

Brief information about the project

Name of the project	AP26197473 «Development of technology for joint thermochemical processing of shale and heavy petroleum products to obtain of motor fuels and chemicals».
Relevance	The proposed project is devoted to the development of a new concept for the joint thermal processing of Kenderlyk oil shale and heavy petroleum products to obtain components of motor fuels and chemicals, according to which the thermal degradation process is carried out without special expensive catalysts and hydrogen and in the absence of special stages of deasphalting and demetallization of heavy petroleum raw materials and with significant desulfurization of liquid products. Oil shales hold a special position among solid fossil fuels both in terms of origin and composition, and in terms of quality of energy and chemical raw materials. They differ from other types of solid fuels in their high content of hydrogen in their organic matter (kerogen). The N/C ratio in their organic mass, reaching in some cases 1.7 (oil 1.9; coal 0.4-0.5), causes high yields of gaseous and liquid products during thermal processing. Therefore, oil shale is considered as a promising source for the production of artificial liquid fuels and raw materials for the chemical industry. Intensification of thermolysis of heavy petroleum residues in order to increase the yield of light distillate products is achieved in the presence of natural activating additives of Kenderlyk shale and in the mode of ultrasound influence. Thermal dissolution of Kenderlyk shale of oil and shale chemical residual fractions is aimed at obtaining thermobitumen used as a rubber plasticizer. Regularities of joint thermolysis of heavy petroleum residues and ordinary Kenderlyk shale in the ratio of 1:1 are the scientific basis of technologies for obtaining light distillate products, which after hydrotreatment can be used as components of motor fuels.
Purpose	The objective of the project is to study the joint thermolysis of Kenderlyk oil shale and heavy petroleum residual fractions in order to develop effective technology and rational ways of processing raw materials into components of motor fuels and special products.
Objectives	1. Develop efficient catalysts and conditions for thermocatalytic hydrogenation of Kenderlyk shale. Determine the main physical and chemical properties of the gasoline and diesel fractions obtained under optimal conditions. Develop a process flow diagram for obtaining motor fuels by hydrogenation. 2. To develop a criterion for obtaining combined liquid fuels and chemical products of joint thermal degradation of heavy petroleum products (residual oil and

	tar) with Kenderlyk shale. Investigate the influence of process parameters on the yield of light fractions. Determine the group hydrocarbon and chemical composition of the obtained liquid products. Develop a process flow diagram for joint thermal degradation. 3. To draw up a material balance of the processes of joint thermal destruction of mechanically activated oil shale from the Kenderlyk deposit and fuel oil in a wide concentration range, followed by an assessment of the quality of the obtained liquid distillate products. 4. Identify the main trends in the detailed chemical composition and yield of light distillate fractions obtained taking into account the effect of ultrasound on the thermochemical degradation of residual oil and tar in the presence of Kenderlyk shale. 5. To develop a process flow diagram for obtaining environmentally friendly components of gasoline and low-sulfur diesel fuel from shale, residual oil shale and tar shale distillates by thermal cracking.
Expected and achieved results	<u>Expected results for 2025 year:</u> The main results of the project will have applied significance. The main results of the project the catalytic activity of natural polymetallic bauxite ores containing compounds of nickel and iron, titanium and iron will be investigated, allowing to achieve more than 90% conversion of the organic mass of shale, contributing to the removal of nitrogen and sulfur from the liquid liquefaction products of the shale of the Kenderlyk deposit and stabilizing the formed low molecular weight fragments without secondary polymerization. A criterion for obtaining a combined liquid product by joint thermal degradation of residual oil shale and tar shale pastes will be developed. The influence of process parameters (temperature, pressure, residual oil/shale and tar/shale ratio) on the yield of light fractions will be studied. The hydrocarbon and chemical composition of the obtained liquid products will be determined. A technique will be developed and the effectiveness of applying ultrasound to a mixture of residual oil and tar with oil shale in the preparation of raw materials will be determined, which allows to increase the yield of total liquid products and the yield of light distillates during thermal degradation in comparison with when there is no influence of ultrasound. Thermocracking of residual oil in the presence of mechanically activated Kenderlyk oil shale in a wide concentration interval will be studied. When implementing the project, the optimal technological parameters of hydrotreatment and the main physical and chemical properties of residual oil shale and tar shale distillates will be determined, including after the extraction of phenols and nitrogenous bases from them. For the practical use of the experimental results of the project, a schematic flow

	chart for the production of gasoline and low-sulfur diesel fuel from shale, residual oil shale and tar shale distillates by thermal degradation will be developed. The main physicochemical and operational properties of motor fuel components will be determined in accordance with the requirements of GOST and the European Union standard. <u>Results Achieved for 2025:</u> In accordance with the expected results of the contract's calendar plan, research was conducted on the hydrogenation of Kenderlyk oil shale and a mixture of shale and fuel oil (mazut) to produce motor fuel components. An assessment of the current state and prospects for applying low-pressure hydrogen hydrogenation for this purpose was also performed. A thermochemical processing of heavy petroleum residues of native and destructive origin (mazut, tar, heavy pyrolysis resins) was conducted in the presence of activating additives (Kenderlyk shale). This process has no international analogues and is carried out at a pressure of 0.5-2 MPa and a temperature of 400-430 °C without the use of hydrogen. A conceptual process flowsheet has been developed for the joint thermal degradation of fuel oil (mazut) with oil shale.
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Usage	Target consumers of the research results (by stakeholder composition): enterprises of the chemical, petrochemical, coal-chemical, and shale-chemical industries in the Republic of Kazakhstan and the CIS. The application of these results can significantly influence the development of science and technology in the field of integrated processing of solid fossil fuels for various industrial applications. Specifically, this includes the production of lightweight and high-strength chemical materials for Kazakhstan, among others. The results

	obtained during project implementation can serve as a scientific basis for the technology of producing rubber plasticizers and light distillate products, which, following hydrotreatment, can be utilized as components for motor fuels.
Priority compared to real-world alternatives	Energy, advanced materials and transportation
List of publications with links to them	Kairbekov Zh.K., Esenaliyeva M.Z., Suimbaeva S.M., Dzheldybaeva I.M., Kairbekov A.A. Study of the process of thermocatalytic hydrogenation of shale from the Kenderlyk deposit // XIV International Russian-Kazakhstan Symposium "Coal Chemistry and Ecology of Kuzbass", October 7-9, 2025. – P. 34.
Patents	-