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GROZNY RESEARCH INSTITUTE AS THE INDUSTRIAL INTEGRATED SCIENTIFIC INSTITUTION IN THE WORLD

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Abstract

The article describes prerequisites for the creation of Grozny Research Institute as a research center for the comprehensive study of oil (geology, drilling, production and refining). Grozny Oil Research Institute is one of the first and oldest institutes of the oil refining industry in the former USSR and in the world. It had a difficult path of development from a factory laboratory to the largest research institute of Russia, which determined the technical progress of the Soviet oil refining industry. The article analyzes the stages of development of Grozny Oil Research Institute in 1928–1965, provides a brief overview of studies conducted in this period, shows its contribution to the development of oil research, the development and improvement of oil refining and petrochemical processes, the production of zeolites and adsorbents, the creation and design of new oil refineries. The article shows that Grozny institute was a pioneer in many areas of oil research: oil emulsions, classification of oils, development of scientific foundations of thermal cracking, catalytic cracking, contact coking, development of processes for the production of residual oils.

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Keywords: Grozny, industrial integration, oil studies, research institute



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1. Introduction

Since the middle of the 19th century, during the transition from the well prospecting and extracting method to the borehole one, many problems associated with the lack of theoretical foundations for exploration, oil field development, oil drilling and oil and gas processing have arisen.

A number of Russian scientists and mining engineers have made a huge contribution to the development of foundations of oil and gas geology, production and rational use of oil in the Caucasus (see e.g. G.V. Abikh, D.I. Mendeleev, V.V. Markovnikov and others). Using the results of studies of the geological structure and oil and gas content of the Apsheron Peninsula, G.V. Abikh published an extensive work on the origin of oil, migration of hydrocarbons from great depths along cracks (faults), oil-bearing rocks and lithological differences overlying them. Since the beginning of the 1960s, G.V. Abikh has conducted geological surveys in the Tersko-Sunzhenskaya region and Dagestan (Daukaev, 2018).

Mendeleev (1863–1907), known as a great Russian chemist, a creator of the periodic table of elements, made an invaluable contribution to the development of meteorology, oil and gas geology, oil refining, etc. based on the study of the chemical composition of oils, conditions of occurrence, location and accumulation of hydrocarbons. D.I. Mendeleev developed a theory of the inorganic origin of oil. After visiting the oil fields of the Caucasus (including Chechnya) and America, D.I. Mendeleev described the development of the oil and oil refining industry in Russia; he suggested paying attention to the need for oil refining for kerosene and lubricating oils (Daukaev, 2018).

Special contribution was made by V.V. Markovnikov (1837–1904), professor at Moscow University. At the end of the 19th century he studied the composition and properties of Caucasian oils. Having visited Grozny in 1897, he appraised the plant of Vladikavkaz railway, describing it as a plant that has no similar ones in Russia (Kolosov, 1962). The work by V.V. Markovnikov on the Caucasian oils was awarded with a gold medal (Sergienko, 1949). His work contributed to the development of oil research in the chemical laboratories of various oil refineries, including in Grozny.

At the end of the XIX century, one more Mendeleev's student K.V. Kharichkov was asked to equip the plant laboratory in order to develop the chemical processing of Grozny oil and purification of distillates" (Dorogochinsky and Zhavoronkov, 1966). K.V. Kharichkov managed to create the first chemical laboratory in the North Caucasus. The range of issues that the scientist dealt with was extensive. He published over 350 scientific papers on the chemical technology, oil refining and oil and oil products. Most of his studies formed the basis of the national school of petrochemistry (Akhmadova and Musaeva, 2018). K.V. Kharichkov was the first Grozny scientist who received great fame and appreciation for deep research and development of new principles of oil refining (Akhmadova and Makhmudova, 2008). In the center of Grozny, where he lived in 1896–1909, there is a memorial plaque (Dorogochinsky, 1978).

