

ISSN 2518-170X (Online)

ISSN 2224-5278 (Print)

**NEWS OF THE NATIONAL ACADEMY
OF SCIENCES OF THE REPUBLIC
OF KAZAKHSTAN, SERIES OF
GEOLOGY AND TECHNICAL SCIENCES**

№5

2026

ISSN 2518-170X (Online)

ISSN 2224-5278 (Print)



N E W S
OF THE NATIONAL ACADEMY OF SCIENCES
OF THE REPUBLIC OF KAZAKHSTAN,
SERIES OF GEOLOGY AND TECHNICAL
SCIENCES

5 (479)

September – Oktober 2026

THE JOURNAL WAS FOUNDED IN 1940

PUBLISHED 6 TIMES A YEAR

ALMATY, 2026



Scopus®



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Indexing in Scopus and Web of Science ensures high international visibility of publications, promotes citation growth, and reflects the editorial board's commitment to publishing relevant, original, and scientifically significant research in the fields of geology and technical sciences.

«Қазақстан Республикасы Ұлттық ғылым академиясының Хабарлары. Геология және техникалық ғылымдар сериясы» ғылыми журналы 2016 жылдан бастап халықаралық реферативтік және ғылымиметриялық Scopus дерекқорында индекстеледі және тұрақты библиометриялық көрсеткіштерді көрсетіп келеді.

Сонымен қатар журнал Web of Science платформасының (Clarivate Analytics, 2018) халықаралық реферативтік және наукометриялық дерекқоры Emerging Sources Citation Index (ESCI) тізіміне енгізілген.

ESCI дерекқорында индекстелуі журналдың халықаралық ғылыми рецензиялау талаптары мен редакциялық этика стандарттарына сәйкестігін растайды, сондай-ақ Clarivate Analytics компаниясы тарапынан басылмды Science Citation Index Expanded (SCIE), Social Sciences Citation Index (SSCI) және Arts & Humanities Citation Index (AHCI) дерекқорларына енгізу қарастырылуда.

Scopus және Web of Science дерекқорларында индекстелуі жарияланымдардың халықаралық деңгейде жоғары сұранысқа ие болуын қамтамасыз етеді, олардың дәйексөз алу көрсеткіштерінің артуына ықпал етеді және редакциялық алқаның геология мен техникалық ғылымдар саласындағы өзекті, бірегей және ғылыми тұрғыдан маңызды зерттеулерді жариялауға ұмтылысын айқындайды.

Научный журнал «News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences» с 2016 года индексируется в международной реферативной и наукометрической базе данных Scopus и демонстрирует стабильные библиометрические показатели.

Журнал также включён в международную реферативную и наукометрическую базу данных Emerging Sources Citation Index (ESCI) платформы Web of Science (Clarivate Analytics, 2018).

Индексирование в ESCI подтверждает соответствие журнала международным стандартам научного рецензирования и редакционной этики, а также рассматривается компанией Clarivate Analytics в рамках дальнейшего включения издания в Science Citation Index Expanded (SCIE), Social Sciences Citation Index (SSCI) и Arts & Humanities Citation Index (AHCI).

Индексирование в Scopus и Web of Science обеспечивает высокую международную востребованность публикаций, способствует росту цитируемости и подтверждает стремление редакционной коллегии публиковать актуальные, оригинальные и научно значимые исследования в области геологии и технических наук.

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News of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technology sciences.

ISSN 2518-170X (Online),

ISSN 2224-5278 (Print)

Owner: «Central Asian Academic Research Center» LLP (Almaty).

The certificate of registration of a periodical printed publication in the Committee of information of the Ministry of Information and Communications of the Republic of Kazakhstan № KZ50VPY00121155, issued on 05.06.2025
Thematic scope: *geology, hydrogeology, geography, mining and chemical technologies of oil, gas and metals*
Periodicity: 6 times a year.

<http://www.geolog-technical.kz/index.php/en/>

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News of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technology sciences.

ISSN 2518-170X (Online),

ISSN 2224-5278 (Print)

Меншіктеуші: «Орталық Азия академиялық ғылыми орталығы» ЖШС (Алматы қ.).

Қазақстан Республикасының Ақпарат және коммуникациялар министрлігінің Ақпарат комитетінде 05.06.2025 ж. берілген № KZ50VPY00121155 мерзімдік басылым тіркеуіне қойылу туралы куәлік. Тақырыптық бағыты: *геология, гидрогеология, география, тау-кен ісі, мұнай, газ және металдардың химиялық технологиялары*

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News of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technology sciences.

