УДК 665.7.03

E. I. Grushova, O. V. Karpenko, O. V. Labkovich, A. A. Al'-Razuki
Belarusian State Technological University

IMPROVEMENT OF MINERAL OILS AND PARAFFIN PRODUCTION TECHNOLOGY

The influence of additives-modifiers (co-reactants) on the main stages of the technological process of base oils and paraffin manufacturing has been studied. Performance of the oil lube cuts selective treatment with N-methylpyrrolidone extractant can be improved by use of a co-extraction agent (ethyl alcohol, isopropyl alcohol). The refined oils obtained during the selective treatment are worthwhile to be dewaxed in the presence of ε-caprolactam modifier. The developed measures can significantly improve the quality of the wax concentrates due to deep extraction of unwanted components from oil fractions and increase the ratio of normal to branched hydrocarbons in gatches (slack waxes).

Key words: oil distillate, refining, solvent, raffinate, dewaxing, crystallizer tank, modifying agent, slack.

Introduction. The basis of modern low-waste and ecologically safe technologies of the base oils production is hydrocatalytic processes [1–3], since the combination of such reactions as deep hydrogenation, hydrocracking, hydroisomerization, catalytic dewaxing in processing oil lube cuts allows to obtain commercial product corresponding to the international requirements. In these processes improving the quality of lubricating oils is achieved by chemical conversion of undesirable components into high-index low-solidifying hydrocarbons with low content of heteroatoms under the action of hydrogen and catalysts at elevated temperatures and pressures. However, when used for crude oil refining these processes practically eliminate the possibility of producing solid paraffins, which are widely used in various sectors of economy: in food industry, in paper production, in medicine, in the production of synthetic fatty acids, higher fat alcohols, in the manufacture of tires, etc. A very important problem, therefore, is that of improving the traditional technology of production of mineral oils and paraffin to push up the quality of the production.

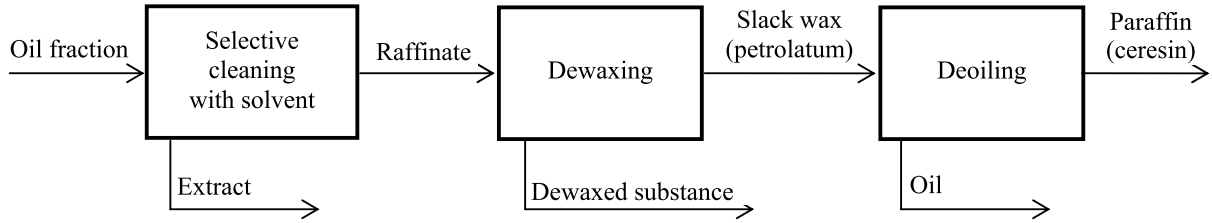
Main part. It is known that the original oil lube cuts contain components forming the basis of base oils as well as so-called undesirable ones that worsen the physical-chemical and operational properties of the oils [4]. They are resin-asphaltene substances (SAV), polycyclic aromatic hydrocarbons with short lateral chains and high molecular paraffin hydrocarbons. To remove undesirable components from oil fractions physical methods are used that do not change the chemical structure of hydrocarbons contained in starting raw materials, i.e. selective cleaning of oil fractions with the use of polar organic solvents and dewaxing of raffinates by crystallization. The end product of these processes is a dewaxed oil, and their by-product is slack wax (obtained in processing raw distillate), or petrolatum (isolated from residual raw materials) used for deoiling to obtain paraffines and ceresins, respectively (see figure).

That is why, improving any stage in the process, one can ensure its intensification due to increased selectivity of the separation at each stage of the process and, as a result, by using the raw materials of improved quality at a later stage.

The work concerned was aimed at developing effective methods to influence the main processes of the technological pattern of obtaining oils and paraffin, that can improve the quality of the end and secondary products.

The first phase of the research involved dealt with the study of the action of modifying additive (co-extraction agent) on the extraction properties of the N-methylpyrrolidone (N-MP) industrial extract in the process of selective treatment of oil fractions of different viscosity, obtained at JSC "Naftan" (Novopolotsk) during vacuum distillation of fuel oil. The extraction was performed at 50°C, the ratio of solvent to raw materials being 3 : 1 (pts. wt), by the technique [5]. Table 1 shows the results of selective treatment of VD-1 (n_D^{50} = 1.4911) and VD-3 (n_D^{50} = = 1.5025) vacuum distillates. It has been established that the degree of purification of oil fractions increases since the refractive index of the raffinate decreases. Thus, the use of ethanol as co-extraction agent increases both the yield of the raffinate and separation selectivity in comparison with the industrial treatment, when only N-MP is used as a solvent.

The second phase of the work dealt with the study of the modifier action on the dewaxing process. ε-Caprolactam was used as the modifier, its consumption being 1 wt % that of raffinate. Dewaxing was carried out by the method [6], a mixture of methyl ethyl ketone (60 wt %) toluene (40 wt %) being used as a solvent (Table 2). The raffinates obtained in experiments 4, 5, 6 (Table 1) were used as raw materials. The composition of paraffins in the selected wax was analyzed by using chromatographic method [7].



