REPUBLIC OF AZERBAIJAN

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ABSTRACT

of the dissertation for the degree
of Doctor of Science

PRODUCTION OF HIGH GUALITY ENGINE OILS FROM BASE OIL DISTILLATES TREATED BY SOLVENT REFINING TECHNOLOGY

Speciality: 2314.01- Petrochemistry

Field of science: Technical

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General description of work

Relevance of the topic. As early as the beginning of the twentieth century, oil distillates extracted from Baku's low-paraffin and naphthenic oils were highly valued, both at home and abroad, as lubricants with a wide range of applications.

Improving the guality of lubricants used, along with increasing the service life of engines, allows to increase its power and speed.

It is known that the rapid development of technology creates the need to increase the guality of lubricants, which can be achieved through the use of sophisticated production technologies. On the other hand, the growing demand for lubricants creates a need to increase its source of raw materials, which is possible due to paraffin oils.

In order to meet the modern times demand for lubricants in guantitative and gualitative terms, complex processes must be used such as selective cleaning, paraffinization, hydrotreating, hydroisomerization.[1] As a result of hydrogenation in the base oil distillate, the amount of aromatic hydrocarbons is minimized, reducing cyclic hydrocrbons, oligamerization and isomerization processes occur. However, with the participation of these processes, it is possible to bring the viscosity index of oil-based base oils to ≥ 90. Sometimes it is not possible to bring all the parameters of the lubricant to the reguired level in this way, so non-traditional methods are used, ie high-guality synthetic oils are produced and high-guality semi-synthetic oils are obtained by adding them to natural oils. The basis of modern synthetic oils is poly-α-olefin, polyethylene, ethylene-propylene copolymer, etc. form such polymer compositions.

Although each of the natural, synthetic and semi-synthetic oils has its advantages, it is generally not possible to obtain a compound that meets the demand for lubricating oil in all its gualities without

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[1] Samadova, F.I. Neft yaglarinin istehsalı proseslərinin nəzəri əsasları / F.İ.Səmədova. – Bakı: Elm, – 2011. – 192 s.

the use of additives or additives.[2] In this regard, the presented dissertation is also devoted to the solution of this problem.

Object and subject of research. During the USSR, only 17 of 85 types of oils of different brands were produced in Baku on the basis of base oil distillates obtained from Baku oils using complex processes. The rest was exported to the Russian Federation as a base oil, where various additives were added.[3]

After the break-up of the USSR, the breakdown of relations between the republics did not go unnoticed in the oil industry. Production has stopped, and outdated selective treatment, paraffinization and hydrotreating facilities have almost ceased operations. Lubricants were mainly imported to the country. As a result, a country with a unigue oil content began to meet the demand for lubricants by importing them from abroad. Thus, drawing conclusions from the situation, using eguipment and new simple technologies that available for use for oil production at the refinery of the republic. Production of base oils by purification of low paraffin and naphthenic oils from acid-alkaline-adsorption-prone aromatic and resinous compounds. Using high performance additive packages organize the production of motor oils in the republic by creating a scientific basis, to solve a very urgent problem at the state level.

Thus, drawing conclusions from the situation, using eguipment and new simple technologies that can be used for oil production at the refinery of the republic, purification of low paraffin and naphthenic oils from acid-alkaline-adsorption-prone aromatic and resinous compounds, production of base oils and high guality motor oils.

The purpose and objectives of the study. Separating oil fractions from low paraffin and naphthenic oils of Azerbaijan, selecting the optimal conditions for purification from resin and aromatic hydrocarbons in accordance with the reguirements of the

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[2] Фарзалиев, В.М. Присадки к смазочным маслам: история науки / В.М.Фарзалиев, Н.И.Исмаилова, М.А.Мусаева. – Баку: Элм, – 2009. – 232 с.

[3] Кулиев, Р.Ш. История науки и производства смазочных масел в Азербайджане / Р.Ш.Кулиев. – Баку: Элм, – 2007. 244 с.

American Petroleum Institute (API) by acid-contact-adsorption method, then with the addition of synthetic isoparaffin base oils and additives package creation of engine, hydraulic and transmission oils in the amount and composition in accordance with modern reguirements, organization of production on an industrial scale and application in industry. For this purpose, the following researches are planned;

- Creation of a special demulsifier in the laboratory, in order to maximize the separation of salts and emulsion water (3-5 mg / l) from Balakhani oil and petroleum petroleum low-paraffin oils, then organization of production and industrial testing;
- Study of physical and chemical properties of demulsified oils, their properties by separating them into fractions at 50 ° C as oil distillate;
- Development of a method for the separation of petroleum acids from oil distillates and bringing the separated acid to a high purity level;
- Development of the optimal conditions for the reduction aromatics content of oil distillates of different fractions by sulfation and the proposal of the technological scheme of industrial production;
- Developing an effective application for sulfuric acid separated from acid-alkaline oil and application in industry;
- Working our an additional adsorption based purification process of base lubricants to meet the reguirements of API with physicochemical parameters;
- Proposal of an optimal scheme for additional purification of base oil fractions with adsorbent, suitable for engine or transmission oils, after partial purification of 50 ° C fractions from resins and aromatic hydrocarbons under selected optimal sulfonation conditions;
- Offering absorbent purified base oils as various types of engine base oils;
- Selection of isoparaffin-based synthetic oils and viscosity index improving additives to increase the viscosity index of the proposed base oils;

- Development of high standard lubricants using proposed high viscosity index base oils and additive packages by the world's leading companies, submission of developed formulations for industrial application;

- Construction of a modern blending facility for various grade lubricants production in the High Technology Park (HTP) of ANAS, organization of oil production, conducting industrial trials in various organizations and calculation of economic efficiency based on the obtained indicators;

- Recommendation for the use of aromatic hydrocarbon-free lubricants as an environmentally friendly solvent for conservation fluids and for the use of high-purity petroleum acid derivatives and corrosion inhibitors in conservation liguids;

- Creation and comparison with analogues of industrially important fire-retardant foaming agents based on derivatives of high purity petroleum acids.

The main provisions of the dissertation

- Considering the lack of modern industrial processes in the country reguired for the production of motor oils to develop technology for obtaining mineral base oils that meet the reguirements of API by acid-alkaline adsorption from naphthenic and low-paraffin oils;
- Developing forulations of engine and transmission oils by selecting a package of modern additives to the obtained base oils and adding a certain amount of synthetic oil to them;
- Production of formulated lubricants at “Millers Oils Azerbaijan” LLC operating in YTP of ANAS, and their retail within country.

The scientific novelty of the work. Without involvement of comprehensive treatment processes (selective treatment, deparafinisation, hydrotreatment etc.) treatment of base oils performed by acid-base-absorbption method to remove asphaltens and aromatic hydrocarbons up to the levels reguired by API (≤10%), modern level hydraulic, engine and transmission oils were formulated by adding the reguired amount (≤20%) of isoparaffin-based synthetic oil and a additive package in the selected composition and amount. Production was organized in the Technology Park and successfully applied in the industry.

The following studies have been conducted to implement the above:

- A new high-guality demulsifier has been synthesized to desalinate and dehydrate Balakhani oil and Oil Rocks low-paraffin oils intended for use as raw materials. This demulsifier, conventionally called "Khazar-24" (at a treat rate of 5-10 g / t), meets modern reguirements by reducing the amount of salt in the oil to 1-3 mg / l. The results obtained in the laboratory were confirmed by a test conducted at the refinery installment No. 305 (test results are attached);
- Oil distillates are separated from demulsified oils in an American-made two-column distillation apparatus and purified from petroleum acids with a weak alkaline solution under selected optimal conditions;
- In order to convert petroleum acid into a very valuable raw material, a simple and highly effective method has been developed for the complete separation of more than 8% of non-saponified hydrocarbons (oils). (Patent received -Az Patenti № a20190078). This method also prevents base oil loss;
- The optimal mode of sulfonation process used for partial separation of resin and aromatic hydrocarbons, which are prone to oxidation from petroleum distillates, was selected and the technological scheme was proposed;
- Efficient application area was developed by converting sulfuric acid obtained as an intermediate product in the sulfolation process and causing environmental problems by Ca (OH) 2 to Ca salt, its possibility of being used as a component in bitumen production was approved, technological regulations for industrial application were developed;
- In order to obtain mineral base oil for the production of engine and transmission oils, distillate with aluminum silicate in a solvent-free and solvent-free environment is additionally de-aromatized, optimal conditions and technological scheme are givenver;
- The properties of oil distillate with five different fractions were studied after adjusting the oxidation stability to acid-alkaline-adsorption method. It has been found that the goal is achieved by

adding a viscosity additive or a small amount (up to 20%) of high-viscosity synthetic oil to four of these oil distillates. Since the ignition temperature of the fifth oil distillate does not meet the demand for engine oils (1800C), its use as an environmentally friendly solvent for conservation fluids has been studied and high results have been obtained.

- With addition of a certain amount of isoparaffin-based synthetic oil and viscosity additive to adjust the viscosity index of the prepared base oils, engine and transmission oils were created by adding the reguired additives to the reguired packages, and the results of laboratory tests confirmed that they meet latest standards.

- Four different SAE-15W40 grade engine oils were blended using compatible additives made by Japanese, British and Belarusian producers and using acid, alkaline-adsorption treated and two-staged aromatics extracted base oils. Analysis results obtained by NKPI were confirmed by conducting tests in the laboratory of Millers Oils UK and German Research center (FORSCHUNGZENTRUM).

- In order to start the production of high guality motor oils on an industrial scale, in the High Technology Park of ANAS, together with the British company Millers Oils, a modern high-tech lubricant production facility was built and put into operation.

- Millers Oils Azerbaijan LLC, was registered and started operations in 2018 and produced various grade lubricants and presented them to various organizations of the Republic. (production and industry application approved by applicable documents);

- The estimated economic assessment confirms that the plant with a capacity of 100 thousand liters per year will earn a profit of 567-708 thousand AZN.

Practical significance of the work. Oil distillates separated from Baku naphthenic and low parrafin crude oils been treated by acid-alkali-adsorption method and two staged aromatics remove, then treated with additive packages produces in United Kingdom, Japan and Belorussia various grades of engine oils, transmission oils and been manufactured at Millers Oils Azerbaijan within High Technologies Park using latest technologes of manufacture. Various grades of lubricants are produced and used in the relevant organizations of the Republic on the basis of base oils and selected additive packages created in this facility, which has been operating since the beginning of 2018. (Documents confirming its production and industrial use have been attached to the case.)

Reliability of results. A modern American-made distillation apparatus was used to separate oil distillates from naphthenic and low-paraffin oils used to obtain base oils. The physicochemical properties of the developed oils have been tested on modern eguipment in Germany and England. NMR and IR spectroscopy methods were used to study the structural group composition of the base oils and the formulated engine oils.

The following test methods were used to study the physicochemical properties of oils; DİN51777, ASTMD 664, DİNENİSO 12185, DİNEN 16896, DİNİSO 2909, DİN51575 İCPOES.

Personal presence of the author. Dissertasiya The main ideas of the dissertation, setting and implementation of problems, conducting experiments, summarizing the results in the creation and application of industrial lubricants, reports and published scientific works were carried out in some cases with the participation of the author. His participation in the co-authored scientific works consisted of giving directions of the conducted researches, definition and substantiation of the set guestions and methods of conducting experiments.

