which is more favorable from the perspective of middle distillate production, a large quantity of a low-value, high molecular weight paraffin fraction—known as Fischer-Tropsch wax—is formed. The conversion of this fraction has been considered crucial for the yield of hydrocarbons within the fuel boiling range and thus for the overall economic viability of the process. Fischer-Tropsch waxes have most commonly been subjected to some form of cracking. In terms of middle distillate quality, it has been found advantageous to perform hydrocracking, as the resulting fractions mainly consist of saturated hydrocarbons. In contrast, when thermo-catalytic cracking is carried out without a hydrogen atmosphere, the products have been found to contain a high proportion of olefins and aromatics. A high content of saturated hydrocarbons has been associated with improved stability, an increase in the smoke point for JET fuels, and an improvement in the cetane number for diesel gas oils. During our experiments, the hydrocracking of Fischer-Tropsch wax was carried out using two different commercially available nickel-containing catalysts in a continuous, single-pass, back-mixing-free microreactor system. The influence of the catalysts and changes in operating parameters on the yield and composition of the products was investigated. In addition, several key properties of the middle distillates were determined, including density, cold flow properties, and distillation characteristics. It was found that increasing the temperature and residence time improved the cold flow properties of the obtained middle distillates.

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