The prospect of creating of the plant for the production of liquid fuel from coal in territory of Eastern Siberia

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Abstract. In this work the shortage level of oil and gas is considered. Receiving various products from coal, exceeding prime cost of mineral raw materials in tens of times. The prospect of creation of the plant of receiving synthetic fuel from coal in territories of Eastern Siberia.

1. Introduction
Today, about half of all energy produced in the world is generated from oil, including almost all energy for autonomous mobile consumers. But for almost ten years, oil prices have been growing rapidly, and its reserves are growing more slowly, and production is becoming more expensive. Oil is a very valuable natural raw material, but according to the estimates of the World Energy Council experts, the known reserves of oil for mankind can last only about 56 years, gas for 60 years or more, and coal for at least 270 years. Consequently, coal is the most profitable mined and subsequently processed raw material. Coal is the most abundant fossil raw material, the Fischer-Tropsch coal process can find much wider application in the near future, giving not only gasoline, but also gas oil and new generation fuels [1-6].

The Fischer – Tropsch process is a well-developed technology that is already being applied on a large scale, although its proliferation is hindered by high capital costs, high operating and repair costs, and relatively low crude oil prices. In particular, the use of natural gas as a feedstock becomes appropriate when “stranded gas” is used, i.e. sources of natural gas located far from the main cities, which are inexpedient to operate with conventional gas pipelines and LNG technology.

2. Purpose of the Study
In terms of coal production, Russia ranks fifth in the world (after China, the USA, India and Australia), 3/4 of coal mined is used for energy and heat production, 1/4 - in metallurgy and chemical industry. A small part is exported, mainly to Japan and the Republic of Korea [2, 7-11].

Open coal mining in Russia is 2/3 of the total. This method of extraction is considered the most productive and cheapest. However, this does not take into account the strong disturbances of nature associated with it - the creation of deep quarries and extensive dumps of overburden rocks. Coal mining in the mines is more expensive and has a high accident rate, which is largely determined by the deterioration of mining equipment. The role of a coal basin in the territorial division of labor depends on the quality of coal, the size of reserves, technical and economic indicators of production, the degree of preparedness of reserves for industrial operation, the size of production, and features of the transport and geographical location. According to the totality of these conditions, inter-district coal bases – the
Kuznetsk and Kansk-Achinsk basins, which account for 70% of coal production in Russia, as well as the Pechora, Donets, Irkutsk-Cheremkhov and South Yakut basins are sharply distinguished [2-3, 12-16].

Today, the Russian coal industry accounts for 354 million tons of mining, 132 million tons of export coal, 165 thousand jobs and 500 thousand in related industries, about 54 billion rubles of taxes and social contributions annually [1, 17-24].

More than 400 different products are obtained from coal, the cost of which is 20-25 times higher than the cost of coal itself. When coking coal, that is, with strong heating without access to air, receive the following main products:

1) Coke oven gas containing methane, hydrogen, ammonia, ethylene, benzene and toluene.
2) Coal tar containing benzene, toluene, xylenes, other homologues of benzene, naphthalene, phenol.
3) Suprasmall water containing ammonia and phenol.
4) Coke, which is almost pure carbon.

And then by-products are synthesized, such as: explosives, various solvents, dyes and medicinal substances that exceed the cost of the main products, thereby the introduction of innovative technologies in the field of processing will allow to extract the largest amount of useful components from the coal mass, ensuring maximum value added [5, 25-26].

3. Results and Discussion

Even in the USSR, enterprises were built for the production of synthetic fuel from coal. There were some difficulties: bulky equipment was very expensive, and complex technology led to the fact that due to multi-stage, frequent heating and cooling, only 35-40% of the energy contained in coal was transferred to the final liquid products. The listed reasons rather determined the termination of the production of synthetic fuels in the 40s, the reconstruction of enterprises for their production into oil refineries and petrochemical plants. The efficiency of coal-chemical production was lower than that of petrochemicals. Especially in conditions when the volume of oil production in the country is constantly growing. New large oil fields between the Volga and the Urals were explored and put into operation. At the Angarsk plant since the mid-1950s. installation of the first refineries began. Oil for them was brought by rail in tanks. In August 1960, the first industrial gasoline from oil was obtained [3, 27].