ISSN 2518-170X (Online),

ISSN 2224-5278 (Print)

Собственник: ТОО «Центрально-Азиатский академический научный центр» (г. Алматы).

Свидетельство о постановке на учет периодического печатного издания в Комитете информации Министерства информации и коммуникаций и Республики Казахстан № KZ50VPY00121155, выданное 05.06.2025 г.

Тематическая направленность: *геология, гидрогеология, география, горное дело и химические технологии нефти, газа и металлов*

Периодичность: 6 раз в год.

<http://www.geolog-technical.kz/index.php/en/>

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NEWS OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC
OF KAZAKHSTAN, SERIES OF GEOLOGY AND TECHNICAL SCIENCES
ISSN 2224-5278
Volume 5.
Number 479 (2026), 325–339

<https://doi.org/10.32014/2026.2518-170X.706>

UDC: 665.6/7, 543.51

IRSTI: 61.51.03

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RESEARCH OF THE FRACTIONAL COMPOSITION OF OIL BY SPECTROSCOPIC METHOD

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Abstract. Relevance. The relevance of the work is due to the global change in the energy market and the tightening of environmental standards, which requires a strategic understanding of the composition of hydrocarbon raw materials. **Objective.** The purpose of the study is to determine the individual molecular composition of oil to optimize oil refining processes. **Methods.** A comprehensive analytical approach was employed, including laboratory distillation under atmospheric pressure followed by analysis of the resulting gasoline (40-170 °C), kerosene (170-240 °C), and light diesel (240-280 °C) fractions using gas chromatography-mass spectrometry (GC-MS) on the Agilent 7890A / 5975C Inert XL GC-MS system with an HP-5MS capillary column. The study revealed that

the research crude oil belongs to the paraffin-naphthene type with a high content of aromatic hydrocarbons (methane-naphthalene-aromatic). The gasoline fraction is enriched with cycloalkanes and aromatic hydrocarbons (xylenes, ethylbenzene), which indicates its potential as feedstock for catalytic reforming or a source of BTF fraction. The kerosene and diesel fractions contain significant amounts of naphthalene derivatives, eicosanes, and sulfur-containing dibenzothiophenes. The presence of marker isoprenoids (prisane, phitane, and pharene) confirms the natural origin of the raw material. Based on the data obtained, an optimal processing scheme is proposed, including hydrotreating of heavy distillates to remove dibenzothiophenes (using reforming gas to compensate for hydrogen requirements) and catalytic deparaffinization to improve the low-temperature properties of diesel fuel. *Conclusions.* The results of the study are of practical importance for refineries, allowing to adjust technological schemes, including hydrotreatment from sulfur compounds of the dibenzothiophene series and the use of excess reforming hydrogen for the purification processes of heavy distillates.

Keywords: oil, fractional composition, mass spectroscopy, kerosene fraction, gasoline fraction, diesel fraction

For citations: Oralova A.T., Tsheskovskaya Ye.A., Tsoy N.K., Matonin V.V., Timoshenko P.S. Research on the Fractional Composition of Oil by Spectroscopic Methods. *News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences.* 2026. No.5. Pp. 325–339. DOI: <https://doi.org/10.32014/2026.2518-170X.706>