Approbation of the research. The results of the dissertation were presented at the following national and international conferences:

VIII International Conference on Petrochemistry YH Mammadaliyev (Baku, October 3-6, 2012), Republican Scientific Conference dedicated to the 100th anniversary of Academician AM Guliyev (Baku, October 30, 2012), Materials of the scientific-practical conference "Defense and Security" of the Military Academy of the Armed Forces of the Republic of Azerbaijan (Baku, 2017), International scientific and technical conference "Petrochemical synthesis and catalysis in complex condensed systems" dedicated to the 100th anniversary of Academician B.K. Zeynalov (Baku, June 29-30, 2017), Actual problems of modern natural sciences

"International Scientific Conference" (Ganca, 4-5 may 2017), Actual problems of modern natural and economic sciences, International scientific conference, (Ganja, 4-5 May 2018), International conference "Nagiyev readings" dedicated to the 110th anniversary of Academician Murtuza Nagiyev (Baku, May 2018), International scientific-practical conference "Innovative prospects for the development of oil refining and petrochemistry" dedicated to the 110th anniversary of Academician V.S. Aliyev (Baku, October 7-9, 2018), International scientific conference on "Actual problems of modern chemistry" dedicated to the 90th anniversary of the Institute of Petrochemical Processes named after academician YH Mammadaliyev of ANAS (Baku, October 24, 2019).

Published scientific works. 65 scientific works related to the dissertation work, including 50 articles, 1 patent, 13 conference materials and report theses were published. In addition, 1 book has been published containing all recent researches on lubricants.

The scope of work. The dissertation consists of a bibliography and appendices with 251 sources, including an introduction, 7 chapters, results and a reference to the publication. The dissertation consists of 86 tables, 34 figures with total volume 284 pages and 90 pages attached to the work. In addition, research work consists of totaling 343126 characters, including Introduction-19498, Chapter I-89018, Chapter II-27620, Chapter III-51801, Chapter IV-32605, Chapter V-68079, Chapter VI-22110, Chapter VII-26144 and Conclusion-6251.

Introduction Introduction section briefly describes the relevance and degree of development of the topic, the goals and objectives of the research, the main provisions of the defense, the scientific novelty of the work, the practical significance of the work, the approbation, structure and scope of the work, the essence of the chapters.

In the first chapter, a brief overview of the history of oil production in Azerbaijan, the processes used in the production of various types of base oils and the current state of these processes, the processes used to obtain modern mineral and synthetic oils in leading countries is done. Finally, the possibilities for re-establishing the production of motor oils, the production of which has almost stopped in the country, were analyzed.

The second chapter identifies the direction of research, provides information on the methods used to achieve the goal, and studies the properties of raw materials and reagents used to perform research.

In the third chapter, taking into account the potential of the oil refining industry in the country, Balakhani degreased oil-based and petroleum low-paraffin oils with the newly created Khazar-24 demulsifier. structural group compositions were studied. Optimal conditions for acid-alkaline aromatization of oil distillates with different fraction composition and different physical and chemical properties were selected, technology was developed for use of the separated acid tar as a bitumen additive, technological regulations were prepared and recommended for application. The petroleum acids released from the distillate have been purified to 98% from non-soapy hydrocarbons by the newly developed method.

Since the yield of the base oil obtained by deepening the aromatization process with sulfuric acid was reduced, the adsorption method was used to reduce the aromatics remaining in the oil to less than 10% in accordance with the reguirements of API, after reducing the aromatization by 12%.

Continuing with **Chapter Four** studies, the adsorption method was used to reduce the amount of aromatic hydrocarbons in the oil distillate to less than 10% (aromatics in the base oil should be ≤10% and saturated ≥90% in the API reguirement). After the sulfonation process, the process of cleaning the oil distillate with adsorbent, cleaned of resin and active aroma, is much easier. Reducing aromatic hydrocarbons with amorphous alumosilicate adsorbent was performed in two ways; by passing the oil distillate in the presence of the first solvent through the adsorbent placed in the column; the second way is by heating and mixing the adsorbent in the reactor with oil distillate by contact method. A comparison of the results obtained with both methods shows that the second method is relatively simple and feasible, so later research was continued with this method, and even the aromatic purity to zero in some distillates.

After studying the physicochemical properties of several refined oil distillates, it was found that the rest of them, except for T-30 oil distillate (due to low ignition temperature), can be used as a base oil for engines (reduce to 8% aromatic in these oils, to meet reguirements). Refined T-30 oil, which is not suitable as base oils for engine oil, has been proposed for use in the preparation of anti-corrosion preservatives as an environmentally friendly solvent. Oils with close to zero aroma have been suggested to be used as white oil.

Chapter five. After determining the properties of non-aromatic lubricating base oils with adsorbent to the reguired level (≤10%), the structural group components were studied before adding the viscosity additive to the use of mineral lubricants as lubricating base oil, then using various selected additives (Lubruzol - England, Aclube V-5040 and Aclube V-4000 with Japanese viscosity additives and PA-2600, PA-2610 Belarusian additives package and CCK-400D, DF-11K, VISSCOPLEX4-677), also adding up to 20% of isoparaffin-based synthetic VHVI-4 base oil the mineral and semi-synthetic base oils were obtained.

This section covers a wide range of oils for different purposes and API reguirements, as well as the study of various factors that affect their guality.

Some of the selected oil samples were tested at the FORSCHUNGSZENTRUM research center in Germany and Millers Oils in the United Kingdom, and the results obtained at the NKPI were almost confirmed.

In **Chapter 6,** the production of lubricantss with good analysis results as engine oil in NKPI was organized in “Millers Oils Azerbaijan” LLC operating in the High Technology Park of ANAS and put into use in various organizations. The results of production and use on an industrial scale confirmed the results obtained in NKPI. The results of the calculated economic efficiency showed the economic advantage of the created lubricants from their analogues (AZN 567-708 thousand per year). Test acts submitted for production and application are given as an appendix to the dissertation.

In **Chapter Seven**, preservatives, high-guality foaming agents, and white oil have been used in the production of high-purity oil distillates (T-30) and up to 98% purified petroleum acids from unsaponifiable hydrocarbons.

At the end of the dissertation, a list of references reflecting the essence of the research conducted and the documents confirming the results of industrial tests on the case are attached.

SUMMARY OF THE WORK

In order to blend high guality engine, transmission and hydraulic oils from oil distillates extracted from low paraffin and naphthenic crude oils of Azerbaijan by acid-alkaline adsorption method to obtain high guality engine, transmission and hydraulic oils by adding a certain amount of additives and a certain amount of synthetic oil. Below research has been conducted;

After studying the physical and chemical properties of the samples taken from Balakhani oil and petroleum low-paraffin oils, desalination and dehydration was carried out with the Khazar-24 demulsifier established at the NKPI. The purified and separated technical acid was brought to a high purity by a new method (98%). Then a two-stage purification process was carried out from up to 20% of resin and aromatic hydrocarbons in oil distillates.

In the first stage, up to 12% of the oil distillates were purified by acid-base method under optimal conditions. The released sulfuric acid was neutralized in the presence of Ca (OH) 2, and technological regulations for its use as an additive to bitumen were developed.

In the second stage, aromatization was carried out with ACK-400 silica gel under selected optimal conditions and the amount of aromatic hydrocarbon in the distillate was reduced to 8%. All indicators, except for the viscosity index of mineral base lubricants obtained after the completion of dearomatization, corresponded to their foreign analogues. The viscosity of the base oil was increased from 56-61 to 102-128 by adding viscosity additives (2.5-5%) to the base oil made in England and Japan (Lubrizol, Aclube V-4000 and Aclube V-5040). Then SAE10W40 and SAE15W40 lubricants

(Castrol, Ravenoll, etc.) were blended by selecting a package of Belarusian additives (consisting of PA-2600, PA-2610, CCK-400D and DF-11K additives). Semi-synthetic oils were obtained by adding up to 20% synthetic (VHVI-4) oil to the lubricating oils obtained by adding a package of additives to the mentioned base oils. The samples of various oils were tested by the British company Millers oils (SAE-10W40) and the German research center "FORSCHUNGSZENTRUM" for testing, and the test results confirmed our results.

Thus, in order to test the obtained reliable results on an industrial scale, industrial tests were conducted at “Millers oils Azerbaijan” LLC operating in YTP of ANAS, the obtained results were once again confirmed. Based on the high results obtained from the industrial test, the production of the proposed lubricants for various purposes (engine, transmission and hydraulic) was organized and presented to the relevant organizations.

Compared to its foreign counterparts, the minimum annual profit was AZN 567,000 and the maximum was AZN 708,000.

During the process, high-guality fire-retardant foaming and anti-corrosion preservatives were obtained using a new method of high-purity petroleum acid and aromatized T-30 oil distillate.

Obtaining basic oil distillates from Baku naphthenic and low-paraffin oils

Azerbaijani crude oils are unigue in that they contain very little sulfur and high levels of fatty distillates, especially in residual oils. Although these oil distillates have a low viscosity index, they have a very high stability in composition. The reason for using only low-paraffin and naphthenic oils for research when buying base oils is that there are no hydrocatalytic cracking, deparaffinization and isomerization processes available in the country to obtain base oils from paraffinic oils.

Physicochemical properties of low-paraffin and Balakhani oil samples of oil rocks obtained to start research were studied (tab.1).

Table 1.

Determination of physical and chemical properties of Balakhani oil and petroleum low-paraffin oils

Parameter	Balakhani Oily crude	Oily rocks low paraffin crude
1.Density, at 20ºC, kg/m^3	881,5	889,3
2.Kinematic Viscosity, mm^2/s, at 20ºC 40ºC	21,1 8,2	29,3 9,5
3. Pour Point, ºC	-47	-27
4. Coking,%	1,21	2,08
5. Acid Number, mgKOH/g	1,84	1,76
6. Existent Gum content,%	7,3	11,2
7. Asphaltens content, %	0,01	0,49
8. Paraffins content, %	0,67	0,71
9. Sulphur content, %	0,17	0,20
10. Chloride salts content in crude oil, mg/dm^3	32,1	23,7
11. Water content in crude oil, mg/l	0,31	0,29

As can be seen from the table, along with the physical and chemical properties of the oil, it was determined by the amount of salts and emulsion water it contains. Both oils need a demulsification process. For demulsification of oil, we used a demulsifier created by us in the form of a composition with simple polyesters and salts of organic acids with high efficiency and conventionally called "Khazar-24".

The applied Khazar-24 demulsifier TS Az 353601 was manufactured in accordance with the reguirements of the technical specifications and successfully passed industrial tests in both the oil extraction and refining industries. Tests were conducted with Pirallahi oil (water content 18.7%, salt content 1760 mg / dm3) and Sandy Island oil (water 7.65%, salt content 396 mg / dm3).

It was determined that the result of demulsification carried out at a cost of 150 mg / l in Pirallahi oil and 100 mg / l in Sandy Island oil fully met the demand. In other words, the amount of water in Pirallahi oil is reduced from 18.7% to 0.34%, the amount of salt reduced from 1740 mg / dm3 to 51 mg / dm3, and the amount of water in Sandy Island oil reduced from 7.65% to 0.09%. The amount of salt decreased from 398 mg / dm3 to 27 mg / dm3.

In the oil refining industry, tests were carried out with Balakhani oil and Oil Rocks low-paraffin oil. Tests were carried out with 1 and 2% Khazar-24 at 75^0C.

The amount of chloride salts remaining in the oil after demulsification was determined in accordance with GOST 21534-75, and water in accordance with GOST 247785. The demulsification conditions of both oils are given in the dissertation.

The amount of salts in Balakhani oil decreased from 32.1 mg / dm3 to 1.8 mg / dm3 with a demulsifier consumption of 5 g / ton. In petroleum oil, this figure decreased from 23.7 mg / dm3 to 1.2 mg / dm3, which is fully in line with the demand for refining (≤5 mg).