2. Problem Statement

Formation, organizational transformations and development of Grozny RI (1928–1965)

In the first years of nationalization of the oil industry, research was conducted in plant laboratories, united into the Central Laboratory of Grozneft in 1920 and headed by the former manager of the

Vladikavkaz railway refinery I.O. Luchinsky. The central scientific laboratory as part of Grozneft association was created to solve practical problems of oil production (Results of the 1927 study of Grozny oils ...). Researchers of the Central Laboratory I.O. Luchinsky, L.A. Selsky, S.A. Vyshetravsky, I.N. Ackerman made a great contribution to the research activities of the laboratory in the 1920s (Akhmadova and Takaeva, 2017).

Since August 1922, instead of Central large laboratories were founded the "United" (later "Central Laboratory of Factory Management") and "Promyslovaya" ones; in 1923, the latter was transformed into the Grozneft laboratory with a larger number of functions.

By 1925, in order to coordinate the work of laboratories at Grozny factories and fields, it became necessary to combine their activities. On April 1, 1925, the Central Laboratory of Grozneft was founded; it united the laboratories of Grozneft and the Central Plant Office. The new laboratories were managed by A.N. Sakhanov, who said that the first research task should be the determination of oil composition. The role of Sakhanov in the oil studies is crucial. Sakhanov was a student of famous Russian scientists – V.I. Vernadsky and N.D. Zelinsky. The Grozny period of his life fell on 1922–1931. Since 1922 Sakhanov lectured at Grozny Oil Practical Institute; in 1923 he was elected a Vice-Rector. However, his vocation was research activities. In 1924–1925, Sakhanov published a number of articles on asphaltenes, paraffins, resins contained in Grozny oils, and the methods for studding them. The study of asphalt-resin-paraffin substances made it possible to classify them.

Grozny oils and their fractions were studied by Sakhanov at the Central Laboratory of Grozneft. By the end of 1925, the first research results were obtained. They were described in the article by A.N. Sakhanov "Grozny oils", where the properties of "paraffinic", "slightly paraffinic" and "paraffin-free" oils of Grozny region were described (Yevdoshenko, 2011). All the laboratory results were summarized in the monograph "Results of the study of Grozny oils", published in 1927 (Yevdoshenko, 2011). This work showed a high level of research work carried out by the Central Laboratory of Grozneft, was of great importance for the development of oil refining in Grozny and served as the basis for creating Grozny research center.

On the basis of the Central Laboratory in Grozny, the research institute for oil production and oil refining – Grozny RI – was created (Daukaev, 2018; Odintsov, 1981). The Institute was created on September 15, 1928. It was an event of great importance for the North Caucasus and the country. The first director was A.N. Sakhanov (Yevdoshenko, 2011). He created analytical; geological; technological, gas, physical, and field departments, a department for testing building materials, metals and fuel. By January 1, 1930, there were 89 people in Grozny RI, and by the end of the first five-year plan, it had turned into a large scientific institution with 17 sub-departments, united into three large departments: industrial, construction-mechanical, refinery oil refining, and 22 factory laboratories. 355 people, including 151 administrative and technical workers and 128 specialists, worked there (GA CR).

By the order of the USSR Ministry of Oil Industry of May 23, 1952, the institute was divided into Grozny Oil Research Institute for Oil Refining and Grozny Oil Research Institute for Oil Production, which on November 15, 1954 were merged into Grozny RI.

In 1965, on the basis of the structural divisions of Grozny RI dealing with oil and gas geology, drilling wells, development of oil and gas fields, a new institute was created – the North Caucasian Oil

Research Institute which was transformed into the North Caucasian Research and Design Institute of the Oil Industry. The latter was created by the order of the State Committee of the Oil Industry under the State Planning Committee of the USSR dated August 11, 1965. By the order of the Presidium of the Supreme Soviet of the USSR of September 21, 1978, the Grozny RI was awarded the Order of the Red Banner of Labor.