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МҰНАЙДЫҢ ФРАКЦИЯЛЫҚ ҚҰРАМЫН МАСС- СПЕКТРОСКОПИЯЛЫҚ ӘДІСПЕН ЗЕРТТЕУ

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Аннотация. *Өзектілігі.* Жұмыстың өзектілігі энергетикалық нарықтың жаһандық өзгеруіне және экологиялық стандарттардың қатаңдатылуына байланысты, бұл көмірсутек шикізатының құрамын стратегиялық түсінуді талап етеді. *Мақсаты.* Зерттеудің мақсаты - мұнай өңдеу процестерін оңтайландыру үшін мұнайдың жеке молекулалық құрамын анықтау. *Әдістері.* Зерттеуде кешенді аналитикалық тәсіл қолданылды, оның ішінде атмосфералық қысымдағы зертханалық айдау, содан кейін алынған бензинді (40-170 °C), керосинді (170-240 °C) және жеңіл дизельді (240-280 °C) фракцияларды талдау, HP-5MS капиллярлық бағанасы бар Agilent 7890A/5975C Inert XL хроматография-масс-спектрометрия жүйесінде газ хроматографиясы-масс-спектрометриясын (GC-MS) қолдану арқылы талдау жүргізілді. Шикі мұнайдың құрамында хош иісті көмірсутектердің (метан-нафтен-ароматты) жоғары құрамы бар парафин-нафтен типті екені анықталды. Бензин фракциясы циклоалкандар мен хош иісті көмірсутектерге (ксилолдар, этилбензол) байытылған, бұл оның каталитикалық риформинг үшін шикізат немесе ВТХ фракциясының көзі ретіндегі әлеуетін анықтайды. Керосин және дизель фракцияларында нафталин туындыларының, эйкозандардың және күкірт құрамдас дибензотиофендердің айтарлықтай мөлшері бар. Маркерлік изопреноидтардың (пристан, фитан, фаресан) болуы шикізаттың табиғи шығу тегін растайды. Алынған деректерге сүйене отырып, дибензотиофендерді кетіру үшін ауыр дистилляттарды гидротазалауды (сутегі балансының талаптарын өтеу үшін сутегі бар риформинг газын пайдалану) және дизель отынының төмен температуралық қасиеттерін жақсарту үшін каталитикалық парафинсіздендіруді қамтитын оңтайлы өңдеу схемасы ұсынылды. *Қорытындылар.* Зерттеу нәтижелері дибензотиофен қатарының күкіртті қосылыстарынан гидротазартуды және ауыр дистилляттарды тазарту процестері үшін артық риформинг сутегін пайдалануды қоса алғанда, технологиялық схемаларды түзетуге мүмкіндік беретін МӨЗ үшін практикалық маңызы бар.

Түйін сөздер: мұнай, фракциялық құрамы, масс-спектроскопия, керосин фракциясы, бензин фракциясы, дизель фракциясы

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ИССЛЕДОВАНИЕ ФРАКЦИОННОГО СОСТАВА НЕФТИ МАСС-СПЕКТРОСКОПИЧЕСКИМ МЕТОДОМ

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Аннотация. *Актуальность.* В условиях трансформации мирового энергетического рынка и ужесточения экологических требований особую значимость приобретает детальное исследование химического и фракционного состава нефти, необходимое для совершенствования технологических процессов ее переработки. Определение индивидуального состава углеводородов и идентификация серосодержащих соединений позволяют оценить потенциальные направления использования нефтяных фракций, обосновать выбор технологических процессов и повысить эффективность получения товарных нефтепродуктов. *Цель.* Исследовать индивидуальный молекулярный состав бензиновой, керосиновой и легкой дизельной фракций нефти методом газовой хромато-масс-спектрометрии для оценки их технологических характеристик и определения перспективных направлений дальнейшей переработки. *Методы.* В исследовании применен комплексный аналитический подход, включающий лабораторную перегонку нефти при атмосферном давлении с последующим анализом полученных фракций: бензиновой (40–170 °С), керосиновой (170–240 °С) и легкой дизельной (240–280 °С). Определение компонентного состава осуществлялось методом газовой хромато-масс-спектрометрии (ГХ-МС) с использованием хромато-масс-спектрометрического комплекса Agilent 7890A/5975C Inert XL, оснащенного

капиллярной колонкой HP-5MS. *Результаты.* Установлено, что исследуемая нефть характеризуется преимущественно парафино-нафтеновым составом с присутствием значительной доли ароматических углеводородов. Бензиновая фракция обогащена циклоалканами и ароматическими соединениями, включая ксилолы и этилбензол, что свидетельствует о перспективности ее использования в качестве сырья для каталитического риформинга или выделения бензол-толуол-ксилольных компонентов. В керосиновой и легкой дизельной фракциях идентифицированы производные нафталина, эйкозановые углеводороды и серосодержащие соединения, в том числе дибензотиофены. Обнаружение изопреноидных углеводородов, включая пристан и фитан, соответствует характерным особенностям нефтяного сырья. На основе полученных аналитических данных предложены направления совершенствования технологической схемы переработки нефти, предусматривающие гидроочистку тяжелых дистиллятов от серосодержащих соединений и каталитическую депарафинизацию для улучшения низкотемпературных характеристик дизельного топлива. Рассмотрена возможность использования водородсодержащего газа каталитического риформинга в процессах гидроочистки с учетом потребностей водородного баланса нефтеперерабатывающего производства. *Выводы.* Результаты исследования подтверждают практическую значимость газовой хромато-масс-спектрометрии для изучения компонентного состава нефтяных фракций и предварительной оценки направлений их технологической переработки. Выявленные особенности распределения углеводородных и серосодержащих соединений могут использоваться при выборе процессов каталитического риформинга, гидроочистки и депарафинизации. Предложенные технологические решения представляют интерес для нефтеперерабатывающих предприятий, однако их эффективность требует дополнительного подтверждения расчетами материального и водородного балансов, а также оценкой технологических параметров соответствующих процессов.