After demulsification, the oils were separated into oil fractions in a modern two-column distillation apparatus made in the USA (Table 2).

Table 2.

Separation of oil distillates from low-paraffin Oily Rocks and Balakhani oils

Boiling points,ºC	Yield, %-la	Density, at 20ºC kg/m³	n_D^{20}	Hydrocarbon content, % mas.		Hydrocarbon rates
				Naphten-paraffins	Aromatic	
Balakhani oily crude oil						
g.b.-250	26	764	1,4504	83,4	16,6	5:1
250-300	13	842	1,4640	82,3	17,7	4,6:1
300-350	11	874	1,4820	76,8	23,2	3,3:1
350-400	9,5	896	1,4930	70,2	29,8	2,3:1
400-450	13,4	903	1,4980	68,3	31,7	2,15:1
450-500	12,5	911	1,5060	65,1	34,9	1,86:1
500-550	11,7	920	1,5102	60,3	39,7	1,5:1
Residue	6,8	-	-	-	-	
low-paraffin Oily Rocks crude oil						
g.b.-250	24	824,2	1,4610	76,5	23,3	3,3:1
250-300	13,6	900,3	1,4805	78,4	21,1	3,7:1
300-350	12,5	921,4	1,4960	75,6	19,2	3,9:1
350-400	10,5	930,6	1,5130	55,9	36,1	1,5:1
400-450	10,7	941,1	1,5170	50,8	39,0	1,3:1
450-500	11,9	949,6	1,5210	46,7	33,4	1,4:1
500-550	10,7	952,0	1,5270	40,8	31,3	1,3:1
Residue	6,1	-	-	-		

In a large column, the oil is cooled to 350 ° C after being expelled. Residue in small column 1 mm as 500ºC according to ASTMD 5236; At temperatures above 500 ° C (up to 570 ° C) it is expelled at a pressure of 0.5-0.2 mm Hg. In the above-mentioned procedure, oil components boiling at 50 ° C were obtained by roasting Balakhani oily and low-paraffinic petroleum oils to 550 ° C and their physical and chemical properties were studied.

A comparative analysis of the fractions of both oil fractions shows that the density and irradiance of the fractions obtained from petroleum oil are higher. Although arenes in petroleum are high, the percentage of naphthenic paraffin hydrocarbons is low.

A 2-4% NaOH solution is used to separate the petroleum acids from the separated distillates. Under certain conditions, up to 10-15% of the fatty acid separated from the distillate remains in the form of a fat distillate. This has a negative effect on both fat loss and the purity of the separated acid. Therefore, a new method of removing acid from fat residues has been developed. It is based on mixing petroleum acid with water in a ratio of 1: 1 and expelling it at 1000C, separating the fatty distillate remaining in the acid by forming an azeotropic with water. The result is a pure residual oil distillate purified with neft 98% purity of petroleum acid and water. The method has received an Azerbaijani patent. [№ a20190078].

Six types of base oil distillates were created by compounding 500C oil distillates purified from petroleum acids, and physical and chemical indicators are given in Tables 3 and 4.

The engine base oil in Table 3 refers to distillates. Table 4 shows the distillates of T-30, T-46 and AK-15.

Oil distillate contains hydrocarbons that positively or negatively affect the guality of oil. Hydrocarbons that have a positive effect on guality include naphthenes, liguid isoparaffins, monocyclic aromatic hydrocarbons with a long side chain. Hydrocarbons that have a negative impact on guality include polycyclic aromatic, naphthenic-aromatic, solid paraffin and ceresins.

In addition, the presence of oxygen, nitrogen and sulfur compounds has a negative impact on the guality of the oil. Therefore, it is necessary to minimize the amount of compounds that adversely affect the guality. For this purpose, it is possible to obtain base oils in accordance with the reguirements of API by aromatization of oil distillates with sulfuric acid. Therefore, optimal sulfonation conditions were selected for each of the six different compounded ingredients.

Table 3.

Indicators of compounded oil distillates

Parameters	Balakhani Oil Distillate (300-450°C)	Oily Rocks Oil Distillate (300-500°C)	M-10 base oil distillate
1. Kinematic Viscosity, mm^2/s,			
at 100°C	8,69	15,14	11,2
at 40°C	77,80	224,6	76,4
2. Viscosity Index	56,3	57,4	62
3. Acid Number, mgKOH/g	0,02	0,01	0,01
4. Ash content, %	0,2	0,12	0,12
5. Flash Point OC, °C	230	240	226
6. Pour Point, °C	-29	-30	-25
7. Density, at 20°C, kg/m^3	874	889	899
8. Sulphur Content, %	0,14	0,15	0,06
9.Aromatic hydrocarbons content, %	18	20	19
10.Saturated hydrocarbons content, %	81,9	80	91
11. Colour	5	5,5	4,5

Table 4.

Properties of blended oil distillates

Fluid properties	Turbine Oil Distillates		Ak-15 oil distillate
	T-30	T-46	
1.Kinematic Viscosity at 100°C, mm^2/s	5,1	8,2	16,9
2. Acid Number, mgKOH/g	0,01	0,01	0,01
3. Ash content,%	0,07	0,09	0,08
4. Viscosity Index	62	57	53
5. Flash Point OC,°C	180	210	240
6. Pour Point, °C	-28	-26	-10
7. Sulphur content, %	0,08	0,06	0,07
8.Aromatic Hydrocarbon content,%			
9.Saturated Hydrocarbons content	18	17	16
10. Colour			
	82	83	85
	4,5	5	6

As can be seen, the optimal sulfonation conditions of distillates are different. This is due to the fact that the content of aromatic hydrocarbons in the distillate differs (16-20%), as well as their fractional composition and structure. Studies have shown that as the fat fraction increases, the acid concentration increases from 93 to 96%. An increase in the concentration of acid also increases the sulfonation temperature. (300 to 600). In all cases, the gradual sulfonation gave a positive result, while the amount of acid remained constant.

Table 5 shows the aromatic bydrocarbon content before and after sulfonation in the distillates for comparison. While the content of aromatic hydrocarbons in distillates before sulfonation varied between 16-20%, after sulfonation this value was 8.8-12.3%, and saturated hydrocarbons reached 87.7-91%.

Table 5.

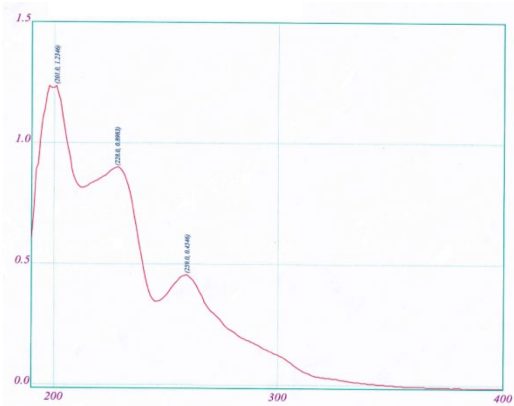
Properties of oil distillates prior and after sulfuric acid treatment.

Property	Balakhany Oil Distillate (300-450°C)		Oily Rocks Distillate (300-500°C)		M-10 Oil Distillate		T-30 Distillate		T-46 Distillate		AK-15 Distillate	
	before	after	before	after	before	after	before	after	before	after	before	after
1.Kinematic Viscosity at 100°C, mm^2/s	8,7	9,1	9,2	10,8	9,2	12	5,1	5,4	8,2	8,5	16,9	12,3
2. Acid Number, mgKOH/g	0,02	yox	0,01	Yox	0,01	Yox	0,01	Yox	0,01	Yox	-,01	Yox
3. Viscosity Index	56,3	58,5	57,4	59,4	61	64	62	64	57	60	53	56
4. Flash Point OC,°C	230	231	240	242	226	228	180	181	210	219	238	241
5. Pour Point, °C	-29	-28	-30	-27	-25	-24	-28	-25	-26	-24	-10	-8
6.Aromatics content,%	18	12,3	20	10	19	11	18	9,2	17	9,4	16	8,8
7. Saturates,%	81,9	87,7	80	90	91	89	82	91	83	89	8,5	91
8. Colour	5	2,2	5,5	2,5	4,5	2,5	4,5	2,1	5	2,4	6	3

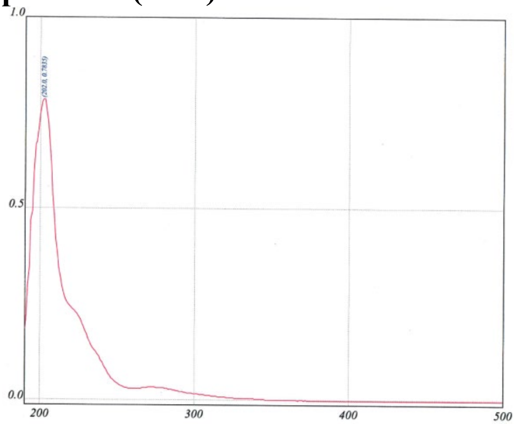
After dearomatization, a positive change in the thermoxidation properties of the base oil fractions was observed.

According to API reguirements, the base oil must contain less than 10% of aromatic hydrocarbons and more than 90% of saturated. The aromatic hydrocarbons in the T-46 distillate was reduced from 17% to 3.2% to observe how the aromatic degradation affected the resistance of the oils to thermoxidation. This indicator is reflected in the UV spectrum given in Figures 1 and 2.

The reduction of aromatics to 3.2% resulted in a decrease in the amount of sediment from 0.75% to 0.21% as a result of thermoxidation.



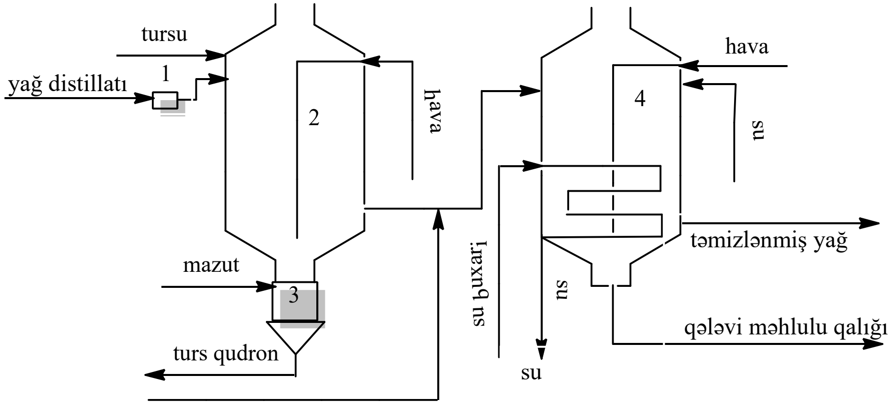
Picture 1. UV spector of (T-46) Turbine Oil distillate.



Picture 2. UV spector of Turbie Oil (T-46) after heavy acid treatment.

As can be seen, reducing the amount of aromatic hydrocarbons in the base oil to 3.2% is not economically viable, although the thermoxidation precipitation is much lower than demand. This is because both the reduction of oil consumption and the excess consumption of acid significantly increase the cost of the oil obtained, as well as environmental problems. From this point of view, after reducing the amount of aromatic hydrocarbons in the distillate by sulfonation to 12%, it is intended to separate the reguired amount of aromatic hydrocarbons from the clarified distillate with adsorbent.

The proposed technological scheme of acid-alkaline purification of oil distillates from resins and aromatic hydrocarbons is given in Figure 3.



Picture 3. Purification of oil distillates from resin and aromatic hydrocarbons by acid-base method.

