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Prospects of GTL Technology Use in the Oil and Gas Industry

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Abstract-:Progress of the global energy industry as well as resources of natural gas of Russia were indicated in this article. The main region of their development over the years is Western Siberia, where more than 80% of gas reserves are explored. It is from here that the main stream of Russian gas flows to countries in Eastern and Western Europe. To date, good prospects have been opened for the preparation of gas reserves and production in eastern Russia with the launch of the Power of Siberia gas pipeline, which determined the high importance of this region, which is of strategic interest to the gas industry in Russia. The main resources of natural gas will be located in remote from the existing gas transmission system, inaccessible areas and areas with a harsh climate, where there are no large markets for the consumption of hydrocarbons. In connection with this, the search is underway for the transportation of natural gas, alternative to pipeline transportation, to the places of consumption. Three possible options are considered. According to the "General scheme for the development of the gas industry for the period up to 2030" , one of the promising options for the development of gas processing industries is the development and implementation of efficient technologies for the production of synthetic liquid fuels (GTL technology) aimed at solving the problems of developing small, mature and hard-to-reach natural gas fields.

The special emphasize was made on one of the promising variants of gas-processing productions development - development and implementation of GTL (Gas to liquid) technology as a new method of production of synthetic liquid hydrocarbons from natural gas. Relevance, possible advantages, and prospects of GTL technology were also mentioned. The example of the Republic of Sakha (Yakutia) shown the possibility of using GTL technology, using as a raw material of natural gas of the Middle-Vilyusk gas condensate (gk) field. Also shown in this article are experimental details of the study of an individual hydrocarbon gas composition, which was determined using the gas chromatography method. The conclusion was made on the Republic's Oil and Gas Complex's overall potential cost-benefit in case of GTL technology implementation.

Keywords: liquefied natural gas (LNG), synthetic fuel, GTL technology (Gas to liquids), hydrocracking, hydroisomerization.

I. INTRODUCTION

Since the beginning of the XX century to this day petroleum still is the main source of raw material for transportation fuel and products of organic synthesis. However, today stricter product quality requirements and increase in alternative and renewable raw material usage in fuel production lead to the critical need of new, competitive and innovative production technologies. At the moment the development of the global energy industry is mostly oriented towards Russian gas. Russia is the leading country in terms of Both proven gas reserves as well as providing up to 30% of the global gas production. There are two contributing trends - large gas reserves and oil-saving tendencies within the country and ongoing oil substitution by gas on the global scale. For a long time, Western Siberia remains the main region in terms of gas field developments, sitting on the 80% of proven gas reserves. That is where the vast majority of gas exported to countries of Eastern and Western Europe comes from, which until recently were the main importers of it. At the present time following an ongoing construction of the 'Power of Siberia' gas pipeline, there are good prospects of gas fields development and production in Eastern Russia, which also determined it as a valuable strategic region for the Russian gas industry.

Table 1. Distribution of natural gas resources by regions of the Russian Federation. (Source: http://vuzlit,ru /1051367 /resursy_prirodnogo_gasa)

Region	Distribution
European part	10%
Western Siberia	77%
The Continental shelf (The Arctic shelf)	8%
Eastern Siberia and the Far East	5%

The main resources of natural gas will be located at the remote places far from the existing gas transportation infrastructure and with harsh climate as well as with pretty much nonexistent hydrocarbonic raw material consumption market. Pipeline transportation costs per unit of energy are very high, therefore massive amount of investments will be required to build those pipelines and compressor stations. According to various estimates in Russia alone one third of the total amount of extracted associated gas is wasted on petroleum field facilities. This causes a considerable damage to the environment and country's economy.

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Through the last decade there has been a search for alternatives to pipeline transport. The options considered by Russia are (Ter-Sarkisov and others. - 2003):

• production of methanol out of gas at the point of extraction;

• gas liquefaction at the point of extraction and transportation to places of consumption in liquid form by LG (liquid gas) tankers;

• GTL (Gas to liquids) technology production - fuels, oils, paraffin or dimethyl alcohol, transported by tankers or pipelines.