Ключевые слова: нефть, фракционный состав, масс-спектрокопия, керосиновая фракция, бензиновая фракция, дизельная фракция

Introduction. The aim of this work is to study the component composition of oil fractions using mass spectrometry and to develop recommendations on possible directions of oil refining processes.

Objectives of the work: substantiation of the most effective method for studying fractional composition; study of fractional composition of oil and development of recommendations on methods of their processing and use, taking into account environmental initiatives.

Studying the fractional composition of oil is the foundation of petrochemical science and a key element in optimizing production cycles. In the context of global

energy market transformation and tightening environmental standards, a deeper understanding of the molecular composition of hydrocarbon feedstocks is acquiring strategic importance (Haijun et al., 2022). According to research (Bodykov et al., 2018), innovative approaches to oil refining in Kazakhstan and other countries today focus not only on the yield of light products but also on reducing environmental impact through detailed monitoring of feedstock components. The object of this study is oil classified as light based on its properties. According to a comparative analysis (Farhan et al., 2021), it is these light oils from the western regions of Kazakhstan that have the best potential for deep processing with a minimum yield of residual products (fuel oil and tar). The density of the sample is 0.82–0.85 g/cm³ allows it to be classified as a high-quality raw material suitable for obtaining the maximum amount of motor fuels. The chemical composition is represented by a mixture of paraffin, naphthenic and aromatic hydrocarbons. An important characteristic is the content of sulfur-containing compounds and the tendency to form paraffin deposits. As noted by (Boranbayeva et al., 2025; Nurgaliyeva et al., 2026; Patel, 2024), the high concentration of solid paraffins in Kazakh oils requires special control of temperature conditions during transportation and primary distillation to avoid a decrease in equipment efficiency. The physical properties of the studied oil are determined by its low viscosity, which significantly simplifies the production and transportation processes. Knowing the precise fractional composition and density allows not only to predict the yield of target products but also to adjust refinery process flow charts. This ensures the rational use of natural resources and the competitiveness of domestic petroleum products in the international market.

Analysis of methods for studying the fractional composition of oil is an important step in obtaining a complete picture of its composition and characteristics. As noted (Elbanna et al., 2024), understanding the composition of oil at the molecular level allows us to predict its behavior during refining. There are several main methods that are widely used in this area and provide various information about the composition and properties of oil:

Distillation analysis: This method is based on the physical separation of oil components based on their boiling points. Distillation allows for the extraction of various fractions of oil, from light gases to heavy fractions. Analysis of the resulting fractions allows us to determine their composition and properties. Classical distillation analysis according remains the primary method for determining fraction yields. However, modern laboratories are increasingly turning to gas chromatography. The "simulated distillation" method replaces cumbersome distillation with rapid chromatographic analysis, ensuring accurate distribution of hydrocarbons from C₅ to C₁₀₀.

For a thorough analysis of complex mixtures, it is not enough to know the boiling point; it is necessary to understand the structure of the molecules. Mass spectrometry allows for the identification and quantification of oil components

based on their mass and molecular structure. Mass spectrometry is often used in conjunction with gas chromatography (Engelmann de Oliveira Garcia et al., 2021) to analyze complex hydrocarbon mixtures. The work (Ming Xie et al., 2023) emphasizes that the use of ultra-high-resolution mass spectroscopy allows the identification of tens of thousands of individual compounds in heavy residues, which is impossible using other methods.

Nuclear magnetic resonance allows us to study the molecular structure and dynamics of oil molecules based on their interaction with a magnetic field. NMR provides information about specific chemical bonds and molecular conformations. According to research (Ming Xie et al., 2023), H and C₁₃ nuclear magnetic resonance is the most optimal for determining aromaticity and the degree of chain branching, which is critical for reforming and cracking processes.