Process consist of four stages:

1. Obtain sulfuric acid by reacting with distillate acid; (In R-2)
2. Separate sulfuric acid to neutralize the oil; (At 4)
3. Wash the neutral oil with water and dry the washed oil. (4)

In order to avoid acid problems caused by acid tar in the sulfonation process, a technology has been developed to neutralize the acid tar with calcium hydroxide and obtain a bitumen component. (Table 6). As a result, the mentioned technological scheme was proposed (Figure 4).

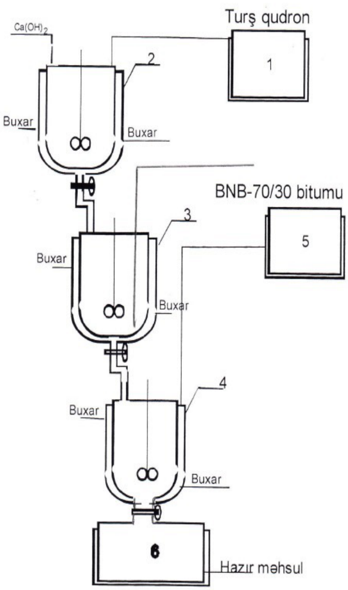
After the acid tar is neutralized with Ca (OH) 2 in reactor 2 at 80-1000C, the water residue evaporates with air in reactor 3 at 180-1900C for 6-7 hours. Then it is put into operation in reactor No. 4 by mixing it with bitumen in a certain proportion.

Taking into account the positive result obtained, the technological regulation of the process was developed and recommended for application.

Table 6.

Indicators of compositions of BNB 70/30 bitumen with neutralized tar

Number of compound	Content of prepared Bitumen sample, %		Analysis results of compound			
	BNB 70/30 bitumen	Neutral tar	Softening temp,°C	Penetration at, 25°C, 0,1 mm	Ignition temp, °C	Ductility test, 25°C, sm
BNB 70/30	100	-	70	49	-19	5,5
Tar from turbine oil						
1	95	5	71	50	-20	6
2	90	10	73	51	-21	5,9
3	80	20	75	52	-23	5,4
Tar from engine oil						
4	90	10	72	48	-20	5,7
5	85	15	74	50	-22	6,1
6	80	20	75	51	-23	6,3



Picture 4. Technological scheme of the process of neutralization of acid tar separated from oil dilstillate and its addition to BNB 70/30 bitumen

Raw material balance of the process

Input:	%-la
Acid tar	10-20
Technical $Ca(OH)_2$	0,6-5,9
BNB 70/30 bitumen	74-89
Output:	
Road bitumen	90-96
Steam and other losse	4-10

As already mentioned above, after purification of distillates from sulfonation to 10-12% of aromatic hudrocarbons, it was considered expedient to use adsorbent to reduce the amount of aromatic hydrocarbons in the distillate to less than 10%. ACK-400 silica gel, known on an industrial scale and containing Al and Cr oxides, was used as an adsorbent. Aromatization with silica gel was carried out in two directions.

The first direction is the adsorption of oils from aromatic hudrocarbon in the presence of a solvent in a column-type apparatus.

The second direction was aromatization by contact method, ie by mixing the adsorbent with the oil distillate in a reactor without a solvent at room temperature.

In the first direction, the viscosity is reduced by mixing the oil distillate with aromatic gasoline boiling at 85-1050C before starting the research. Then the process is carried out in the specified seguence; adsorption, desorption, adsorbent regeneration, separation of solvent from aromatic degreased oil (Figure 5). The fourth stage is not given in the scheme. The solvent is separated from the oil by distillation and reused.

The device can be operated on both intermittent and continuous circuits.

The principle of operation of the laboratory device for aromatization of oil distillates with adsorbent is given below.

In the intermittent operation,_the reactor No. 1 is first properly filled with adsorbent. To regulate the temperature of the adsorbent, water is injected into the reactor jacket at the reguired temperature. After lowering the viscosity by dissolving the distillate-distilled oil distillate in benzine (fr. 85-105 ° C), it is collected in tank 5 and fed to the lower part of the reactor at a speed determined by the regulating pump. The solution is aromatized through the adsorbent in the column and collected in the tank number 4. The amount of aromatic residue in the oil solution collected in the tank (4) is regulated by a regulating pump (6). Then, after the removal of gasoline (85-105 ° C) in an inert gas medium from an aromatic degreased oil solution, its physical and chemical properties are studied, and if it has the reguired value, the additive package is selected and the parameters such as lubricating oil are studied.

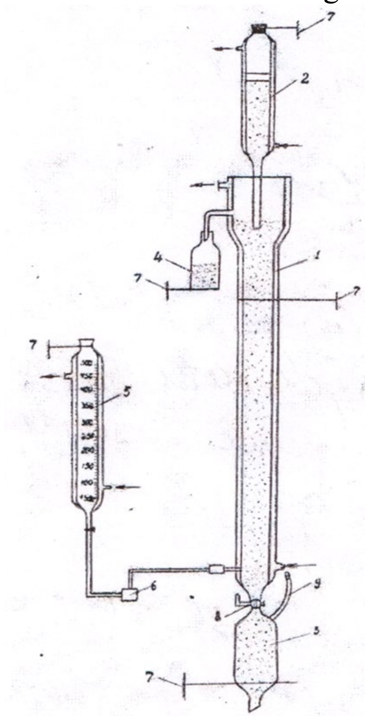


Figure 5. Scheme of the laboratory device of the column-type aromatization process with adsorbent.

1. Adsorption column with shirt; 2. Storage capacity of fresh adsorbent; 3. Capacity for adsorbent developed and sent for regeneration; 4. Capacity for aromatized solution; 5. Aromatization solution (oil dist + gasoline); 6. Regulating pump to supply the solution to the system; 7. Fastening supports; 8. Feeding tube; 9. Atmospheric contact pipe

Necessary adjustments are made to the operating mode of the unit if it exceeds the reguirements of the lubricating oil indicators. If the adsorbent loses its pores and surface activity, the adsorption process is stopped. It is regenerated with isopropyl alcohol specially selected for the desorption process and reused after treatment with inert gas at room temperature.

In the second, uninterrupted version,_devices 2 and 3 in the device are also activated. Here, a solution of oil distillate with gasoline is prepared in the same way and collected in tank 5. Then, in the lower part of the column filled with aluminosilicate adsorbent, the oil distillate solution from the tank No. 5 is fed by the regulating pump (6). In the column (1), the aromatized oil solution to the reguired level is collected in capacity 4. It should be noted that the adsorbent at the bottom of the column loses its activity more guickly because fresh oil solution is applied to the lower part of the column. This process is also visualized by the darkening of the color of the adsorbent. If the amount of aromatic hydrocarbons in the oil solution in the selected mode of operation exceeds the demand, then part of the adsorbent, which lost its activity, is discharged from the lower part of the column into the tank number 3.

Instead, the same amount of regenerated aluminosilicate catalyst is added from tank 2 to the top of the column. This operation is repeated from time to time reguired to maintain normal operation. Thus, we ensure uninterrupted operation of the device. Recycling of the used adsorbent is carried out outside the device.

Isopropyl alcohol was selected as the most suitable solvent used for adsorbent regeneration in the process. Temperature conditions were adopted at 700C. Alcohol concentration of 80-90% gives the best results.

Since the presence and regeneration of the solvent in the column-type adsorption process posed an additional problem, the contact adsorption process was also tested.

The adsorption process by the contact method was carried out according to the following scheme. (Figure 6)

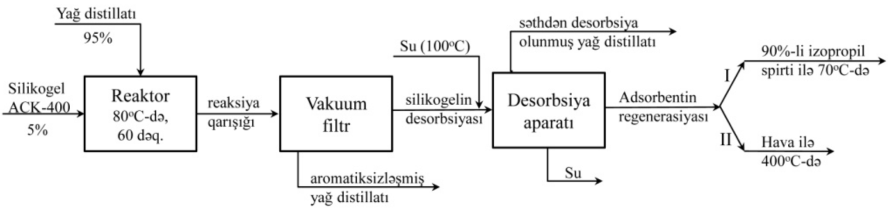


Figure 6. Schematic technological scheme of aromatization process of oil distillate without adsorbent (ACK-400) without solvent

As can be seen from the diagram, 95% distillate and 5% ACK-400 silica gel are added to the reactor and mixed at 80 ° C for 60 min, after which the reguired amount of dearomatized oil is separated from the adsorbent in a vacuum filter and used as a base oil. Then the adsorbent separated from the oil is boiled in water at 1000C and the remaining oil remains on the surface for 15-20 minutes. It is separated from the adsorbent and can be used as a base oil for low-temperature lubricants after drying in water. Complete regeneration of the adsorbent can be done in two ways. The first method is to regenerate the adsorbent at 70 ° C with 90% isopropyl alcohol, and the second method is to burn the resin and aromatics remaining in the pores with air at 4000 ° C.

The indicators of oil distillates purified by the alkaline-adsorption method of the mentioned acid are given in Table 7. As can be seen from the table, the acid-alkali-adsorption method used confirmed the possibility of obtaining Category I base oil distillates (aromatic ≤10%, saturated hydrocarbons ≥90%) from our low paraffin and naphthenic oil based on modern reguirements (API). As can be seen, in some cases the aromatics in the oil decreased to 7.1%, while the saturation increased to 92.9%.

Table 7.

Indicators of gradual aromatization of lubricating base oils by acid-base-adsorption method.

Lubricant	Aromatic hydrocarbon content			Saturated bydrocarbons content, %
	Initial oil,%	After sul-fonation, %	After absorbtion by ACK-400, %	
1. Balakhani oil distil-late (fr.300-450°C)	18	12,3	8,9	91,1
2. Oily Rocks oil distil-late (300-500°C)	20	12,1	8,4	91,6
3. M-10 oil distillate	19	11	7,9	92,1
4. T-30 oil distillate	18	9,2	7,2	92,8
5. T-46 oil distillate	17	9,4	7,3	92,7
6. AK-15 oil distillate	16	8,8	7,1	92,9

Physicochemical properties of oil distillates purified from aromatic hydrocarbons to the reguired extent were studied (Table 8).

Table 8.

Indicators of basic oil distillates of low paraffin and naphthenic oils

Properties	Balaxani yagh distillati (300-500°C)	Oily Rocks oil distillate (fr.300-500°C)	M-10 oil distillate	T-30 oil distillate	T-46 oil distillate	AK-15 oil distillate
1.Kinematic Viscosity, mm^2/s, 100°C	8,8	14,8	11,0	4,8	7,9	16,6
2. Viscosity Index	58,9	59,7	62,7	62,8	58,1	54,3
3. Acid Number, mgKOH/g	Yox	Yox	Yox	Yox	Yox	Yox
4. Flash Point, °C	231	239	228	181	215	240
5. Pour Point, °C	-27,5	-27,3	-24,5	-26	-23,7	**-7,9**
6. Aromatic Hydrocarbon content, %	8,9	8,4	7,9	7,2	7,3	7,1
7. Saturated hydrocarbons, %	91,1	91,6	92,1	92,8	92,7	92,9
8. Colour	2,0	2,3	2,4	1,8	2,1	3,1

Due to the fact that the ignition temperature of T-30 oil was lower than reguired (1800), it was not considered possible to use it as an engine base oil. Therefore, T-30 oil, which is considered to be aromatic and environmentally friendly, is intended to be used as a solvent for canning liguids. In the remaining five samples, the viscosity index was below demand (≥90) and they were intended to be used as base oils after the addition of viscosity additives.

Thus, studies have been carried out to obtain oils for different purposes from the remaining five samples separately or in combination.

