A PROCESS FOR PRODUCING AVIATION OIL FROM SANGACHALY SEA CRUDE

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Systematic research has been carried out at the Institute of the Petrochemical Industry, Academy of Sciences of the Azerbaidzhan SSR, in recent years, to extend the crude reserves for producing MK-22 aviation oil.

The present article contains information on the processing of a concentrate from highly paraffinic and gummy Sangachaly sea crude for producing aviation oil.

A concentrate having the following properties was used for producing MK-22 aviation oil:

Density ρ_4^{20}	0.9423
Viscosity at 100°C	
nominal	7.3
kinematic, cS	56.4
Coke value, %	6.0
Flash point, °C	280
Yield, % on the crude	35.3

The concentrate was deasphalted in a continuous pilot plant operating under the conditions given in [1].

Deasphaltizates with coke values of 1.0 and 0.6% and with yields on the concentrate of 78.5 and 72.5%, respectively, were used for aviation oil production.

The aviation oil was obtained from the deasphaltisized concentrate both by adsorption and selective refining as well as by the acid-contact refining process used in the refinery.

TABLE 1. Characteristics of the Filter Stocks and of Oils Refined to Different Extents by Acid-Contact Refining

Amt. of reagent, %: acid	Amt. of reagent, %: clay	Oil yield, %	Dist. during cont. refin., %	Yield during deparaffina.	Density ρ_4^{20}	Viscosity at 100°C, cS	$\nu_{50} : \nu_{100}$	V.G.C.	V.I.	Coke value, %	Acid No., mg KOH	Setting point, °C	Color on the NPA scale, No.	Refractive index n_D^{20}
Deasphaltizate . . .		—	—	—	0,9191	22,3	—	0,853	—	1,08	0,14	53	8—	1,5083
Filter stocks														
12	16	75.0	3,3	—	0,9013	14,3	—	0,83[illegible]	—	0,37	0,01	52	4 1/2	1,4988
14	18	73,2	9,2	—	0,9001	14,4	—	0,836	—	0,30	0,01	52	4—	1,4986
18	22	72,9	22,0	—	0,9014	16,7	—	0,835	—	0,40	0,02	52	4 1/2	1,5006
Finished oil after deparaffination														
12	16	—	—	63,0	0,9081	16,5	7,5	0,814	74	0,48	0,02	—18	7—	1,5057
14	18	—	—	63,0	0,9054	16,9	7,3	0,842	79	0,47	0,02	—20	7—	1,5044
18	22	—	—	57,0	0,9040	22,1	7,8	0,833	82	0,58	0,02	—20	7—	1,5025

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TABLE 2. The Quality of the Raffinate from Adsorption Refining before and after Deparaffination

Amt. of absorb., %	Yield on the crude, %	Density ρ_4^{20}	Viscosity at 100°C, cS	$\nu_{50} : \nu_{100}$	V.G.C.	V.I.	Coke value, %	Acid No., mg KOH	Melting or setting point, °C	Color on the NPA scale, No.	Refrac. index n_D^{20}
Deasphaltizate		0,9191	22,3	—	0,853	—	1,0	0,130	53	8+	1,5083
Raffinates											
200	23,3	0,9062	18,7	—	0,841	—	0,24	0,006	48	3—	1,4983
300	22,6	0,8992	17,2	—	0,831	—	0,14	0,007	48	2—	1,4925
400	20,6	0,8938	16,1	—	0,825	—	0,09	0,012	50	1+	1,4898
500	20,2	0,8935	15,5	—	0,825	—	0,05	0,012	51	1	1,4890
Finished oils after deparaffination											
200	15,1	0,9090	22,8	8,9	0,838	69	0,38	0,009	—18	3 1/2	1,5046
300	14,1	0,9026	20,2	8,0	0,833	74	0,22	0,012	—18	2—	1,4981
400	12,9	0,8971	19,2	8,0	0,825	80	0,10	0,018	—18	1 1/2	1,4955
500	11,6	0,8958	19,1	7,7	0,824	80	0,08	0,018	—20	1 1/2	1,4918

TABLE 3. Antioxidation Properties of the Oils Obtained by Adsorption Refining by the NAMI (DK-2) Method

Amt. of adsorbent, %	Viscosity increment at 100°C, cS	Amt. of sludge, %	Sludge composition, %	
			viscosity at 100°C, cS	V.G.C.
200	19,0	4,9	0,4	4,5
300	11,2	2,1	0,5	1,6
400	7,4	2,3	0,4	1,9
500	8,0	1,2	0,5	0,7
MK-22 (commercial)	27,0	6,3	2,3	3,9

Table 1 contains the data for the production of MK-22 oil from the deasphaltizate with a coke value of 1% by acid-contact refining. The deasphaltizate was refined both before and after deparaffination with four times its amount of a solvent mixture (25% acetone, 35% benzene, and 40% toluene) at a temperature of −25°C.