The first option, methanol production does not solve the problem, as the global market of methanol is small and rather saturated. Methanol also has a series of serious disadvantages if used as an alternative to automobile gasoline or energy carrier, few of which are high toxicity and it being able to be absorbed by the skin as well as high solubility which might cause serious risk to nearby water areas.

Projects of gas liquefaction (СПГ, condensed natural gas) are already brought to life in a significant number of cases. These projects are quite capital intensive and only are worthwhile in cases of large gas fields located off the coastal areas or shelves. A promising avenue for the usage of natural gas in remote locations is its conversion to synthetic liquid fuels.

According to "General plan of gas industry development during the period before 2030", one of the promising ways for gas-processing plants is development and implementation of Gas to liquids (GTL) refinery process technologies aimed to solve problems of small, developed and remote natural gas fields development (Russian Business newspaper. - 2010).

There are identified advantages of natural gas usage as raw material for GTL production. Vast resources, environmentally friendly characteristics, and good potential of profitability make natural gas a more promising raw material for the Chemical and Fuel and Energy Complex.

The reason of GTL technology relevancy are in the following advantages over traditional ways of liquid oil production (Nutchina M.A., Zakharova S.S.- 2017):

• remoteness of natural gas fields. Up to 60% of discovered and proven gas reserves are located far away from the final consumer, including the Arctic (Science and technologies / Petrochemistry - 2017) . In such cases transporting products in liquid form appears to be the most cost effective method, rather than building gas pipelines. According to various estimates GTL projects require several times less investments than projects of gas liquefaction, considering the same volume of raw gas converted. Also, there are ways to provide remote gas field sites and facilities with liquid fuels, by establishing low-tonnage fuel production;

• processed product quality. GTL product is an eco-friendly fuel. It contains less than 1 ppm of sulfur, does not contain any aromatic compounds and tar, which levels in fuels are heavily controlled in the developed countries;

• production independency of oil market volatility possibility of utilization of associated petroleum gases, which are mainly flared. In Russia alone one third of the total amount of extracted associated gas is wasted on petroleum field facilities. (Moscow: Institute for Financial Studies, 2007). This causes a considerable damage to the environment and country's economy.

Consequently, more and more big oil and gas companies turn their heads on the new motor fuel production method - Gas to liquid (GTL) technology.

In world practice, GTL technology is known from 1955 (GTL: technologies, projects, prospects. – 2006.). At the moment there are few fully functioning GTL plants. In 2011 Shell company established the biggest such plant in Qatar, with a capacity of 140 000 barrels a day as well as it is planning to build a similar plant in the US. In addition to this other big oil refining companies - Exxon Mobil, Conoco Phyllips, Chevron Marathon Statoil have their own GTL projects at different stages of development. Among Russian companies interested in the technology there are Gazprom, Lukoil, and Sakhatransneftegaz. But at the moment there are none implemented GTL projects on the commercial scale.

GTL (Gas to liquids) technology is a chemical reaction of converting natural and associated gas into synthetic and motor fuels (Mordkovich V.Z. - 2007). Process consists of the following phases:

1.Gas preparation (drying, desulfurization). Desulfurization is done by hydrogenation of sulfur compounds to get hydrogen sulfide, which is then adsorbed by zinc oxide.

2.Synthesis gas production out of prepared gas. To get synthesis gas, natural gas is transformed into a mixture of hydrogen and carbon oxide by partial oxidation

$CH_4 + ½\ O_2 \Leftrightarrow CO + 2H_2$

or steam reforming.

$CH_4 + H_2O \Leftrightarrow CO + 3H_2$.

3. Synthesis gas conversion to higher hydrocarbons. This phase determines the composition and the number of synthetic hydrocarbons. Cobalt and iron are used as a catalyst. For cobalt catalyst synthesis temperature varies between 170-270· C, pressure - 1-30 atm. (low-temperature synthesis of Fischer-Tropsch), for iron - 250-325· C, pressure - 20-30 atm. (high-temperature synthesis of Fischer-Tropsch) (Arutyunov., Krylov O.V -1998).