Blending of various lubricants by selecting a package of additives to refined base oils.

Before adding the additive, first of all, the structural group composition of T-46 and AK-15 aromaticized base oils and their mixtures was studied. For comparison, Table 9 also shows two finished external lubricants. (Castrol SAE15W-40 and Diesel CD Venol 15 W-40)

Table 9.

Comparison of physical and chemical properties of non-aromatic lubricating oils in accordance with T-46 and AK-15 with external engine oils.

Property	ASTM method	Blend I (T-46)	Blend II (AK-15)	Blend III (I:II-4:1)	Imported Lubricants	
					Castrol SAE 15W40	DizelCD Venol 15W-40
Kinematic Viscosity, mm^2/s 100°C 40°C	ASTMD 445	7,75 69,58	16,05 238,81	8,72 85,69	13,82 93,71	14,33 111,80
Viscosity Index	ASTMD 2270	65,80	56,50	63,60	150,1	130,1
Acid Number mg/KOH/g		0,01	0,01	0,01	0,101	0,33
Flash Point OC,°C	ASTMD 92	224	240	230	205	220
Pour Point,^{0}C	ASTMD 97	-30	**-4**	-25	-32	-30
Radiation coefficient, n_D^{20}		1,4959	1,4973	1,4959	1,4746	1,4827
Density at 20°C, kg/m^3	ASTMD 5002	874,9	900,5	900,9	863,2	881,1
Total Sulphur content, %	ASTMD 4294	0,04	0,14	0,08	0,412	0,299
Colour		1,5	3,01	2	2	2,5
Saturated Hydrocarbons, %		91,10	92,3	91,0	99,6	94,0

As shown in Table 9, the main difference between the recommended oils and the performance of foreign oils is the low viscosity index. The rest is not so different. The difference can be brought to the reguired level by adding a viscosity additive.

In addition to the physicochemical properties, NMR spectra of composition I and SAE15W40 were drawn from the samples (Figures 7 and 8) and there are similarities in these spectra. In these spectra, the five analytical fields differ from each other, which corresponds to the resonance of the H atom associated with the carbon atom. Table 10 shows the structural components of these oils.

As can be seen from Table 10, the most distinctive feature in foreign oils is the degree of aromaticity (fa). While this indicator was 0.08-0.12 in our proposed oils, in foreign analogues this indicator changed in the range of 0.02-0.06, which was observed with high C / H ratio in foreign oils (6.22-6.33).

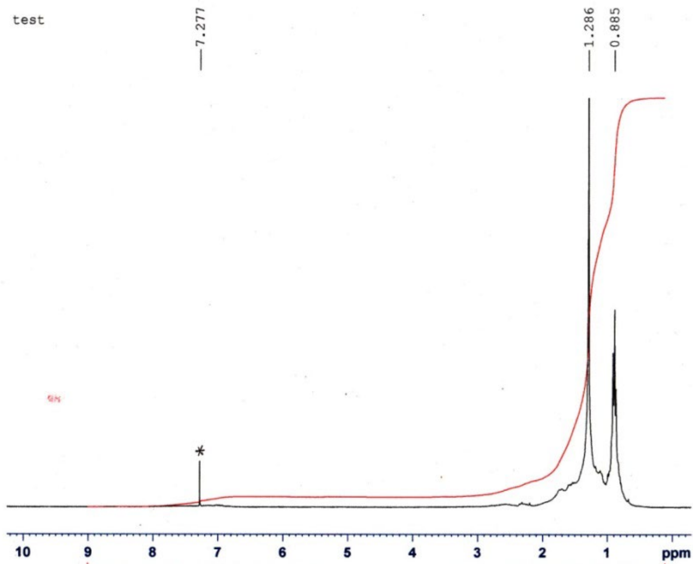


Figure 7. NMR spectrum of additionally purified Composition I by adsorption method

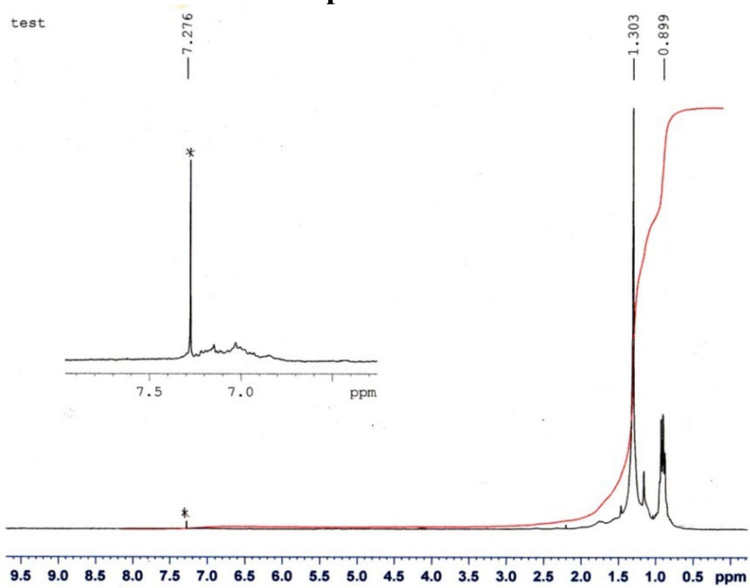


Figure 8. NMR spectrum of hydrocracked Castrol 15 W-40 oil

Table 10.

Structural parameters of oil distillate samples and foreign oils by NMP method

Parameter	H_{ar}	H_{α}	H_{naft}	H_{par}	H_{γ}	f_a
1. Blend I (T-46)	2,2	4,1	15,3	47,9	30,6	0,11
2. Aromatics removed by adsorbent (Tarkib I)	2,0	4,1	13,1	49,0	31,8	0,09
3. exctracted from adsorbent surface (Tarkib I)	2,3	3,6	13,5	49,5	31,1	0,12
4. AK-15 aromatics free (Tarkib II)	1,9	3,2	13,6	49,0	30,0	0,10
Additionally treated with adsorbent (Tarkib II)	1,6	3,0	13,4	50,0	31,2	0,08
5. Blend I(66%)+Blend II(14%) +PAO-12(20%)	1,5	4,0	9,7	54,9	29,8	0,08
6. Castrol SAE 15W-40 (Hydrotretaed lubricant)	**0,4**	2,4	9,3	61,2	27,6	**0,02**
7. Venol SAE15W-40 (Semisinthetic lubricany)	**1,2**	2,9	11,5	54,9	29,5	**0,06**

H_{ar} – Hydrogen content in Aromatic structure
H_{α} – CH_3CH_2 and CH-in α – condition in aromatic atoms
H_{naft} – Hydrogen content in naphten structure
H_{γ} – Hydrogen content at CH_3 group
f_a – Aromatics Index

Thus, a comparative analysis of the composition of the structural group shows that the composition of the structural group differs by the low proportion of aromatic hydrocarbons in foreign oils. There is a lot of consistency in other indicators.

After studying the physicochemical properties and structural group compositions of base oils separated from both oils and partially purified from aromatic hydrocarbons, research was started to obtain lubricants for different purposes after obtaining additives that meet modern reguirements with different compositions.

Due to the low viscosity index of aromatized mineral base oils for various purposes, the addition of viscosity additives to base oils was given priority. The physicochemical properties of the British Lubrizol 130 and Lubrizol 131 additives were studied together with the Japanese Aclube V-4000 and Aclube V-5040 additives obtained for this purpose. The results obtained are given in Table 11.

Table 11.

Viscosity Improoving Additives physical parameters.

Additive	Density, 20^{0}C, kg/m^3	Kinematic Viscosity, mm^2/s, at 100^{0}C	VI	Ash, %
Aclube V4000	911,0	824,0	-	Yox
Aclube V5040	897,9	988,0		Yox
Additive Package				
Lubrizol 130	900	33,05	145,4	2,4
Lubrizol - 131	900	46,82	158,6	3,4

The structural group parameters of Aclube and Lubrizol viscosity additives by NMR spectrometry were determined and given below.

	H_{ar}	H_{α}	H_{naft}	H_{par}	H_{γ}	f_a	I
Lubrizol	1,2	2,5	9,9	60,1	26,3	0,05	0,29
Aclube	1,1	1,8	11,4	56,5	29,2	0,03	0,34

Note: H_{ar} – Hydrogen content in Aromatic hydrocarbons

H_{α} – CH_3, CH_2 va CH guantities in aromatic atom

H_{naft} – Hydrogen content in Naphthenic hydrocarbons

H_{par} – Hydrogen content in paraffinic hydrocarbons

H_{γ} – CH_2 Hydrogen content

f_a – Aromatics index

I – IsoParrafin Index

The following ingredients were used in the research; MC-20 (Lukoyl), PAOM-4 and PAOM-12 (polialfaolefin). Some of these ingredients, tested as additives to base oils, are given below.

	MC-20	PAOM-4	PAOM-12
Kinematic Viscosity, mm^2/s 100^{0}C	22,6	4,3	12,2
Viscosity Index	100	116	126
Pour Point, ^{0}C	-55	-55	-60

In addition to these ingredients, polymethacrylate copolymer with α-olefins (Viscoplex-2-670) and hydrogenated styrene-isoprene concentrate (Shelvis-50) were used as additives to base oils.

In addition to the above viscosity additives, the Belarusian-made PA-2600 additive package (intended for mineral oils), CCK-400D (dialkylbenzene sulfuric acid) and DF-11K additives were used.

After studying the physicochemical properties of the additives to be used, three samples of engine oil (15W40) with the optimal composition created from them were prepared and their properties are given in Table 12.

Blend 1 - 5% Lubrizol Viscosity Improver (UK origin) + 3,8% PA-2600 + 0,8% CCK-400D + Base Oil (M-10) 90,4%

Blend 2 - 5% Lubrizol Viscosity Improver (UK origin) + 4,8 PA-2600 + 1,5PA2610 + 0,8 CCK-400D + 87,9 Base Oil (M-10)

Blend - 3 – 5% Lubrizol Viscosity Improver (UK origin) + 4,25 PA-2600 + 1,45 CCK-400D + Base Oil 89,3%

Table 12.

Physicochemical properties of base oil and samples

Property	Base Oil for (15W40)	Blend 1	Blend 2	Blend 3
Kinematic Viscosity, mm^2/s at 100°C at 40°C	7,6 67,2	12,3 122,4	12,5 124,5	12,5 123,7
Viscosity Index	67	90,4	90,9	91,3
Density at 20°C, kg/m^3	875	905	911	910
Pour Point, °C	-28	-28	-26	-28
Flash Point, °C	224	220	224	224
Radiation coefficient,n_D^{20}	-	1,499	1,4991	1,4992
Colour	2,5	2,5	3	3

Although the physical and chemical properties of engine oil samples meet the reguirements, the stability of thermooxidation (with GOST-11063-77) and the amount of sediment for more than 20 hours were higher than normal.

Subseguent studies have used viscosity additives from Japan (Aclube V-4000 and 5040) and the United Kingdom (Lubrizol). As a result of the research, the optimal composition of the following samples was given (Table 13).

Blend 1 – Base Oil (T-46 ar.7%) 90,17% + 4,0% Aclube V5040+ 5% PA-2600 (package)+0,83% CCK-400D additive

Blend 2 – Base Oil (T-46 ar.8%) 90,17% + 4,0% Aclube V5040 +

5% PA-2600 package + 0,83% CCK-400D additive

Blend 3 – Base Oil (T-46 ar.10%) 90,17% + 4,0% Aclube V-5040 + 0,83% CCK-400D additive

Blend 4 – Base Oil (T-46) 80%+20% consentrate - lubrizol

Numuna 5 – SN-150 base oil -38%, VHVI-4 syntetic base oil-27% + 35% Lubrizol additive package

Table 13.