Thus, in 1928-1965, Grozny RI was a complex institute in geology, oil production, oil refining and petrochemistry. IN 1928-1965, it has grown into one of the largest research institutes of the oil industry. The issues studied by Grozny RI covered all areas of the oil industry: geology, oil drilling, oil and gas production and processing.

3. Research Questions

Main research areas and achievements

3.1. Research in oil refining, associated gas and oil chemistry

The most fundamental works of the Grozny RI team were about the development of group and structural-group methods for studying the chemical composition of petroleum products, properties and compositions of oils and hydrocarbon gases of the North Caucasus, Ukraine, Turkmenistan, etc.; clear rectification of gasoline hydrocarbons; modifications of thermal cracking; high-octane components produced by chemical processing of hydrocarbon gases by polymerization of olefins, alkylation of isoparaffinic and aromatic hydrocarbons with olefins, isomerization, etc.; patterns and features of the catalytic cracking process; technologies for producing catalysts for the catalytic cracking process; deep processing of heavy oil residues, including by the method of contact coking; the basic laws of oil-paraffin production and methods for producing raw materials for these processes.

4. Purpose of the Study

Many studies in oil refining, catalytic and thermal processes, chemical processing of hydrocarbon gases and heavy oil residues were carried out for the first time in the USSR.

The activities of Grozny RI can be divided into several periods: the development stage (1928–1930), the pre-war stage (1930–1940), the military stage (1941–1945), and the post-war stage (1946–1965).

In 1928–1930 (the development stage), the research was aimed at solving problems in field geology, chemistry and oil refining, and production of oil fuels (Butorin, 1930). Despite the large scientific backlog, the research activities were little known. Therefore, the institute had to establish ties with industrial enterprises. In addition to research in geology, drilling, and oil refining, there were up to 150 works requiring their permission through research, consultation and control (Palchikov & Dorogochinsky, 1967).

5. Research Methods

In the pre-war period, the institute studied oil and oil products and developed scientific foundations of the thermal cracking process, which was very important for the USSR. The main task was a detailed study of the oils of Grozny region in order to develop a method for their rational processing. The first major work was a comprehensive study of the properties of oils produced in Grozny. The Institute developed methods for studying the properties of oils, including the well-known method for determining the chemical composition of distillates, a general classification of oils and a method for determining the potential content of light oil products.

Grozny RI made a significant contribution to the classification of oils which were divided into six classes. The scientific classification based on the group chemical composition of oil fractions made it possible to choose the most effective methods of oil processing. Later, the American classification of oils was developed, and oil was divided into nine classes. In 1931, Grozny RI published the work "Chemical composition of oil and oil products", which was the first systematized work in this area. This work systematized and expanded the existing methods of analysis, and described the chemical nature of petroleum products.

6. Findings

In-depth studies carried out by the institute to determine the chemical composition, potential content of gasolines and light products made it possible to establish the paraffinic nature of these oils. Proceeding from the country's demand for paraffins and the paraffinic nature of oils, Grozny RI studied the possibility of paraffin plant construction in Grozny. The first paraffin plant was built in Grozny in 1928. Until 1950, this plant was the only one in the country. In the 1950s, Grozny RI developed a new technology for continuous wax production using selective solvents. The extensive work in this area was summarized in the monograph by A.N. Pereverzeva, N.F. Bogdanov and Yu.N. Roshchina "Production of petroleum paraffins (1973).

In 1930–1940, along with research of Grozny oils and development of clear separation processes (superfine rectification), Grozny RI carried out in-depth studies of the thermal cracking of gasoline fractions. Scientists of the Institute identified the most important regularities of the thermal cracking process, studied the issues of chemistry and technology of the process. Based on the research, Grozny scientists were the first to substantiate the types of cracking processes – light cracking, deep cracking and cracking to coke, liquid phase and vapor phase cracking, cracking for obtaining distillates of diesel fuels, feedstock for catalytic cracking. The main research results were used in the production process. More than 70 % of gasoline produced in the USSR were produced at Grozny cracking plant. The research results were described in a number of articles and the book by A.N. Sakhanov and M.D. Tilicheeva "Cracking in the liquid phase". This unique work summarizes the results of many years of research in thermal cracking and confirms the priority of Grozny residents in developing the scientific foundations of thermal cracking (Sakhanov & Tilicheev, 1928). The workers of the cracking laboratory of Grozny Research Institute have regularly studied, investigated and analyzed the activities of Grozny thermal cracking units (Akhmadova, 2014).