Flowchart of obtaining purified mineral oil and paraffin (ceresin) from oil lube cut

Table 1

Indicators of oil fractions selective treatment with solvent based on N-methylpyrrolidone

Test number	Solvent	Raffinate	
		Yield, wt %	n_D^{50}
Raw materials – VD-1 vacuum distillate			
1	N-MP	65.3	1.4684
2	N-MP + 5% ethyl alcohol	67.0	1.4672
3	N-MP + 5% isopropyl alcohol	49.5	1.4663
Raw materials – VD-3 vacuum distillate			
4	N-MP	62.39	1.4800
5	N-MP + 5% ethyl alcohol	63.5	1.4787
6	N-MP + 5% isopropyl alcohol	58.0	1.4785

Table 2

Indicators of raffinates dewaxing

Test number	Dewaxed oil		*h*-Paraffin and *n*-paraffin ratio in paraffin
	Yield, wt %	n_D^{50}	
4	92.8	1.4848	2.6
5	93.7	1.4830	3.2
6	92.0	1.4835	2.5
4*	91.6	1.4858	1.9

* No modifier was added to the raffinate.

Data in Table 2 show that adding the modifier makes it possible to increase the yield of dewaxed oil. This also improves the quality of the paraffin obtained as the content of paraffin hydrocarbons of normal structure increases, apparently, because of the fact that branched paraffins remain in dewaxed oil, bringing about the reduction of the oil refractive index as compared to that of the dewaxed oil obtained by crystallization without the modifier.

The third phase is planned to study the action of modifying additives on the oil content of the slack waxes obtained. It will allow to find the possibility of controlling the conditions of oils selective purification and dewaxing as well as to achieve constant composition of slack wax on to the stage of deoiling and that of producing commercial paraffin.

Conclusion. It has been found that by using modifiers at the basic stages of the technological process of obtaining base oils, i.e. at the stage of selective treatment of oil fractions with polar solvents and that of dewaxing oils by the method of deep cooling with the use of a solvent, it is possible to increase the yield of dewaxed oil, to raise the content of paraffin hydrocarbons of normal structure in the slack wax and, consequently, to reduce the content of oil in it.

References

1. Somov V. Ye. *Strategicheskiye prioritety rossiyskikh neftepererabatyvayushchikh predpriyatiy* [Strategic priorities of Russian refineries]. Moscow, TsNIITEneftekhim Publ., 2002. 292 p.

2. Pleshakova N. N., Tyshchenko V. A., Tomina N. N., Timeryazin A. A. Hydroforming of naphtene-aromatic oil lebe cuts. *Neftekhimiya* [Petrochemicals], 2008, no. 5, pp. 344–351 (in Russian).

3. Zakleva R. R., Petrov S. M., Klyukova P. P., Bashkirtseva N. Yu. Preparation of base oils of Group III API classification from heavy hydrocarbon feedstocks using hydrocatalytic processes. *Vestnik Kazanskogo tekhnologicheskogo universiteta* [Bulletion of the Kazan Technological University], 2014, no. 17, pp. 209–212 (in Russian).

4. Akhmetov S. A., Serikov T. P., Kuznetsov I. R., Bayazitov M. I. *Tekhnologiya i oborudovaniye pererabotki nefti i gaza* [Technology and equipment of oil and gas]. St. Petersburg, Nedra Publ., 2006. 868 p.

5. Grushova E. I., Taperko E. S. *Metod ochistki mineral'nykh masel* [A method of mineral oil purification]. Patent BY, no. 20020324, 2006. 2 p.

6. Grushova E. I., Mikhaleva I. V. Effect of the modifier on the dewaxing of oil distillates. *Trudy BGTU* [Proceedings of BSTU], series IV, Chemistry, Organic Substances Technology and Biotechnology, 2002, issue XVI, pp. 61–63 (in Russian).

7. Karpenko O. V., Grushova E. I., Shulyak I. V., Pas'kova A. N., Bakhmutskaya L. V., Turko M. P. Use of paraffinic emulsious as apolarcoreactants during suvite flotation. *Trudy BGTU* [Proceedings of BSTU], 2014, no. 4, Chemistry, Organic Substances Technology and Biotechnology, pp. 22–24 (in Russian).

Information about the authors

Grushova Evgeniya Ivanovna – D. Sc. Engineering, professor, Department of Technology of Petrochemical Synthesis and Polymer Materials Processing. Belarusian State Technological University (13a, Sverdlova str., 220006, Minsk, Republic of Belarus). E-mail: Grushova.e@mail.ru

Karpenko Olga Vladimirovna – graduate student. Belarusian State Technological University (13a, Sverdlova str., 220006, Minsk, Republic of Belarus). E-mail: skibutt_ola@mail.ru

Labkovich Olga Valeriyevna – student. Belarusian State Technological University (13a, Sverdlova str., 220006, Minsk, Republic of Belarus). E-mail: olya.labkovich@mail.ru

Al'-Razyki Adnan Ahmed – undergraduate student. Belarusian State Technological University (13a, Sverdlova str., 220006, Minsk, Republic of Belarus). E-mail: ahmed_adnan19@yahoo.com

Received 23.02.2015