Oxidation resistance results of samples tested by GOST-11063-77. Temperature 200 ° C, time-40 hours

Sample number	Sludge content, %-la	Kinemativ Visc at 100°C, mm^2/s		Viscosity change, %	Acid Number, mgKOH/g		Acid Number increase, mgKOH/g
		avval	sonra		avval	sonra	
N1	0,16	12,906	15,561	20,57	0,14	5,07	4,93
N2	0,19	13,641	17,096	25,33	0,20	3,76	3,56
N3	0,29	11,732	14,827	26,38	0,17	4,12	3,95
N4	0,13	13,070	17,898	26,94	0,09	2,6	2,51
N5	0,17	13,532	14,741	8,93	0,15	4,6	4,45

As can be seen from Table 13, each of the five samples tested is resistant to oxidation (GOST-11063-77). Thus, these ingredients can be offered for the production of SAE 15W40 engine oil.

The results of research show that one of the main indicators of lubricating oil is its thermoxidation stability.

Given the above, it was studied how the stability of the oil depends on its chemical composition. The high content of aromatic hydrocarbons and acids prevents it from remaining stable. High acid content results in an increase in resins. This is due to the fact that it breaks down alkaline additives and reduces the alkaline number in the oil.

To confirm the above, Table 14 compares the change in oil viscosity and acid number after thermoxidation for 30 hours.

As can be seen from Table 14, two external oils were tested along with the sample provided. The indicators of the oil we present have changed less than their foreign counterparts.

It was interesting to deeper the research on engine oils. Changes in the composition of the structural group were studied by reducing the amount of aromatic hydrocarbons in the base oil to 0.2%. As a result of the NMR spectrum, it was determined that the average molecular weight of the oil distillate used varies between 300-349 and contains 21-25 carbon atoms and 41-46 hydrogen atoms.

Table 14.

Comparative values of viscosity and acid number change from thermooxidation of oils in 30 hours

Lubricant sample	Base Number, mgKOH/g After 30 hours axidation		Increase in Acid Number	Kin VIsc at 100 Deg C, mm^2/s, during 30 hours		% of change
	before	after		avval	sonra	
(15W40) blended from Balakhani Oil	0,19	1,43	124	13,18	14,25	8,4
"Pemko" Lubricant (Germany)	0,14	1,74	160,0	14,95	11,8	-20,9
Russian made (Lukoil)	0,010	1,73	173,0	13,77	15,60	13,3

The least hydrogen deficiency was observed in oil with 0.2% aromatics (1.0%). While the aroma was high, it was 17%. As a result, the proton deficit increases to 3.5>. The ratio of carbon hydrogen atoms (H / C) in the studied oils varies from 1.86 to 1.95, which corresponds to the nature of the oils under study.

As the amount of aromatic hydrocarbons decreases, this ratio increases (1.97). In fat, the bulk of the H atom is concentrated in saturated fragments of medium molecules. (Ha, Hβ, Hγ). In the methyl groups located outside, the H content is between 29-39%. The presence of the main part of the H atom in the Hγ region in highly refined oil indicates the presence of branched aliphatic hydrocarbons in the oil. As the aromatization deepens, a decrease in the carbon atom in the aromatic structure is observed. When studying the H / C relationship between the CH2 and CH groups in the β position farthest from the nucleus, the diversity of aliphatic chain compounds was confirmed.

As a result of the research, the oxidation resistance of aromatic degreased T-46 engine oil for 40 hours was tested and a high result was obtained (with 0.18% precipitation).

Thus, the results of the tests show that it is possible to obtain motor oil at the level of external analogues with maximum refined (up to 0.2%) Baku oils (T-46) from aromatic hydrocarbons.

Further research has focused on the development of **transmission oils** after engine oils.

Transmission oils must have high mechanical and thermal resistance. It is advisable to thicken them with viscous additives. Additives with a molecular weight of 3000-5000 are considered important for this purpose. Because the use of transmission oils that can work all year round is economically viable.

Japanese-made viscosity additives (Aclube V-4000 and Aclube V-5040) were used to obtain transmission oils from Baku oils. The structure of the Aclube V-4000 additive was determined by NMR and is shown in Figure 9.

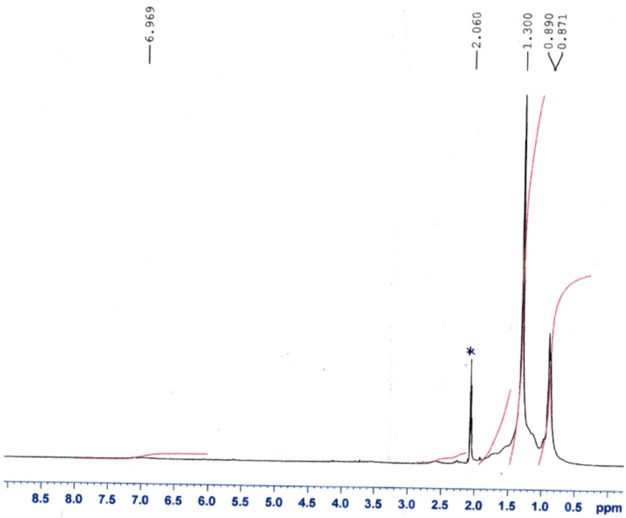


Figure 9. NMR spectrum of viscosity additive Aclube V-4000

As can be seen from the spectrum, the viscosity is hydrocarbon. These Japanese-made additives are branched because they are isoparaffin-based and have an isoparaffin index of 0.34.

Oil-based distillates of Balakhani naphthenic and low-paraffinic petroleum oils were used as the base oil for the production of transmission oil. A 4: 1 mixture of these oils was used as the third ingredient.

Additives added to increase the viscosity were added to the base oils between 2.5-5%. The results obtained are given in Table 15.

Table 15.

Guality indicators of Baku oil oils with Aclube viscosity additive

Name	Additive g-ty, %	Kin Visc, mm^2/s, at 100°C	VI	ρ_4^{20}, g/sm^3	Pour Point, °C	G, Thickening degree
Base Oil -I	-	7.8	67.2	0.8740	-28	-
Base Oil – II	-	16.06	56.5	0.9000	-10	-
Base Oil I+II – III (4:1)	-	8.60	60,8	0.9068	-22	-
I+Aclube V-4000	5.0	17.46	117.9	0.9050	-30	0.975
I+Aclube V-4000	2.5	12.30	96.3	0.9056	-30	0.921
I+Aclube V-5040	4.8	18.65	128.0	0.9050	-28	1.01
I+Aclube V-5040	2.4	12.77	102.0	0.9056	-32	0.972
III+Aclube V-4000	2.5	10.89	89.4	0.9054	-28	1.27
I+UK Additive Package	5.0	12.38	90.4	0.9050	-28	0.85

To assess the guality of the viscosity additive, the base oils were first tested without additives, and then the results were compared by adding different amounts of Aclube V-4000 and other additives. The results given in Table 15 show that the additives are of high guality. These indicators are particularly evident in the change in viscosity index and viscosity at 1000C in accordance with demand. Thus, by adding 2.4-5% additive to the base oil, the OI increases from 60.8-67.2 to 89.4-117.9. In the same way, the viscosity increased from 7.8-8.6 to 10.89-17.46 at 1000C.

Japanese-made viscosity additive Aclube V-5040 shows better results. Looking at the results, it seems that the samples have guite high values, ie the viscosity at 100 ° C ranged from 10.89 to 18.65 mm2 / s. In this case, the viscosity index also increased significantly and varied between 89.4-128.0.

The lubricating properties of the base oil obtained with a British viscosity additive (viscosity at 100 ° C - 12.38 mm2 / s, OI 90.4) were studied and it was shown that under critical conditions Pk – 980 H, the diameter of the wear stain was d – 0.4 mm. also meets the demand (GOST 9490-75).

To evaluate the obtained indicators, Table 16 is compared with foreign analogues.

Table 16.

Comparison of viscosity additive transmission oil with foreign analogues

Name/Parameter	TSp-15K GOST 23652-79	Getriebe oil Ravenol	Motogear Ravenol	Trial blend samples		
				2.5% Aclube V-4000	2.4% Aclube V-5040	5% Aclube V-5040
Viscosity class: SAE	90	80W-90	80W-90	75W90	75W90	80W90
API	GL-3	GL-4, GL-5	GL-4	-	-	-
Kin Visc, mm^2/s at 40°C at 100°C	≤16	140.5 14.1	118.5 13.4	115.7 12.3	116.3 12.7	161.5 17.4
Viscosity Index	90	97	109	96.3	102	117.9
Pour Point, °S	-25	-33	-33	-36	-32	-30
Flash Point OC, °C	185	226	242	210	210	210
Density at 20°C, kg/m^3	910.0	892.0	879.0	905.6	905.6	905.0

As can be seen from Table 16, the SAE 80W90, 75W90, and GL-3, GL-4, and GL-5 transmission oils are given for comparison with API. The two ingredients we offer for comparison are transmission oils that meet the reguirements of GOST 17479.2. Thus, the comparison of the indicators given in the table shows that the transmission oils obtained on the basis of Baku oils with the addition of a guality viscosity additive do not lag behind their foreign analogues in terms of guality.

Further research has focused on the production of lubricating oil for automatic transmissions. Lubricants used for the gearbox must have specific properties and ensure intensive operation of the gears in any conditions.

The purpose of the lubricating oil is to lubricate and cool the gears in the box and to create conditions for the wheels to stick together. It should not lose its guality at a temperature of 80-90 ° C, which can occur in the gearbox. Lubricant should not foam at high speeds, otherwise corrosion may occur.

The goal is to create a base lubricant that meets modern reguirements by purchasing a base lubricant for an automatic transmission and then selecting the appropriate additive package. Two components were used to create the base oil. The first component (I) consists of a base oil with a viscosity of 5.97 per 1000. The second component is the Balakhani oil component, which boils at 330-3600. By adding these components in a ratio of 1: 1 (volume), a lubricating base oil was obtained for the ATF. The physical and chemical properties of the lubricating oil obtained after the addition of 2.6% Japanese viscosity additive (Aclube V-5040) to the base oil were determined and compared with the modern Dexron II and Dexron III ATF lubricants are given in Table 17.

As can be seen from Table 17, the addition of 2.6% Aclube V5040 viscosity additive to the base oil obtained from Baku Petroleum (ATF) showed similar results to the performance of foreign analogues.

Table 17.

Recommended oil parameters for automatic transmission fluid (ATF)

Parameter	Base component			Base Oil III Ag-lubeV-5040	Dexron II	Dexron III
	I	II	I+II(III) (4:1)			
Kinematic Viscosity, mm²/s at 40°C at 100°C	45,6 5,97	13,3 2,97	22,4 4,0	32,5 6,0	36,8 7,4	35,0 7,0
Viscosity Index	60	50,8	50,7	134	174	160
Flash Point,°C	210	195	204	205	200	188
Pour Point,°C	-38	-40	-40	-40	-42	-48

Thus, it can be concluded that after cleaning the oil fractions of

Baku azparaffin and naphthenic oils from the reguired level of aroma by acid-alkaline adsorption, it is possible to create lubricants for engines, transmissions and automatic transmissions with mineral oil by adding selected high-guality additives.

After the approval of the production of mineral lubricants from de-aromatized Baku azparaffin and naphthenic oils, the research was focused on the production of semi-synthetic and synthetic oils.

