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Coke Production from Coal Tar Fractions

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Abstract—A method is proposed for producing coke from distilled coal tar fractions. The influence of heat treatment of the tar fractions on the coke yield is investigated. The physicochemical characteristics of the coke produced from the tar fraction boiling above 280°C are investigated.

Keywords: coal tar, distilled tar fractions, coking, coke, hydrogenation

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At present, no industrial method is available for processing primary coal tar to generate pitch, which is a valuable product. As annual tar production (currently millions of tons) continues to increase, hydrogenation processes become more attractive. Such technology may be used to generate components of standard-quality motor oil and chemical products currently derived from petroleum. Currently, primary coal tar is processed to obtain liquid boiler fuels, low-boiling phenols, and some oils and binders for road construction.

Low-temperature coal tar may be purified by hydrogenation for 1.5 h at 330–390°C and 8 MPa, with a catalyst/tar ratio of 1 : 40 (by mass). It is of interest to determine how the tar composition, which depends on the hydrogenation temperature, affects the structure of the needle coke produced. Analysis of such data indicates that selecting the optimal hydrogenation temperature facilitates the removal of heteroatoms—especially sulfur.

In hydrogenation at 390°C, the aromatic compounds in the tar are polarized, on account of cracking and polycondensation. That improves the graphitization of needle coke [1].

Olefins and sulfur seriously impair the preparation and quality of coke. Data show that hydrogenation with a very small quantity of Mo-based nanoparticles may selectively remove olefins and sulfur. For this purpose, Mo_2C is much better than for MoS_2: 95% of olefins are removed. The structural parameters of the tar are hardly modified, indicating that aromatic compounds are retained [2, 3].

To develop the enrichment of coal tar by hydrogenation, we use untreated samples of semicoking tar from AO Sary-Arka Spetskoks (Karaganda, Kazakhstan), which is derived from Shubarkol coal; and also distillation residue with t_{bo} > 320°C from Kumkol petroleum (Kazakhstan), with the following characteristics: density (at 20°C) 0.8077 g/cm^3; and viscosity 9.69 mm^2/s. It contains 14.73 wt % paraffins; 1.52 wt % asphaltenes; and 8.2 wt % tars. The elemental composition is as follows: 83.85 wt % C, 11.27 wt % H, 1.81 wt % S, 0.80 wt % N, and 2.27 wt % O. Table 1 presents the tar characteristics.

Enrichment of highly aromatic fractions and heavy hydrocarbon residue by hydrogenation in the presence of molybdenum disulfide synthesized in situ from aqueous solutions of the precursor has been extensively studied. For example, extensive data have been obtained regarding the morphology of the catalyst and its capabilities, and the composition of the emulsion has been optimized [4–6].

The catalysts are synthesized by adding an aqueous solution of nickel para-molybdate (0.025–0.12 wt % of the raw materials) and dispersing the resulting mixture in a homogenizer at 130°C, with a plate speed of 1500 rpm. Then the mixture of tars and catalyst is heated to 70–80°C and charged in the reactor. Reactor heating by a replaceable electrofurnace is turned on and, on reaching 150°C, mixer operation begins. The temperature is measured by a thermocouple and maintained automatically to within ±2°C. The working pressure is 5.0 MPa; the temperature is 350–450°C, and the reaction time is 15 min. These parameters are chosen on the basis of research regarding the enrichment of