Infrared spectroscopy allows us to analyze the interaction of oil molecules with infrared radiation, which provides insight into the characteristics of functional groups and chemical bonds in the sample. Also, infrared spectroscopy serves as an operational control tool (Ozhigina et al., 2016, Yugay et al., 2021, Razakova et al., 2020; Tyan et al., 2025).

Each of these methods has its own advantages and limitations, and they are often combined to obtain the most complete information on the fractional composition and properties of oil. For example, the Fourier transform infrared (FTIR) method is indispensable for the rapid detection of polar groups (oxidized compounds, sulfoxides), which allows one to assess the degree of oil degradation or the content of heteroatomic impurities in it. The exact choice of method depends on the specific goals: from operational quality control at oil refineries to fundamental research into the genesis of oil.

Materials and Methods. The oil field under study is located in the border area between Kazakhstan and Russia. The fractional composition of the oil was studied by collecting oil samples at the field and then analyzing their chemical composition. Distillation separation of the oil and mass spectroscopy were used to determine the composition of the various fractions.

Sampling was carried out using a metal portable sampler. Next, the analyzed oil sample was subjected to a distillation process at atmospheric pressure in a specially equipped unit, which included the following main components: a distillation flask, a refrigerator and cooling bath, an electric heating element, and a glass mercury thermometer.

As a result of laboratory distillation of oil at atmospheric pressure, three main product fractions were obtained:

- gasoline fraction at 40-170° C;
- kerosene fraction at 170-240° C;
- fraction of light diesel fuel at 240° C to 280° C.

Each fraction of petroleum distillate products was specially prepared before analysis. This included extraction and sample purification processes to remove

potential impurities and contaminants that could interfere with the analytical results.

A 5975 Inert XL mass-selective detector was used to analyze the obtained fractions. Mass spectrometers in this series are widely used to analyze complex mixtures of substances in various fields, such as chemical analysis, pharmaceuticals, ecology, and other scientific research requiring high sensitivity and accuracy in the analysis of chemical compounds.

The qualitative and quantitative composition of the obtained fractions was analyzed by gas chromatography-mass spectrometry (GC-MS) on a chromatograph-mass spectrometric system consisting of an Agilent 7890A gas chromatograph coupled with an Agilent 5975C Inert XL MSD mass-selective detector (Agilent Technologies, USA). Hydrocarbons were separated on an HP-5MS quartz capillary column (length 30 m, internal diameter 0.25 mm, stationary phase thickness 0.25 μm ; 5% phenyl, 95% dimethylpolysiloxane).

Chromatographic separation conditions:

- carrier gas: high-purity helium (99.999%), column flow rate — 1.0 ml/min (constant flow rate).

- injector temperature: 280 °C.

- sample injection mode: with a split ratio of 1:50. The injected sample volume is 1.0 μl . Thermostat temperature program:

- for the gasoline fraction: isotherm at 40 °C (5 min), then heating at a rate of 5 °C/min to 200 °C (hold for 2 min).

- for the kerosene and diesel fractions: initial temperature 50 °C (hold for 2 min), heating at a rate of 6 °C/min to 300 °C (hold for 10 min).

Mass spectrometry is one of the most rapidly developing and effective methods for the analysis and structure determination of individual organic, synthetic, and natural compounds and their mixtures (Marshall, Rodgers, 2004). Due to its extremely high sensitivity, information content, and reliability, and the ability to be used in combination with gas and liquid high-performance chromatography, the method is widely used in organic chemistry, polymer chemistry, medicinal chemistry, petrochemistry, pharmacology, toxicology, environmental protection, forensics, industrial control, and other fields.

The resulting mass spectra were analyzed using specialized software that allows the molecular masses and structures of chemical compounds to be determined based on the obtained data.

Chemical compounds were identified by comparing their mass spectra and retention times (RT) with data from the NIST14 and Wiley 9th Edition electronic mass spectral libraries. Particular attention was paid to identifying positional and structural isomers of alkanes, cycloalkanes, and arenes with similar electron impact mass spectra. The high selectivity of chromatographic separation on an HP-5MS capillary column, combined with strict retention time (RT) control and comparison of linear retention indices (RI) with the library database, enabled

reliable differentiation of isomeric structures. A compound was considered identified if the mass spectral match (Qual) was at least 80%. Quantitative calculation of the relative component contents was performed by normalizing the chromatographic peak areas.