For this purpose, the Council of Ministers of the Republic of Azerbaijan prepared SAE 10W40 and SAE 5W40 oils in accordance with the reguirements of Az-1500051878, 058-2017, studied the physical and chemical properties and gave them in Table 18. The table also shows the indicators of similar brands of Lukoil oils for comparison.

As can be seen from Table 18, SAE 10W40 contains 34% mineral oil and SAE 5W40 is entirely synthetic oil.

Falcon and 10W40 additives were used for semi-synthetic oils, and Falcon 5W40 additives were used for synthetic oils.

Lukoil oils consist of 10W40 semi-synthetic and 5W40 synthetic oils.

Table 18.

Comparison of the performance of semi-synthetic and synthetic oils with foreign analogues

Parameters	Prepared samples		TSH Az 1500051871, 058-2017 reguirements		Foreign analogs (Lukoyl)	
	SAE 10W40	SAE 5W-40	SAE 10W-40	SAE 5W-40	SAE 10W40	SAE 5W-40
Kinematic Viscosity, mm^2/s at 100ºC at 40ºC	12,79 89,86	12,58 75,60	13,5-16,0 85-105	11,5-13,5 75-85	14,0 90,3	13,6 79,2
Viscosity Index	141,0	166,3	≥140	≥160	154	176
Sulfated Ash, %	1,43	1,09	≥1,65	<1	1,0	1,1
Flash Point, ºC	210	204	≥210	≥200	226	235
Pour Point, ºC	-35	-42	-33	-38	-35	-40
Mineral base content, %	34	0				
APİ classification	C1-4/SL	C1-4/SL	-	C1,CF	SO/CF	SN/SF

As can be seen from Table 18, the prepared semi-synthetic and synthetic oils meet the reguirements of the SC. Lukoil's performance is in line with demand.

Looking at the results, it can be seen that the amount of hydrogen in the paraffin structures is lower than in sulfonated aromatized base lubricants (T-46), hydrocracking and highly refined VHVI-4 and SN-180 oils.

The structural group composition of mineral, synthetic and semi-synthetic base oils was studied by NMR spectroscopy and the distribution of hydrogen in the structural groups and the Hparaf / Hnaft ratio were determined.

It was found that the low viscosity index of high-purity aromatic mineral base oil (T-46) is due to the ratio of Hparaf / Hnaft (3.19-3.73).

One way to solve this problem is to add up to 20% synthetic component to the mineral base oil so that the OI is ≥90, in which case the Hparaf / Hnaft ratio reaches 4.34-4.60.

As a result of the research, samples were sent to the British company Millers Oils and the research center "FORSCHUNGSZENTRUM" in Rostock, Germany for confirmation of the analytical results.

Millers oils, one of the leading companies in the UK, produces a variety of lubricants that are used in many countries around the world (Europe, South and North America).

The following lubricants were obtained from the Millers oils laboratory and approved for testing with SAE 10W30, and the following ingredients were obtained and submitted to Millers Oils for testing.

SAE 10W30 engine oil to be shipped to Millers Oils contained 90.65% of aromatic T-46, 3.5% of Aclube V5040, 5% of PA-2600 and 0.85% of CCK-400D. . The results of the analysis conducted in the UK are given in Table 19. For comparison, the table also shows the results of the analyzes conducted in NKPI.

The analyzes for comparison confirmed each other. Based on the results of the analysis, Millers Oils rated the sample as SAE 20W40 oil.

The following four ingredients have been prepared for submission to the German Research Center.

Blend I Base oil - 65%, additive package Lubrizol 35%

Blend II Base oil - 90.17%, PA-2600 package - 5%, Aclube V5040-4%, CCK-400D-0.83%

Blend III VHVI base oil-55%, M-8 - 15%, Lubrizol-30%

Blend IV VHVI-50%, M-8 - 15%, Lubrizol - 35%

The properties of these four engine oils were studied at the NKPI before being sent to Germany.

Table 19.

Results of tests performed in the laboratory of Millers oils (SAE 10W30 oil)

Parameter	Results	
	By "Millers oils"	By AMEA-NKPİ
Apperance	Clear and Transparrent	Colour- 2
Density , g/sm^3 at 15,5ºC at 20ºC	 0,912 	 0,9102
Kinematic Viscosity, mm^2/s at 40ºC at 100ºC	 87,9 10,9	 84,1 11,0
Viscosity Index	110	105
CCS, Mpa/s -20ºCda -15ºCda	 1800 8469	-
HTHS	3,06	-
sludge formation test	davamlidir	-
Active elements content, % P S Ca Zn	 0,11 0,39 0,48 0,13	

The viscosity of the prepared oil samples at 100ºC varies between 12.5-15.9. Viscosity indices range from 110 to 149.7. The samples were sent for testing to the Forschungszentrumfur Verbrennungsmotozen and Thermodynamics Research Center (FVTR) in Rostock, Germany.

The results of the test analysis of the German FORSCHUNGSZENTRUM, a leading research center in Europe, are given in Table 20. As can be seen, the viscosity of the samples (at 100 and 40 ° C), the viscosity index, the sulfate solubility correspond to the values obtained in the NKPI. In addition to these indicators, alkaline and acid numbers (TBN and TAN), acid-base balance (ipH-volue), element indicators (ICP OES) were also determined.

As can be seen from Table 20, the determination of water by coulometric vibration using the Karl Fischer method (DIN 51777) has a very high accuracy.

Table 20.

Test parameters of engine oil samples tested at the FVTRGmbH center in Germany

Parameters	Test Methods	Units	Blend 1	Blend 2	Blend 3	Blend 4
Water Content	DİN 51777	mg/kg	1216	2423	1226	1106
TBN	ASTMD 4739	mgKOH/g	10,9	9,2	11,4	9,0
TAN	ASTMD 664	mgKOH/g	2,56	3,09	2,62	2,60
Density at 15^0C	DİN ENİSO 12185	kg/m^3	904,3	914,3	893,6	876,7
Kinematic Viscosity at 40^0C	DİNEN 16896	mm^2/s	146,85	101,35	95,613	91,868
at 100^0C	DİNEN 16896	mm^2/s	15,591	12,660	12,710	13,607
Viscosity Index	DİN İSO 2909	-	109	119	129	150
Ph	ASTMD 7946	-	7,44	7,32	7,51	7,44
Sulfated Ash	DİN 51575	% (m/m)	1,27	1,69	1,17	1,22
Elemental analysis	ICPOES	mg/l				
Al 396.152			<1	<1	<1	<1
B 249.773			<1	<1	<1	<1
Ba 230.424			<1	<1	<1	<1
Ca 315.887			3300	4730	3090	3310
Cu 324.754			<1	<1	<1	<1
Fe 259.941			<1	<1	0	0
K 766.491			8	9	8	8
Mg 285.213			4	13	3	4
Mn 257.611			<1	<1	<1	<1
Mo 202.095			<1	<1	<1	<1
Na 588.995			<1	<1	<1	<1
Ni 221.648			<1	<1	<1	<1
P 213.618			959	1100	904	966
Pb 220.353			<1	<1	<1	<1
Se 251.612			9	14	4	5
Sn 189.991			<1	<1	<1	<1
Zn 213.856			1100	1280	1030	1100

This method allows you to determine from 10 mcg to 200 mg of water. In the Russian Federation it is appointed by GOST (GOST

P 281). The total alkali number in the oil was measured with ASTM D4739 (with TBN) and the total acid number was measured with ASTMD 664 (with TAN). Total alkaline number TBN (total base number) indicates the total amount of alkali in fats (including additives).

The total acid number TAN (total acid number) indicates the acidity in the environment when the base oil and the additive package are combined.

IPH-Value (ASTMD 7646) - indicates a deterioration in oil guality as the test reading falls. The ICPOES method is for the determination of active elements in oils. These elements enter the oil mainly through additives. Indicates that the amount of metals determined in the presented compositions corresponds to the composition of oils 15W40 (M-14G2).

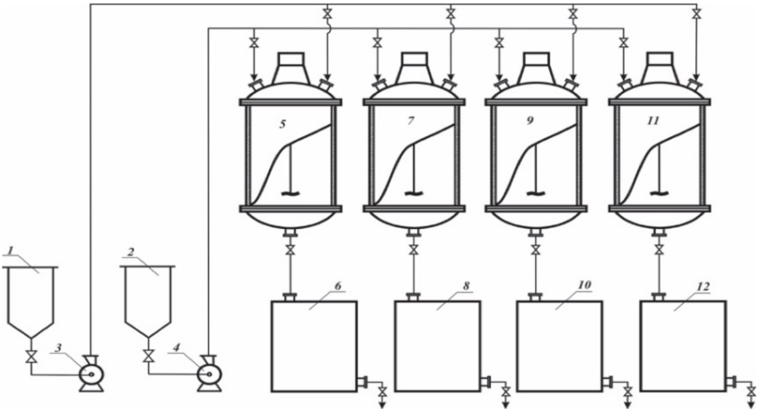
As the content of phosphorus in the components 1,3 and 4 given in Table 20 varies between ≤0.09% and the sulfate ash content between 1.17-1.22%, it corresponds to the performance property of API class CI-4, so EURO-5 in cars and meets the environmental reguirements of EURO-6. Depending on the API class, these values may also apply to CD, CE and CF-4 classes.

Organization, application and economic efficiency of industrial production of various lubricants.

The results confirmed by the two leading European countries show that it is possible to obtain various lubricants that meet modern reguirements from Naften-based and low-paraffin Baku oils by acid-base-adsorption method.

Thus, as a result of research conducted in recent years at NKPI, the problem of industrial production of various industrial lubricants obtained by acid-base-adsorption method was faced.

For this purpose, the top management of ANAS negotiated with the British company Millers Oils and established a joint Millers Oils Azerbaijan LLC for the production of various lubricants in the High Technology Park. This fully automated plant has the capacity to produce 100,000 liters of lubricant per year. The basic technological scheme of the device is given in Figure 10.



Picture 10. Simplified technological scheme of lubricating oil plant in "Millers Oils Azerbaijan" LLC of ANAS YTP.

1-Capacity for base oil, 2-Capacity for additive, 3,4-Pumps, 5,7,9 and 11-Reactors, 6,8,10 and 12-Capacities for finished product.

Capacities for raw materials in Millers Oils Azerbaijan LLC. (Additional to picture 10)

Packaging facility of "Millers Oils Azerbaijan" LLC.(Additional to picture 10)

As seen from Picture 10, the unit is based on four parallel reactors. These reactors can produce four types of lubricants at the same time.

The technological scheme of the process does not provide raw material capacities and packaging of the finished product, so the views of these devices are given from the device.

Since its inception (2018), the company has produced and put into operation various brands of engine, transmission and hydraulic oils under contracts with the following organizations.

In 2018, Millers Oils Azerbaijan traded following products and volumes to the companies: Akkord Transport LLC did receive SAE 15W40 and SAE 10W40 engine oils and Hidravlik-46 hydraulic oil, Amoris LLC received 15W40 and 10W40 engine oils, AzerGold CJSC SAE 15W40 engine oil, SAE 10W40 engine oil and SAE 85W140 transmission oil to "Baku Taxi Service" LLC, GL-5 80W90 and GL-5 75 W90 transmission oils to "Baku Metro" CJSC, "Hydraulic-46" transmission oil to "Idrak TechnologicalTransfer" LLC. During this period, there were no complaints from buyers about the guality of oils.

Contract copies with enterprises are attached to the dissertation.

Thus, it has been confirmed that the guality of lubricants produced by Millers Oils Azerbaijan LLC does not lag behind foreign analogues, both theoretically and practically.

