Table 1. Results for tar hydrogenation (5.0 MPa, $\tau = 15$ min, 1 : 1 tar–petroleum mixture, high-pressure laboratory system)

Characteristic	Temperature, °C	Yield (wt %) of liquids boiling at			Total yield of distillates, %	Gas + H_2O, wt %	Slurry, wt %	Losses, wt %
		<180°C	180–250°C	250–320°C				
No catalyst or sulfur	350	5.3	11.4	13.2	29.9	36.0	16.2	17.9
	400	7.8	15.3	24.0	47.1	36.3	9.1	7.5
	450	10.3	7.6	12.9	30.8	36.0	19.3	13.9
With nanoheterogeneous Ni- and Mo-based catalysts								
0.025%Ni + 0.03% S	350	2.3	15.8	43.4	61.5	15.5	14.1	8.9
	400	2.7	23.2	52.4	78.3	8.7	9.0	4.0
	450	2.8	17.0	48.4	68.2	15.5	13.3	3.0
0.025%Mo + 0.03% S	350	2.3	15.2	42.0	58.5	22.8	14.5	4.2
	400	2.7	22.8	52.3	76.8	8.2	9.2	5.8
	450	2.8	11.5	38.8	51.5	26.4	14.2	7.9

Table 2. Results for the coking of >280°C distillation fractions from tar hydrogenation in the presence of Ni-based catalyst

Yield, wt %			Coke characteristics, wt %		
coke	liquids	gas + losses	A^c	S^{tot}	V^{daf}
46.0	41.3	12.7	0.13	0.16	8.4

Table 3. Characteristics of coke roasted at 1300°C

Effective density, g/cm^3	CLTE at 200–400°C, K^{-1}	ER, Ω m	S_{me}
2.11	$(1.42–1.84) \times 10^{-6}$	43	5.0

In other words, the product obtained when nickel catalyst is used is better suited to filtration.

The Mo content is 0.0003% in the filtrate and 1.3% in the filtration residue; the corresponding figures for Ni are 0.0013% and 0.8%. That indicates that most of the catalyst is concentrated in the solid residue and may be returned to the process simply by adding the residue to the new tar portion.

Table 2 presents the results of laboratory coking for distillates boiling above 280°C, as well as the characteristics of the coke produced. The liquid products contain 80–85% of fractions boiling above 280°C and may be returned for coking. The fractions boiling below 280°C consist mainly of monocyclic and bicyclic aromatic hydrocarbons (including up to 15% naphthalene and up to 7% monomethylnaphthalenes) and must be sent for processing together with the hydrogenation products of the tar.

To determine the characteristics of the coke sample, it is roasted at 1300°C with 5-h holding, in accordance with State Standard GOST 22898–78. Table 3 presents the results. We see that the effective density of the coke matches that of regular anisotropic coke. It has low values of the coefficient of linear thermal expansion (CLTE) and electric resistivity (ER), as is typical of highly textured coke.

The mean microstructure score for the coke according to State Standard GOST 26132–84 is $S_{me} = 5.0$, with 95.8% distribution of the structural components. That corresponds to lobed coke with large fibers (35–70 μm), without any orientation of the structural elements.

After heat treatment at 2000 ± 30°C, we determine the parameter $\sin^2\alpha$, which characterizes the susceptibility of the coke to graphitization. We know that, for Conoco SP needle coke, $\sin^2\alpha = 0.95–0.97$; for KNPS isotropic coke, $\sin^2\alpha = 0.81–0.83$.

For the coke produced from hydrogenated coal tar, we obtain $\sin^2\alpha = 0.93 \pm 1$. That result falls between needle coke and isotropic coke, somewhat closer to needle coke.

Thus, we find that hydrogenated coal tar from the coking of Shubarkol coal is a potential source of coke with improved structure (anisotropic coke). In complete processing of the tar with recirculation of the residue (its addition to the coking batch) and hydrogenation of the tar using nanoheterogeneous nickel sulfide catalyst, the yield of such coke is 50–55%. That is 1.5 times the yield in the industrial coking of pitch.