Most of the Soviet thermal cracking units were first built in Grozny, where their work was thoroughly studied. Of 23 foreign-made thermal cracking units, eight ones were built in Grozny.

In 1941–1945, despite the difficult wartime, Grozny RI was engaged in the research of new catalytic processes aimed at the production of aviation fuels necessary for the front. During this period, it developed the process of sulfuric acid alkylation, and the first pilot plant for sulfuric acid alkylation was built from domestic materials by the project developed by Giprorozneft (Sulumov, 2016). The work on the start-up of the sulfuric acid alkylation was performed under the general supervision of A.Z. Dorogochinsky. This installation laid the foundation for the domestic industry of sulfuric acid alkylation; it was the first to study the features of sulfuric acid alkylation on an industrial scale using various types of raw materials. This installation became the main school for training personnel.

In this difficult period, Grozny RI developed the process of catalytic refining of petroleum products using activated clays.

In 1946–1965, the institute developed and implemented many methods: catalytic cracking, improved sulfuric acid alkylation technologies, improved oil preparation technologies for refining and primary oil refining, production of catalysts, oils, etc.

Since 1940, under the leadership of B.K. Amerka, advanced development of catalytic cracking processes began. In 1941, by the decree of the State Defense Committee of the USSR B.K. Amerika was appointed Head of the Department for Research of the Catalytic Cracking Process. For three decades, the institute developed modifications of this process using activated natural clays, granular synthetic catalysts, spherical and microspherical zeolite-containing catalysts. B.K. Amerika was not only the organizer of research work, he took an active part in the design and development of pilot and industrial catalytic cracking units. Thanks to him, the country received various domestic modifications of catalytic cracking units. The first domestic catalytic cracking process and the production process of a bead synthetic aluminosilicate catalyst were developed by Grozny RI. The first pilot industrial catalytic cracking unit was built in 1945 and early 1946 on the territory of plant No. 867. At the beginning of 1946, the unit was installed, and on May 1, 1946, it was put into operation (Odintsov, 1981; Abdulmezhidova, 2007).

The Soviet government appreciated the creators of the catalytic cracking process and awarded them with the title of laureates of the State Prize (Odintsov, 1981).

One of the important achievements of Grozny Research Institute was the method for producing synthetic zeolites. The historical role in the synthesis of zeolites belongs to Mirsky, Mitrofanov, Meged and others (Akhmadova and Khadisova, 2008). In 1958, Mirsky developed a technology for producing effective adsorbents – zeolites. The industrial production of these adsorbents began in 1960 at Grozny cracking plant.

In 1960–1965, technologies implemented by Grozny plants were of great importance for the country: the method for producing fuel was used by the design bureau of Korolyov; dearomatization of solvent gasolines with diethylene glycol in a rotary disc contactor, which replaced the ineffective sulfuric acid cleaning process; electrorefining of petroleum products. Using this technology, 40 units were built. They were launched under the guidance of Grozny RI.

The idea to use associated petroleum gas was proposed by I.N. Strizhov (1872–1953), who worked in the Grozny fields for more than 25 years. Attention was paid to the production of gasoline from gas. Strizhov believed that we must stop burning and losing gasoline and take measures to obtain this gasoline in tanks and turn it into currency (Strizhov, 1926). In Grozny, petroleum gas began to be utilized at the beginning of June 1909 (Odintsov, 1981). In the early 1920s, the specific gravity of gas, the content of gasoline and non-hydrocarbon impurities were determined. The method developed by Strizhov was implemented only in 1923. Absorption and compression gasoline plants were built in Grozny; August 11, 1924 is considered the day of the birth of the gasoline industry in the USSR (Jafarov, 2005). The research results of Grozny scientists contributed to the development of gasoline production. The gasoline plants in Grozny were designed under the guidance of I.N. Ackerman (Yevdoshenko, 2009). Ackerman complained that in our country gas is considered a waste and in most cases it is discharged into the atmosphere (Ackerman, 1924).

