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Application of Nanoheterogeneous Molybdenum Sulfide Catalysts to the Hydrofining of the Semicoking Tar of Coal from the Shubarkul Deposit

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Abstract—The hydrofining of semicoking coal tar from the Shubarkul deposit (Republic of Kazakhstan) in the presence of nanoheterogeneous molybdenum sulfide catalyst systems (Mo content, 0.025–0.12%) was studied in order to intensify processing technology. The catalysts were in situ prepared in the coal tar with the addition of a sulfidizing agent—elemental sulfur in an amount of 0.03 –0.09 wt % on a raw material basis. It was found that the effective Mo content of the catalyst was 0.025%, and the amount of sulfur was 0.03%, which made it possible to obtain a maximum yield of total liquid products (76.8%), which mainly contained diesel fuel fractions, at 5 MPa and 400°C.

Keywords: coal tar, hydrofining, nanoheterogeneous molybdenum sulfide catalyst systems
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INTRODUCTION

One of the main disadvantages of current technologies for the catalytic hydrogenation of high-molecular-weight hydrocarbon raw materials is the use of heterogeneous catalysts, which have certain problems associated with their deactivation under the influence of a reaction atmosphere accompanied by changes in the catalyst texture, the adsorption of reaction products on the catalyst surface and a decrease in the fraction of the active surface, surface carbonization, loss of mechanical strength, etc. In most cases, the service life of heterogeneous catalysts is significantly shortened due to the complexity of their regeneration.

In the published literature, it was noted that catalysts introduced into the process in the form of highly dispersed particles uniformly distributed in the volume of raw materials are more effective the processing of coal and heavy hydrocarbon raw materials (coal distillates, heavy oils, bitumen, and oil residues) [1, 2]. From the point of view of dispersion efficiency in raw materials, the most promising are nanoheterogeneous catalysts obtained in situ from precursors in a reaction medium [3].

Table 1. Characterization of the semicoking tar of coal from the Shubarkul deposit

Characteristic	Value
Water content, %	3.4
Density at 20°C, g/cm^3	1.071
Ash content, %	0.11
Fractional composition, wt %:	
initial bp, °C	112–120
boiled to 180°C	2.4
180–330°C	19.0
above 330°C + losses	78.6
Concentration, wt %:	
polyaromatic hydrocarbons	60.0
substances insoluble in toluene	1.3
substances insoluble in quinoline	0.2
Closed cup flash point, °C	121
Conradson carbon rate, %	2.3–3.5
Weight fraction of sulfur, %	0.35
Content of actual tar + asphaltenes, %	27.0