Results and Discussions. The obtained oil fractions were analyzed using mass spectrometry.

Tables 1–3 present the main (major) components of each of the studied fractions, which have individual peak areas above the threshold level and are characterized by high reliability of the library search (Qual > 80). The remainder of the chromatogram area (unspecified % area) is represented by a collection of numerous trace/minor hydrocarbons (individual content of each less than 0.1–0.3%), peaks with low identification confidence (Qual < 80), as well as an unresolved mixture of complex hydrocarbons (UCM). Table 1 presents the results of the gasoline fraction analysis.

Table 1. Results of gasoline fraction analysis.

RT	Area %	Library/ID	Qual
Alkanes (paraffins) and isoalkanes			
3.1334	0.4945	Heptane	91
3.8485	1.2320	Heptane, 2-methyl-	94
6.4670	2.8722	Octane, 2,6-dimethyl-	80
5.3888	1.6835	Octane, 3-methyl-	90
8.8544	0.5970	Decane, 2-methyl-	83
Cycloalkanes (naphthenes)			
4.0576	1.0783	Cyclohexane, 1,3-dimethyl-, cis-	91
4.1786	0.1340	Cyclohexane, 1,1-dimethyl-	83
4.4206	0.1319	Cyclohexane, 1,3-dimethyl-, trans-	91
4.9047	1.4929	Cyclohexane, 1,1,3-trimethyl-	90
5.1467	0.3514	Cyclohexane, 1,2,4-trimethyl-, (1.alpha.,2.beta.,4.beta.)-	87
5.5208	0.1943	Cyclohexane, 1,2,4-trimethyl-	93
6.0379	0.4397	1-Ethyl-3-methylcyclohexane (c,t)	81
Aromatic hydrocarbons (arenes)			
3.7715	0.7413	Toluene	91
5.0807	1.6317	Ethylbenzene	90
5.2127	3.0049	Benzene, 1,3-dimethyl-	97
5.5978	1.2837	o-Xylene	95
6.7860	0.9153	Benzene, 1,3,5-trimethyl-	91
7.3911	4.3288	Benzene, 1-ethyl-2-methyl-	87
9.7566	0.7139	Benzene, 1,2,4,5-tetramethyl-	93

Appendix: RT is the retention time of the substance on the HP-5MS capillary column (min); Area %—relative area of the chromatographic peak (%); Library/ID is the name of the connection according to the NIST/Wiley library; Qual is reliability coefficient for matching the mass spectrum and retention index (%). The separation of isomers was confirmed by chromatography.

Analysis of gasoline fraction data allows us to evaluate the qualitative and quantitative composition of hydrocarbons and other components in a gasoline sample.

The main components of the gasoline fraction and their percentage content:

- Benzene, 1-ethyl-2-methyl - 4.3288;
- Benzene, 1,3-dimethyl - 3.0049;
- Octane, 2,6-dimethyl - 2.8722;
- Octane, 3-methyl - 1.6835;
- Ethylbenzene - 1.6317.

These compounds make up a significant portion of the fraction and can influence the physicochemical properties of gasoline, such as antiknock properties (octane number), fractional composition (volatility) and chemical stability."

The gasoline fraction contains a variety of hydrocarbons, including alkanes and isoalkanes, cycloalkanes, and arenes. The presence of dimethyl-substituted alkanes and aromatic hydrocarbons indicates the gasoline's potential as a high-octane fuel. The low content of light C5–C6 alkanes indicates that this fraction is a "heavy naphtha."

The kerosene fraction was then studied. The results are presented in Table 2.

Table 2. Results of the analysis of the kerosene fraction.

RT	Area %	Library/ID	Qual
Alkanes and isoalkanes			
11.6379	3.0944	Undecane, 2,6-dimethyl-	82
17.7990	0.3951	Undecane, 3,6-dimethyl-	80
16.3908	9.5558	Pentadecane	90
18.7342	0.7553	Hexadecane, 2-methyl-	86
Mothballs			
12.3750	0.3036	Naphthalene, 1,2,3,4-tetrahydro-6-methyl-	81
12.8481	1.7099	Naphthalene, 1-methyl-	93
14.9825	1.1558	Naphthalene, 2,3-dimethyl-	98
15.0375	1.1409	Naphthalene, 2,6-dimethyl-	98
16.5998	5.3495	Naphthalene, 1,6,7-trimethyl-	98
Cycloalkanes			
11.9350	0.6671	Cyclohexane, 2-butyl-1,1,3-trimethyl-	90

The identification quality of most compounds is high (Qual > 80), which indicates sufficient reliability of the analysis results.

