Brief information about the project

Name of the project	AP14869180 «Development of effective technologies with joint hydrogenation processing of coal and oil shale of the Republic of Kazakhstan for the production of motor fuel components and chemicals» (0122PK00963)
Relevance	Under present-day conditions and in the future, in connection with limited oil reserves (no more than 90 billion tons) and many times more significant coal and oil shale reserves across the globe, including Kazakhstan, Estonia and Russia, the issues of their chemical processing are also becoming important today. Hydrogenation of solid fuels is a universal method of producing liquid products, which, with respect to the organic matter of oil shale (OMOS) and coals (OMC) can be performed under low hydrogen pressure because of their specific structure. The organic matter of oil shale can be used as additives (10-20 %) for coal hydrogenation to initiate its destruction as a result of the higher reactivity of OMOS. This research trend has recently attracted the attention of researchers from Germany, Russia, USA, Japan and other countries. Besides, the OMOS contains a substantial amount of hydrogen - over 9 %, which determines the low hydrogen consumption as compared with coal hydrogenation (hydrogen content of 5-6 %) and more favorable economic parameters of refining.
Purpose	Project goal is to develop high performance technology and scientific and technical solutions for the joint hydrogenation processing of Taldykol coal and Kiyin oil shale (in the presence of nanoheterogeneous nickel sulfide catalysts) and produced coal and shale distillates to produce motor fuel constituents and chemicals.
Objectives	1. Determine the characteristics of coal from the Taldykol deposit, shale from the Kiyin deposit, and oil paste-forming agent. To study the chemical composition and properties, the effect of technological parameters (temperature, pressure, ratio of shale to coal) with a fixed amount of paste-forming agent on the yield of light fractions in the process of hydrogenation of coal from the Taldykol field. Investigate the process of preliminary ozonolysis and the effect of γ-radiation on the process of hydrogenation of Taldykol coal. Study of the formal kinetics and thermodynamics of the processes of hydrogenation processing of Taldykol coal. 2. To determine the effective amount of additives of shale from the Kiyin deposit to coal from the Taldykol deposit for joint hydrogenation in the optimal technological parameters of the process (temperature, pressure, quantity, chemical mechanism of action of a nanoheterogeneous nickel sulfide catalyst synthesized *in situ* from aqueous solutions precursor) when hydrogenating a mixture of coal + shale with the addition of a sulfiding agent - elemental sulfur. 3. To determine the hydrocarbon-type content and chemical composition, sulfur content of the obtained distillate coal and shale fractions with a boiling points up to 180 °C and up to 180-360 °C. To study the chemical composition of initial and dephenolized light distillates with the use of physicochemical methods.

	4. To study the influence of technological parameters of hydrotreatment of coal and shale gasoline and diesel fractions on the degree of removal of heteroatomic and unsaturated compounds, aromatic hydrocarbons in the presence of industrial catalysts. 5. To develop Process Flow Scheme for obtaining motor fuel constituents using the joint hydrogenation of Taldykol coal and oil shale from the Kiyin field. To identify the main physical and chemical and performance properties of obtained motor fuel constituents in accordance with the requirements of the operating standards currently in force.
Expected and achieved results	The effective amounts of additives of the Kiin shale to the coal of the Taldykol deposit for joint hydrogenation in the optimal technological parameters of the process (temperature, pressure, amount, chemical mechanism of action of a nanoheterogeneous nickel sulfide catalyst synthesized in situ from aqueous solutions of a precursor) during hydrogenation of a mixture of coal+shale with additives of a sulfiding agent – elemental sulfur were determined. Based on the results obtained, a conclusion was made about the rather high activity of nickel sulfide catalysts in the process of hydrogenation of coal from the Taldykol deposit. Modification of catalysts with additives of elemental sulfur (0.75-1.25%) allows to increase the yield of liquid products up to 79.0-88.6% compared to the implementation of the process in the presence of unmodified catalysts. The group hydrocarbon and chemical composition, the sulfur content of the obtained distillate coal shale fractions with temperature up to 180°C and 180-360°C were determined. The chemical composition of the initial and phenol-free light distillates was investigated by physical and chemical methods. According to the results of the study, the addition of oil shale to coal allows to carry out under optimal conditions the process of hydrogenolysis of the organic mass of coal with a high degree of transformation to liquid distillate products without coke formation. The degree of transformation of the mixture of the organic mass of shale and coal is much higher than of coal. The influence of technological parameters of hydrotreatment of coal and shale gasoline and diesel fractions on the degree of removal of heteroatomic and unsaturated compounds, aromatic hydrocarbons in the presence of industrial catalysts will be studied. Process Flow Scheme for obtaining motor fuel constituents using the joint hydrogenation of Taldykol coal and oil shale from the Kiyin field will be developed. The main physico-chemical and performance properties of the obtained components of motor fuels with boiling point of 180-360 °C will be determined in accordance with the requirements of GOST R 52368-2005 and the EU standard EN 590-2004 and initial data will be provided for the development of technological regulations of a demonstration plant for the obtaining of motor fuel components from coal distillates using hydrogenation processes.
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List of publications with links to them	1. Kairbekov Zh.K., Dzheldybaeva I.M., Kairbekov A.Zh., Suimbaeva S.M., Moldabaev A. Application of preliminary ozonolysis and gamma radiation to increase the reactivity of coal from the Taldykol deposit during hydrogenation // Proceedings of the VIII International Russian-Kazakh scientific and practical conference "Chemical technologies of functional materials", Almaty, 2022. – P. 211-213 (in Russ). 2. Kairbekov Zh., Suimbaeva S.M., Ermoldina E.T., Dzheldybaeva I.M. The effect of ozonolysis on the depth of catalytic hydrogenation of coal from the Taldykol deposit. Russian-Kazakh Symposium "Coal Chemistry and Ecology of Kuzbass" 2022, Kemerovo, Russia.-P. 20. (in Russ). 3. Zh. Kairbekov, I.M. Dzheldybayeva, S.M. Suimbayeva, A.Zh. Kairbekov. The influence of preliminary ozonation and γ-radiation on the depth of hydrogenation of coal from the Taldykol deposit // Materials of the International Scientific Conference "Promising directions for the development of chemical science, technology and ecology" dedicated to the 75th anniversary of the A.B. Bekturov Institute of Chemical Sciences and the 120th anniversary of Academician of the Academy of Sciences of the Kazakh SSR A.B. Bekturov Almaty, 2022. - P.94-96. (in Russ). 4. Kairbekov Zh.K., Esenalieva M.Z., Suimbaeva S.M., Dzheldybaeva I.M., Kairbekov A.Zh. Joint hydrogenation of Taldykol coal and Kiinsky shale // Proceedings of the IX International Russian-Kazakh scientific and practical conference Novosibirsk, 25-27 May, 2023. - P.53-55. (in Russ). 5. Kairbekov Zh., Sarmurzina R.G., Esenalieva M.Z., Kairbekov A.Zh., Suimbaeva S.M., Dzheldybaeva I.M. Obtaining fuel products by combined hydrogenation of coal and shale. // Kazakhstan journal for oil & gas industry. - 2023. – No5. – P.83-91. (in Eng). DOI: https://doi.org/10.54859/kjogi108656
Patents	-