Studies of gases were carried out by K.V. Kharichkov in 1903. In the subsequent years up to 1923, there were no data on gas studies in the technical literature (Dorogochinsky, 1947).

Since 1923, research on gases was restarted (Odintsov, 1981; Dorogochinsky, 1947; Bogaevsky, 1927). The main results of studies of oil gases obtained in 1939–1946 were summarized in the monograph by A.Z. Dorogochinsky (Dorogochinsky, 1947). It analyzes gases from the Oktyabrsky, Starogroznensky, Gudermes, Tashkala, Goragorsky, Malgobeksky, exploration areas of Grozny region and gases produced by the thermal cracking method, reforming and direct distillation of oil. In one more fundamental monograph, A.Z. Dorogochinsky (Dorogochinsky and Luther, 1960) presented the results of long-term studies of associated, natural and refinery gases and specified their compositions and properties.

2. Research in geology, drilling and development of oil and gas fields

In the 1940–1950s, researchers of Grozny RI studied the artificial impact on productive strata in order to increase their oil recovery. In 1944, the gas injection was carried out into the layer of the thrust wing and the edge waterflooding.

The researchers created original designs of single-cone bits, whose penetration was three times higher than the penetration of serial three-cone and core bits, providing 100 % core recovery.

Since the creation of the laboratory of regional geology under the leadership of Khutsiev, studies on the geological structure and oil and gas content of the Eastern Ciscaucasia and the Terek-Kuma lowland began. Geologists compiled structural maps. The laboratory conducted the research on the main regularities of the tectonic structure of Grozny region and possible tectonic relationships that favor the formation of oil deposits (Daukaev, 2018).

It was established that there are conditions that are favorable for the formation of oil and gas deposits in the Mesozoic sediments.

This period in the geological research is characterized as follows: "the geologists performed laborious work on drawing up various-scale structural maps, which made it possible to clarify the spatial location of local structures, some issues of deep tectonics, establish the relationship between deposits and carry out tectonic zoning" (Ershov and Tonkonogov, 1971, p. 21).

The laboratory of hydrogeology and geochemistry headed by A.M. Nikanorov conducted research on the resources of iodine and bromine in the groundwaters of Chechnya and Ingushetia. They zoned this

territory by the content of trace elements in the waters, developed ways to study groundwater, and hydrocarbon deposits. For more than 20 years, Nikolaev has been conducting research on underground thermomineral waters of Miocene sediments and their sources. Within the Tersko-Sunzhenskaya oil and gas region, he identified 5 hydrogeochemical zones, differing in the composition of waters, salinity, water dynamics and other parameters (Nikolaev, 1963). He also gave specific recommendations on the prospects for the rational use of thermal waters.

7. Conclusion

The article shows that Grozny RI was a pioneer in many areas of oil research: oil emulsions, classification of oils, development of scientific foundations of thermal cracking, catalytic cracking, contact coking, development of processes for the production of residual oils, creation of thermal cracking units, pilot and industrial catalytic cracking units, installations for the production of catalytic cracking catalysts, production of zeolites and zeolite-containing catalysts, designing of new oil refineries, etc.

Grozny RI has obtained data for the design of new oil refineries. The Institute's developments have been implemented in Angarsk, Omsk, Pavlodar, Donetsk, Yaroslavl, Gorky, Ufa, Salavat, Baku, Guryev, Fergana, Novokuibyshevsk, Volgograd, Kirishi and other cities of the Soviet Union, as well as abroad. This is just a small list of works and achievements in oil refining.

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