The main components of kerosene are (%):

- Pentadecane - 9.5558;
- Naphthalene, 1,6,7-trimethyl - 5.3495;
- Undecane, 2,6-dimethyl - 3.0944;
- Naphthalene, 1-methyl - 1.7099;
- Naphthalene, 2,3-dimethyl - 1.1558.

The kerosene fraction is composed primarily of normal and branched alkanes of the C11–C16 range, as well as naphthalene derivatives. This hydrocarbon composition ensures high specific heat of combustion and flame stability, which is a critical requirement for civil and military aviation fuels.

Diesel fraction is another important component of crude oil obtained during refining. It typically contains heavier hydrocarbons than gasoline and has a higher boiling point. Diesel fraction analysis data are presented in Table 3.

Table 3. Results of diesel fraction analysis.

RT	Area Pct	Library/ID	Qual
Saturated hydrocarbons (paraffins)			
18.6461	3.8135	Pentadecane, 2,6,10-trimethyl-	90
19.4603	5.1441	Pentadecane, 2,6,10,14-tetramethyl-	90
16.3797	5.7822	Pentadecane	93
14.4654	0.6742	Dodecane, 2,7,10-trimethyl-	80
17.8870	6.9120	iso-Heptadecane (or 2-methylhexadecane)	90
19.3173	8.5165	iso-Heptadecane (or 3-methylhexadecane)	94
20.6705	8.0175	Heptadecane	90
20.8575	3.6914	Hexadecane, 2,6,10,14-tetramethyl-	95
21.4956 – 23.9271	2.03	Isomers of octadecane (C18)	86
23.1789 – 26.5345	11:26	Eicosane isomers (iso-C20)	91
27.5687 – 30.4402	2.40	n-Eicosane (n-C20)	91
Aromatic compounds			
14.9715	0.4622	Naphthalene, 2,3-dimethyl-	97
15.0375	0.4491	Naphthalene, 2,6-dimethyl-	98
16.6768	0.3936	Naphthalene, 2,3,6-trimethyl-	97
16.7648 – 17.2709	3.19	Trimethylnaphthalene isomers	98
17.0618	0.6809	Naphthalene, 1,4,6-trimethyl-	97
19.9113	0.4737	Dibenzothiophene	91
22.8489	0.6287	1,7-Dimethyldibenzothiophene	94

Most components were identified with high quality (Qual > 80), which indicates sufficient reliability of the analysis results.

The main components of kerosene are (%):

- Eicosane isomers (iso-C20) - 11.26;
- iso-Heptadecane (or 3-methylhexadecane) - 8.5165;
- Heptadecane - 8.0175;
- iso-Heptadecane (or 2-methylhexadecane) - 6.9120;
- Pentadecane - 5.7822.

The n-alkanes (normal paraffins) present in the studied oil provide a high cetane number, isoprenoids improve low-temperature properties (prevent rapid solidification), arenes increase density and lubricating ability, but reduce the cetane number, dibenzothiophene and 1,7-dimethyldibenzothiophene reduce environmental friendliness; they determine the need for hydrotreating (Burov et al., 2020).

The diesel fraction studied is characterized by a predominance of C15–C20 alkanes and methyl-substituted naphthalenes. The presence of marker isoprenoids (pristane, phytane, and faresan) confirms the natural origin of the feedstock. The main technological challenges are the high concentration of high-molecular-weight paraffins (eicosanes) and difficult-to-remove organosulfur compounds (dimethyl dibenzothiophenes) (Schmitz et al., 2004).

In terms of fractional composition, the crude oil under study is closest to ESPO grade or light Urals grades. It has good potential for yielding light petroleum products (gasoline + kerosene + diesel). The total yield of light fractions can exceed 50%, which is typical for high-quality light crude oils.