But at the moment there is a problem of reducing oil reserves and, consequently, a search is underway for alternative methods for producing products derived from oil. Projects that closed in the 40s for the production of liquid fuel from coal, become promising and should be taken into consideration, and then improved, in view of modern technologies, with the aim of: improving the quality of synthetic fuel, lowering energy costs for production, etc [1, 28].

To convert the organic mass of coal into an oil-like substance, three chemical tasks must be solved:

1. remove oxygen from it, and with it such harmful impurities for fuel as nitrogen and sulfur, in the form of water, ammonia and hydrogen sulfide, respectively, having spent a lot of hydrogen for this, which is already so low in coal;
2. add to the organic mass of hydrogen to the ratio of hydrogen and carbon in oil;
3. disaggregate the macromolecules of the organic mass of coal to the molecular weight of the oil components.

Of all these tasks, the third is easiest -for a long time, thermal and thermocatalytic processes have been used in the processing of combustible minerals, in these processes the vibrational movements of atoms in molecules increase under the influence of heat, and the least strong chemical bonds are broken and large molecules turn into smaller ones [2].

The development of the technology for the production of liquid fuel from coal requires significant investment, while one should not expect a quick return on investment. Plants for the production of liquid fuels from coal can be profitable only temporarily, in the event of a rise in price of oil. Graphs of changes in oil prices in recent years show that periods of falling oil prices are invariably replaced by periods of rising prices. Fuel made from coal is competitive at an oil price above $ 40 per barrel. In recent years, periods during which the production of liquid fuels from coal have been cost-effectively prevailing. If
this dynamics of oil prices continues, then the production of coal into liquid fuel will be generally profitable, although the income from this type of activity will not be stable. America has successfully used periods of rising oil prices, increasing shale gas production, and curtail production in the event of a fall in oil prices. Testing the methodology for quickly deploying or stopping the production of liquid fuel from coal will increase the attractiveness of investments in such a project.

The payback period for the production of liquid fuel from coal is from 7-8 years and above. It is clear that such projects are a long-term investment of world-class players. This slows down the development of commercial production of synthetic liquid fuels from coal. At the same time, the attractiveness of the formula “gasoline from coal” does not leave alone many manufacturers. Therefore, requests for the development of technology to specialists in the deep processing of coal are constantly received. The economic feasibility of the production of liquid fuel from coal is determined by the sufficient reserves of coal in our country and commercial efficiency comparable to the distillation of oil.

Currently, the widespread use of coal processing technology in liquid fuels is also hindered by environmental problems caused by this production. In particular, the problem of carbon dioxide emissions. Carbon dioxide emissions from the production of synthetic liquid fuels from coal are twice as high as from the production from petroleum. An important problem is also the high water consumption in the production process. For every ton of liquid fuel produced, 5 to 7 tons of water is consumed. Solving these problems will also help to increase the competitiveness of liquid fuel and coal plants.

In China, the world's largest single coal-liquid fuel processing plant was officially commissioned in the Ningxia Hui Autonomous Region. The project was implemented, as the country is rich in coal resources, but is experiencing a shortage of oil and gas, which Russia expects in 50 years. At the current stage, the country imports more than 60 percent oil.

The total investment in the project amounted to about 55 billion yuan / 7.9 billion US dollars. The plant is capable of turning more than 20 million tons of coal into 4 million tons of oil products annually, including 2.7 million tons of diesel fuel, 980 thousand tons of naphtha and 340 thousand tons of liquefied gas, said the deputy general director of the coal mining company at Shenhua Corporation in Ningxia Yao Ming. Among the by-products of production are 200 thousand tons of sulfur, 75 thousand tons of various alcohols and 145 thousand tons of ammonium sulfate, he added [4].

Another example of the commercial application of liquid fuel technology from coal. In 2015, the INFRA Group, which developed and patented a new generation of liquid synthetic fuel production technology based on the Fischer — Tropsch synthesis process from natural or associated gas (GTL), biomass and coal (XTL), commissioned a catalyst factory. Production of 15 tons per year produces a patented Fischer — Tropsch synthesis catalyst developed by the company's specialists. The factory’s task is to manufacture the catalyst for the INFRA GTL plants, as well as to develop processes for the production of new catalyst modifications on an industrial scale. In 2016, INFRA designed and built a GTL (gas-to-liquid) modular transportable refinery for the processing of natural and associated gas into M100 synthetic oil in Wharton (Texas, USA). The company plans include commercial operation of the plant and sale of synthetic oil. At the request of the oil and gas company, the INFRA group began designing the GTL plant, which is planned to be located in the Nenets Autonomous Okrug. A plant with a capacity of 20 thousand petroleum products per year will produce winter diesel fuel and high-octane gasoline from natural gas from the Vasilkovsky gas condensate field. The implementation of the construction plan for the GPP using the latest INFL GTL technology from INFRA will ensure the market of the Nenets Autonomous Okrug with high-quality commercial fuel - diesel and gasoline - and significantly reduce the cost of purchasing an expensive northern delivery. The feasibility study for the construction was carried out in 2017, the design was completed in 2019 [4].