It was established that MK-22 aviation oil meeting GOST 1013-49 could be obtained by refining the deasphaltizate with 18% and 22% of its amount of sulfuric acid and gumbrin, respectively. In this case the amount of distillate during concentration distillation of the filter stock (steam distillation at 350°C) was 22% on the filter stock.

The amount of sulfuric acid used for obtaining MK-22 type aviation oil from Sangachaly sea crude should therefore be 18% on the crude, i.e., it is three times that required for refining deasphaltizates from a mixture of Surakhan and Karachukhurst crudes and from Peschan crude, and 1.5 times that required for refining the concentrate of the mixed crudes supplied to the refinery.

This indicates that it is not worthwhile producing aviation oil from the gummy Sangachaly sea crude by acid-contact refining, particularly since the yield of MK-22 oil from this crude is only 7.9% on the crude, instead of the 11.8% from the mixture of Surakhan and Karachukhursk crudes, and the 10% from Peschan crude [2, 3].

Adsorption refining of the deasphaltizate was carried out according to the method of the All-Union Scientific-Research Institute of the Oil Industry at 35°C. The amount of adsorbate was two to five times the amount of crude taken.

The results of this adsorption refining as well as the quality indices of the finished oils after deparaffination are given in Table 2.

Analysis of oils which had been refined to different extents by adsorption refining showed that increasing the amount of adsorbent used to five times that of the feed stock made it possible to produce MS-20 type aviation oil. The viscosity of the oil obtained on refining the deasphaltizate with three times its amount of adsorbent did not meet the GOST specifications for MK-22 oil.

The oil yield was 11.6 and 14.%, respectively, on using five- and threefold amounts of the adsorbent.

TABLE 4. The Quality of the Products Obtained by Furfural Refining of the Deasphaltizate

Amount of furfural, %	Product	Yield, %	Density ρ_4^{20}	Viscosity at 100°C, cS	V.G.C.	Coke value, %	Acid No., mg KOH	Flash point, °C	Color on the NPA scale, No.	Refractive index n_D^{20}
—	Deasphaltizate	—	0.9146	20.0	0.849	0.60	0.03	280	6	1.5063
200	Raffinate	78.6	0.9010	17.3	0.833	0.27	0.03	279	5	1.4951
	Extract	21.4	0.9824	38.3	—	3.17	0.31	280	Dark	—
400	Raffinate	76.0	0.8959	16.7	0.827	0.17	0.02	276	5	1.4920
	Extract	24.0	0.9661	35.8	—	3.00	0.18	254	Dark	—

TABLE 5. Characteristics of the Selectively Refined Oils

Quality index	Selective-contact refined oil		Hydrorefined oil (200% furfural)
	200% furfural	400% furfural	
Density ρ_4^{20}	0.9038	0.8983	0.9023
Viscosity at 100°C, cS	22.0	20.7	22.1
$\nu_{50}:\nu_{100}$	8.3	8.1	8.2
V.G.C.	0.834	0.827	0.833
V.I.	77	78	79
Coke value, %	0.42	0.20	0.40
Acid No., mg KOH	0.02	0.02	0.02
Setting point, °C	−16	−18	−18
Color on the NPA scale, No.	6+	5+	6
Refractive index n_D^{20}	1.4980	1.4946	1.4978
Thermooxidation stability, min	32	21	38
NAMI (DK-2) stability			
viscosity increment, cS.	80.5	68.4	17.6
amount of sludge, %	6.4	6.2	5.6
Yield during deparaffination, %	66.1	62.0	65.0

Tests carried out on a DK-2 apparatus by the NAMI (State All-Union "Order of the Red Banner of Labor" Automobile and Automobile Engine Scientific-Research Institute) method,on oils which had been refined to various degrees, showed that oil stability increased sharply on increasing the amount of adsorbent (Table 3).

The stability of all the adsorption-refined oils was significantly better than that of MK-22 activation oil produced from the crude being currently processed – the mixture of Surakhan and Karachukhursk crudes.

We used a deasphaltizate with a lower coke value (0.6% instead of 1.0%) for producing the aviation oil by selective refining, since the oil produced from the deasphaltizate with a coke value of 1.0% by means of selective refining did not meet the GOST specification on density.

The deasphaltizate was refined in a continuous furfural pilot plant using furfural in two-and fourfold amounts by weight of the feedstock, at the following extraction column temperatures: top 130°C, middle 110°C, and bottom 90°C.