In terms of chemical composition, the presence of xylene and toluene makes the analyzed crude oil similar to Urals crude, which is traditionally rich in aromatics, which is beneficial for petrochemicals. The detection of pristane and phytane in the diesel fraction indicates that the analyzed crude oil is of organic origin (sapropelic type). In terms of diesel composition, it is closer to ESPO, as it contains moderate amounts of naphthenes and sulfur compounds (dibenzothiophenes).

Thus, the crude oil under study is a middle distillate. It produces good yields of kerosene and diesel, which are currently in high demand on the market. The presence of sulfur compounds (dibenzothiophenes) places it on par with Urals crude oil. Unlike Brent crude (Speight JG 2015), it requires a sophisticated hydrotreating system. The presence of aromatic hydrocarbons in the gasoline fraction (C8-C9) allows for the production of high-octane fuel with lower reforming catalyst costs.

Conclusion. Gas chromatography-mass spectrometry (GC-MS) analysis using an HP-5MS chromatographic column and an Agilent 5975C Inert XL mass-selective detector ensures high sensitivity and accuracy in determining the chemical and isomeric composition of petroleum fractions. Based on the GC-MS analysis of all three distillate fractions, the studied oil belongs to the paraffin-naphthene type with a high content of aromatic hydrocarbons (methane-naphthene-aromatic

type). Light distillates (gasoline fraction) are characterized by a low content of light C5-C6 alkanes (which classifies the fraction as "heavy naphtha"), the absence of organosulfur compounds and a high content of cycloalkanes and C8-C9 arenes; the middle fraction (kerosene) is enriched with alkylnaphthalenes, and the heavy fraction (diesel) is enriched with high concentrations of n- and iso-paraffins C15-C20 with the presence of difficult-to-remove organosulfur compounds of the dibenzothiophene series.

Based on the analysis of the composition of these fractions, recommendations can be made for their further industrial processing and most efficient use.

The gasoline fraction is an optimal raw material for catalytic reforming due to the high content of cycloalkanes (methyl and ethylcyclohexanes) in order to obtain high-octane components of commercial gasolines (AI-95, AI-98, Euro-5/6 class) or the separation of individual aromatic hydrocarbons (BTX (*gasoline, toluene, xylenes-fractions*)) (Sihlovec et al., 2026).

The kerosene fraction is "heavy" and contains high levels of C14-C16 paraffins. This fraction is suitable for the production of jet fuel, provided the boiling point is strictly controlled (to avoid excess pentadecane) and the dearomatization process is performed. The high methylnaphthalene content makes this distillate a valuable feedstock for producing high-energy-density fuels required for special-purpose equipment. Technological requirements may include improving the crystallization temperature to meet, for example, the TC-1 (Jet A-1) grade, hydrotreating under mild conditions, and blending with lighter fractions.

As mentioned above, the main technological challenges in processing diesel fractions are the high concentration of high-molecular-weight paraffins (eicosanes) and difficult-to-remove organosulfur compounds (dimethyl dibenzothiophenes). Recommended application: producing the base component of premium summer diesel fuel after hydrotreating on Ni-Mo catalysts. Catalytic dewaxing (isomerization) can also be used to convert n-paraffins to iso-paraffins, which lower the pour point from +5°C to -35°C, enabling the production of winter diesel fuel.

The proposed process chain enables maximum refining depth for this type of crude oil.

The proposed processing schemes ensure maximum refining depth for this type of crude oil. The high potential of the gasoline fraction for catalytic reforming yields significant volumes of hydrogen-rich gas (HRG), which serves as a valuable internal resource to offset the hydrogen demand of the kerosene and diesel hydrotreating units. This reduces the specific cost of hydrogen generation within the overall refinery configuration, although the final hydrogen balance must be integrated into a plant-wide accounting scheme for all hydroprocessing units.

The primary development vector for this type of feedstock is petrochemical production (aromatic hydrocarbon production) and the production of high-quality winter fuels, provided that catalytic isomerization processes for heavy paraffins are implemented.

As a result, the oil will be of higher quality, and the sludge can be used as a secondary resource. This will reduce the impact on the environment, particularly on soils (Tsoy et al., 2024).

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ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)**

Managing Editor: *T. Apendiyev*
Editors: *D.S. Alenov, A.Shormakova*
Computer layout: *G.D. Zhadyranova*

Signed for print: Oktober 14, 2026
Format: 70×90 1/16. 26.5 printed sheets. Order No. 5.

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