Projects created for the socio-economic development of Eastern Siberia are either postponed or completely closed, not invested. While, on the example of the Kemerovo region, projects receive approval and are launched. Yes, of course, the Kuznetsk coal basin is considered one of the largest coal basins, but investing in the development of enterprises in Eastern Siberia, namely the Krasnoyarsk
Territory, Irkutsk Region, where the largest coal deposits are located, they will bring additional considerable profit.

An example of a project implemented in the Kemerovo region is the development of mini-plants for the production of liquid fuel from coal. Project participants are:

- NP “South Ural Technical Society” (Miass, Chelyabinsk Region) is responsible for the development of technical documentation, maintaining contractual relations, organizing the manufacture and delivery of components.
- LLC “Kvant” (Novokuznetsk, Kemerovo region) - development of technology, manufacturing of an electric discharge installation, assembly and factory testing of the kit, commissioning.
- NPO SPb EC LLC (Saint-Petersburg) - is a technology partner, is responsible for the promotion, replication of the development and its active implementation at industrial enterprises in the country and abroad.

The main difference between the project and existing methods of coal processing is precisely in a significant reduction in unit costs, equipment costs due to the exclusion of processes occurring at high temperatures and pressures, and the exclusion of catalytic reactions. Technology is much cheaper and simpler. There is no need to build entire factories with a giant production cycle, to bear huge costs.

Kansk-Achinsky coal basin, the second largest coal producer after the Kuzbass. It is located several hundred kilometers east of Kuzbass on the territory of the Krasnoyarsk Territory and partially in the Kemerovo and Irkutsk Regions. This Central Siberian basin has the most significant reserves of brown energy coal mined by open pit mining. Coal mining in the basin in 2006 exceeded 40 million tons per year, the largest coal mining enterprise is the largest in Russia coal mine “Borodinsky” - 20 million tons / year. The large sections also include “Berezovsky”, “Nazarovsky”, “Pereyaslovsky”, “Kansky” sections. Having created and launched a project for processing coal into liquid products, such as phenols, cresols, xylenols, the demand for which is very high (this is the raw material for the production of high-tech plastics), good profit will be realized.

In the Irkutsk region in 1945, the plant No. 16 was built to produce motor fuel from Cheremkhov coal. The Irkutsk-Cheremkhovsky basin stretches along the Upper Sayan from Nizhneudinsk to Lake Baikal. It is divided into the Baikal and Prisayansk branches. The production volume is 3.4%, the production method is opening and the advantage of such a production method is that it is relatively cheap and safe for workers. The deposit is far from large consumers, delivery is difficult, therefore, local coal is mainly used in Irkutsk enterprises. The stock is about 7.5 billion tons of coal. Therefore, a promising project will be the resumption of the plant and technologies for the production of liquid fuel from coal in the Irkutsk region. The total cost of the project will be approximately 5 billion rubles [5].

4. Conclusion
Thus, modern Russia is able to solve many problems and circumvent the difficulties that existed 60-80 years ago, using new production technology, powerful devices and erudite specialists. Oil reserves are diminished every year, as are gas reserves, so coal chemistry has a great prospect and interest in new coal processing projects. Especially, such projects should be considered in Eastern Siberia, the further development of which will ensure the main increase in coal production in the industry, and further, the creation of coal processing plants with the prospects of introducing new technologies for producing liquid products.

There are examples of successful implementation of projects to create and commercialize the production of liquid fuel from coal. In China, America, and Germany, much attention is paid to the development of this type of production. Kemerovo region, rich in coal reserves, is actively developing in this area. Eastern Siberia has large reserves of coal and every reason to attract investment and expand the production of liquid fuel from coal.

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