The properties of the products obtained by selective refining are given in Table 4.

The quality indices of the finished oils obtained after deparaffination and contact after-refining are given in Table 5.

Table 5 shows that it is possible to obtain MK-22 type oil on refining the deasphaltizate with twice its amount of furfural. Further refining reduced the viscosity and the coke value of the oil.

This oil, however, did not meet the GOST density specifications for MS-20 aviation oil. The yield of oils refined to different degrees was 12.5 and 10.4% on crude.

TABLE 6. The Quality of Aviation Oil Produced by Different Refining Methods

Index	Refining method				
	acid contact (18% acid and 200% furfural)	hydrorefining (200% furfural)	selective-contact (200% furfural)	adsorption (200% furfural)	MK-22 (commercial)
Yield, % on the crude	7.9	13.1	12.5	14.1	–
Density ρ_4^{20}	0.9040	0.9023	0.9038	0.9026	0.9036
$\nu_{50} : \nu_{100}$	22.1	22.1	22.0	20.2	22.6
Viscosity at 100°C, cS	7.8	8.2	8.3	8.0	8.2
V.G.C.	0.833	0.833	0.834	0.833	0.833
V.I.	82	79	77	74	78
Coke value, %	0.58	0.40	0.42	0.22	0.60
Acid No., mg KOH	0.02	0.03	0.02	0.012	0.01
Setting point, °C	−20	−18	−16	−18	−14
Refractive index n_D^{20}	1.5025	1.4980	1.4980	1.4981	1.4991
Corrosion, g/m^2	None	4.4	17.0	None	
Thermooxidation stability, min	39	38	32	26	35
Stability on the DK-2 (NAMI) apparatus					
viscosity increment, cS	17.6	17.6	80.5	11.5	27.0
amount of sludge, %	5.8	5.6	6.4	2.1	6.2
Sludge composition, %					
carbenes and carboids	2.8	0.4	1.2	0.5	2.3
asphaltenes and hydroxyacids	3.0	5.2	5.2	1.6	3.9

In order to improve the antioxidation properties of the selectively refined oil, the raffinate obtained on refining the deasphaltizate with twice its amount of furfural was hydro after-refined at 325°C and 50 atm in the presence of a commercial alumino – cobalt – molybdenum catalyst.

An examination of the hydrogenizate showed that hydro after-refining markedly improved the antioxidation properties of the oil. After oxidation tests, for example, this oil had a viscosity which was 1/4.5 that of the oil from selective-contact refining (17.6 and 80.5 cS, respectively).

The use of hydro after-refining instead of contact after-refining of the raffinate also led to an increase in oil yield from 12.5 to 13.1%.

Table 6 contains the results of tests carried out on oils refined by the different methods. They show that aviation oil which is as good as commercial MK-22 aviation oil can be obtained from Sangachaly sea crude.

A comparison of the oils which have been refined by different processes showed that the adsorption purified oils proved to have better physicochemical and antioxidation properties.

Increasing the amount of furfural led to only an insignificant improvement in the thermooxidation stability of the oils.

The adsorption refined oil had a better color and a lower coke value than the selectively refined oil.

The poorest antioxidation properties were shown by the aviation oil produced by selective-contact refining. The quality and antioxidation properties of the aviation oil produced by hydro after-refining of the raffinate and those of the acid-contact refined oil were similar to each other.

The yield of oil from selective refining and hydro after-refining was twice that from acid-contact refining.

The oils produced from Sangachaly sea crude have good anticorrosion properties. The oils refined by the various procedures gave sludges of different composition after oxidation.

The use of selective and adsorption refining led to a significant reduction in the amounts of carbenes and carboids in the oxidized oils.

The oil produced by adsorption refining had the best antioxidation properties (according to the NAMI method).

CONCLUSIONS

1. Conditions have been worked out for producing aviation oil from Sangachaly sea crude. Aviation oil can be produced from this crude by acid-contact, adsorption, and selective refining methods, but in view of the large consumption of reagents and the low yield of finished oil it is not expedient to use acid-contact refining.

2. A comparison of the aviation oils produced by the different methods shows that the adsorption and hydro after-refined oils are the best. These oils have better antioxidation properties and are obtained in a higher yield.

3. The use of hydro after-refining instead of contact after-refining of the raffinate (200% furfural) yields aviation oil whose quality and stability are as good as the commercial MK-22 oil being currently produced from a mixture of Surakhan and Karachukhursk crude. This method is therefore the best one for producing aviation oil from Sangachaly sea crude.

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