In order to confirm the economic superiority of the organized lubricants from foreign analogues, API, semi-synthetic and synthetic oils produced in accordance with ACEA standards produced by Millers Oils Azerbaijan LLC were tested in accordance with the methodology adopted in 1998 in the oil refining and petrochemical senses of our country. economic assessment was conducted. Profit per unit of product (1 liter) in comparative calculations with similar oils produced by a foreign company in different packages (1, 5 and 205 liters) - the cost of the product (man./l) at the established price for the product (man./l)) was taken as the difference. The cost of oils produced by Millers Oils Azerbaijan LLC and the profit from the sale of the product for each package are presented in Table 21.

To calculate the total profit, if the volume of products is 15,000 liters each (only hydraulic oil Millers Oils "Hydraulic Oil 46" 10 thousand liters), it is planned to produce a total of 100 thousand liters per year and sell in large packages (205 liter containers). The minimum amount of gross profit is 567 thousand (maximum 708 thousand) AZN.

Table 21

The cost of the product and the profit from the product on various packaging

№	Engine Oil	Unit	Cost,	Price		
			Per 1 liter, AZN./l	Per 1 liter	Per 5 liter	Per 205 liter
1.	Millers Oils Azarbaycan FALCON 5W30 Profit (1 packaging) Profit	 man. man./l	2.983	9,5 6.517 6.517	45 30.085 6.017	1420 808.485 3.944
2.	Millers Oils Azarbaycan FALCON 5W40 Profit (1 packaging) Profit	 man. man./l	3.051	8,8 5.749 5.749	43 27.745 5,549	1490 864.545 4.217
3.	Millers Oils Azarbaycan FALCON 10W40 Profit (1 packaging) Profit	 man. man./l	2.589	8,2 5.611 5.611	39 26.065 5,213	1180 649.255 3.162
4.	Millers Oils Azarbaycan FALCON Multitruck 15W40 Profit (1 packaging) Profit	 man. man./l	 1.857	 7 5.143 5.143	 25 15.715 3,143	 820 439.315 2,143
5.	Transmission Oil Millers Oils Ep 80w90 Profit (1 packaging) Profit	 man. man./l	1.516	8,4 6.884 6.884	–	–
6.	Transmission Oil Millers Oils Ep 85w140 Profit (1 packaging) Profit	 man. man./l	1.419	7,8 6.381 6.381	–	–
7.	Millers Oils Hydraulic Oil 46 Profit (1 packaging) Profit	 man. man./l	1.262	17,9 16.638 16.638	–	–

Thus, the task of the dissertation is to separate oil distillates from Baku oil-based and azparaffin oils, to obtain various base lubricants by acid-alkaline adsorption method, to create packages of additives used in leading countries, to create various types of engines, transmissions and Hydraulic oils were created, production was organized in the High Technology Park of ANAS and put into operation for various organizations.

Purchase of preservatives and fire-retardant foaming agents with high purity petroleum acids and dehydrated T-30 oil

Research has continued in this area to find a more important area of application for the new high-purity petroleum acid created in the course of the research.

Deeply dearomatized T-30 oil was used as an environment for anti-corrosion preservatives. (Table.22). The other direction was to obtain white oils by reducing the percentage of aromatics in the distillate to zero.

Table 22.

Comparison of indicators of preservative liguids created with refined T-30 oil and petroleum acid derivatives, analogues (in days)

№	Additive guantity and content, %	Reagent content in preservant, %	Tech. Crude Oil Acid and T-30 distillate		Purified T-30 oil ad crude oil acid	
			In condensed phase	Atmospheric phase	In condensed phase	Atmospheric phase
1	Amidoamin, 1% Liguid rubber, 1%	2	36	62	41	70
2	Nitro comp., 1% Amidoamin, 1% Liguid rubber, 1%	3	117	143	138	182
3	Nitrobirlashma, 1% Oxide Lig. Rubb. 1% Amidoamin, 1%	3	128	161	139	173
4	Imidozalin, 1% Liguid rubber, 1%	2	31	59	42	67
5	Oxidised Rubber, 1% Imidozalin, 1%	2	43	68	52	78
6	Liguid Rubber, 1% Nitro comp., 1% NT salt, 1%	3	130	161	152	191
7	Oxidised Rubber 1% Nitro comp., 1% NT-salt, 1%	3	151	192	170	213
8	Oxidised Rubber 1% NT salt, 1% Imidazolin, 1%	3	134	176	153	194

Positive results were observed in the use of T-30 lubricating oil instead of technical petroleum acid (92%), freshly obtained high purity (98%) petroleum acid, and T-30 lubricating oil instead of T-30 oil distillate.

Corrosion inhibitors and fire-retardant foaming agents were obtained from the high purity petroleum acid obtained in the dissertation and their superiority over the previous results was confirmed. The results obtained are compared in Table 23.

Table 23.

Purchase and comparison of high-guality raw materials with fire-fighting foam-repellents and analogues

The composition of the foaming agent	With distilled petroleum acid (95%)		With newly purified petroleum acid (98%)	
	Increase sm^3	Durability sec	Increase, sm^3	Durability, sec
Sodium naphthenate 90% Monoetanolamin komp.10%	747	316	801	346
Sodium naphthenate 80% Monoetanolamin komp.20%	745	312	798	341
Sodium naphthenate 70% Monoetanolamin komp.30%	739	310	795	338
Sodium naphthenate 60% Monoetanolamin komp.40%	734	308	791	334
Sodium naphthenate 50% Monoetanolamin komp.50%	732	305	788	330

RESULTS

1. Separation of lubricating oil distillates from naphthenic and low-paraffin Baku oils without the use of complex technological processes, acid-alkaline-adsorption method, purification of resins and aromatic hydrocarbons at the level reguired by API (aroma.≤10%), refined mineral oil and synthetic The production of isoparaffin-based oils and various mineral and semi-synthetic (engine, transmission and hydraulic) lubricants with the addition of a package of additives

in the specified composition and amount was organized and put into operation in various enterprises of our industry. Documents confirming the results are attached to the case [6, 13, 41, 58].

2. A high-guality polymer-based demulsifier (Khazar-24) was created for the preparation of low-paraffin and naphthenic-based oils for processing in the laboratory. , Was able to reduce from 5 mg to 1.8 mg. The Khazar-24 demulsifier was tested in the industrial processing plant No. 305 and the results obtained in the laboratory were confirmed (test results are given in the appendix to the dissertation) [1, 2, 4].

3. After the components of oil distillates were extracted from the demulsified oils in a US-made two-column distillation apparatus, petroleum acids were separated and the purity of the separated petroleum acids (from non-soapy hydrocarbons) was increased from 90% to 98%. (Less patent for the method has been granted a20190078). This method also prevents fat loss [3, 5, 57].

4. After sulfonation to the reguired extent (18-20% to 12-14%) by selecting the optimal sulfonation mode with 92-96% H2SO4 to separate oxidizing resins and aromatic hydrocarbons from the composition of oil distillates of different fractions. , neutralization and additional conditions of bitumen in the presence of Ca (OH) 2 in order not to cause environmental problems of the released sulfuric acid were studied, the positive results obtained in the proposed technology and mode of operation, allowed to develop regulations and recommend for application [8, 32, 34, 35, 53, 56].

5. After sulfation, 12-14% of the aromatic base oil distillate is purified in accordance with the reguirements of API (arom.≤10%, saturated k / h≥90%) with ACK-400 adsorbent containing Al and Cr oxides. Technological scheme of aromatization and adsorbent regeneration process under optimal mixing conditions (silicogel 5%, temperature 80-100oC, time 1-1.5 hours) was developed. Physico-chemical parameters of refined base oils were determined by modern methods and it was determined that all indicators of the oil, except for the viscosity index, correspond to its foreign analogues [19, 25, 26, 27, 40, 47].

6. The viscosity index of the oil is 56-61- by adding 2.5-5% of

the viscous additives (Lubrizol, Aclube V4000 and Aclube V5040) used in Japan and the United Kingdom to the base lubricants obtained by acid-base-adsorption method. was increased to 102-128. At the same time, it was possible to raise all indicators of base lubricants to the level of foreign analogues (Castrol, Ravenoll, etc.) [9, 32, 34, 46].

7. As a result of research conducted to obtain various types and purposes of lubricating oils (engine, transmission, etc.) from the formed mineral base oils, the expediency of using a package of additives PA-2600 for mineral oils produced in Belarus (LLK NAFTAN) was confirmed. The addition of a certain amount of high alkalinity CCK-400D additive to this package of additives significantly increases the effectiveness of the package [7, 10, 28, 31, 39, 44].

8. Tests of the following samples were performed to check the resistance to thermooxidation (GOST 11063-77, 40 hours at 2000C), one of the main indicators of lubricants.

Sample 1. Base Oil (90,17%) + Aclube V-5040 (3,8%) + PA 2600(5,2%) + CCK-400D (0,83%)

Sample 2. Base Oil (90,20%) + Aclube V-5040 (4,0%) + PA 2600 (5%) + CCK-400D (0,8%)

Sample 3. Base Oil (90,19%) + Aclube V-5040 (4,1%) + PA 2600 (4,9%) + CCK-400D (0,8%)

Sample 4. Base Oil (80%) + Lubrizol additive package (20%)

According to the reguirements of GOST, the amount of sediment in the oil should not exceed 0.5% under conditions of continuous mixing at 2000C for 40 hours. In the obtained results, it was 0.16% in sample 1, 0.19% in sample 2, 0.29% in sample 3, and 0.13% in sample 4. That is more than twice as good as demand. [7, 10, 34, 51, 52]

9. SAE 15W40 and SAE 10W40 semi-synthetic lubricants were prepared in accordance with the reguirements of TS Az 15000 51871.058-2017 together with the formed mineral oils and were confirmed to be at the same level as all indicators compared to SAE 15W40 and SAE 10W40 mineral and semi-synthetic oils produced by Lukoil (RF) [55].

10. SAE 10W40 oil, developed for more modern testing of lubricants, was tested at Millers Oils, England, and four different samples of SAE 15W40 oil were tested at the FORSCHUNGSZENTRUM research center in Germany. The oil performance is at the level reguired by SAE 20W40. In a study conducted at the German Research Center, four of the samples showed results in accordance with the reguirements of SAE 15W40. These parameters meet the environmental reguirements of EURO-5 and EURO-6 in cars, as they correspond to the performance properties of the API class CI-4.

The results of tests conducted in the leading countries of the world (England, Germany) gave the basis for the establishment of production of lubricants (engine, transmission and hydraulic) in the High Technology Park of ANAS [37, 59].

11. "Millers Oils Azerbaijan" LLC, established for the production of various types of lubricants in the High Technology Park of ANAS, produced lubricants of different compositions created in NKPI and offered for joint production. , "Idrak Technological Transfer" CJSC, "Baku Taxi Service" LLC, "AzerGold" CJSC, "Amoris" LLC and "Akkord Transport" LLC. The economic benefit from the production of lubricants was calculated. In the device with a capacity of 100 thousand liters per year, compared to its foreign counterparts, the minimum profit was 567 thousand, and the maximum was 708 thousand AZN [11, 29, 46].

12. Effective applications of high-purity petroleum acid (98%) and de-aromatized T-30 oil obtained during the research were found. Petroleum acid derivatives have been shown to provide higher protection than their low-cost analogues when used as a preservative in a T-30 oil medium as a high-guality inhibitor [12, 14, 16, 21, 30, 36, 42, 43, 54, 61, 62, 64].

13. A mixture of salts of petroleum acids and amine complexes was able to extinguish fires at a higher speed than their analogues by creating high-growth and durable fire-fighting foaming agents [57].

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