$nCO + (2n +1)\ H_2 \rightarrow C_nH_{2n+2} + nH_2O$

$nCO + 2nH_2 \rightarrow C_nH_{2n} + nH_2O$

4. Product refining (diesel fuel, naphtha, paraffin, kerosene, aviation fuel, grease oils). Hydro-cracking and hydroisomerization processes can be used for upgrading the quality of the final product. The final phase is the stage of waste and product segregation.

Prospects of natural gas conversion to synthetic liquid fuel field development are promoted by (Prospects of gas to motor fuel and other chemical product conversion. Materials of JSC “Gazprom” Science and technology council.- 2000):

• deceleration in growth of explored oil reserves - raw material for liquid motor fuels. According to expert estimates, due to consistent global growth in motor fuel consumption, proven oil reserves should last another 40 years. Because of that there will be a huge increase in demand of other hydrocarbon raw material, natural gas in particular;

• ongoing global warming, which might cause catastrophic consequences on all of the Earth's continents. Because of that in 1997 160 countries signed the Kyoto Protocol calling the industrially developed countries to reduce gaseous emission, which contributes to greenhouse effect. In particular nitric oxide, methane, carbon dioxide gas etc. Therefore, requirements are becoming much stricter in terms of flaring of natural, associated and other hydrogen gases on plants, refineries and petrochemical plants;

• stricter environmental requirements of motor fuels on sulfur levels, aromatic hydrocarbons (benzene in particular), olefins on the global market;

• ensuring high quality liquid motor fuel productions using natural and associated gas of remote fields and reserves. Further development of Russian energy sector faces the need of exploring and developing natural gas fields, located in significant distances from the consumer and with absence of reliable transport infrastructure. Use of GTL technology in remotely located fields, as well as the ones in the Arctic, will not only help properly utilize natural gas , but also provide the global market with a new highly effective product. In the Republic of Sakha (Yakutia) there is an established raw material base of oil and gas production. Currently, Yakutia is one of the developing natural resource production areas and in the nearest future might be considered as the central oil and gas production region in eastern Russia. The main production of natural gas (roughly 98%) is concentrated in Leno-Vilyuskaya and Leno-Tungusskaya oil and gas pump provinces (Nauka, 1969). Therefore we can make a conclusion that Yakutia has a big natural resource and raw material base, required to establish both larger and smaller GTL projects.

Sredne-Viluysk gas-condensate field is the mainly exploited one. It is one of the largest by its gas reserve. By January the 1st, 2016 its remaining reserves were: BC1 category gas - 143,506 billion m³, C2 · 33,814 billion m³ (Safronov-2009). For designing a GTL block on the plant we chose natural gas as a raw product, which comes by the pipeline from the Sredne-Viluysk gas-condensate field from Triassic product horizons to the Yakutsk Gas Processing Plant, where it is refined, went through drying and liquefaction to get liquefied gas (mixture of propane and butane) and natural gasoline (pentane and the higher hydrocarbons). Using the method of gas chromatography (Chalaya-1997) we have investigated an individual hydrocarbon composition of natural gas, as seen in table 2.

RESULTS & DISCUSSIONS

Table 2. Sredne-Viluysk gas-condensate field's raw material composition

CH_4 % by V	C_2H_6 % by V	C_3H_8 % by V	$\sum C_4H_{10}$ % by V	$\sum C_5H_{12}$ and fur	CO_2 % by V	N_2 % by V	O_2 % by V
94,03	4,45	0,85	0,07	0,01	0,05	0,53	0,01

It was identified that hydrocarbon composition of natural gas meets the requirements of ГОСТ 5542-87 (GOST), is characterized by the high methane content, mixture of propane and butane content, low content of carbon dioxide gas, nitrogen and complete absence of hydrogen sulfide.

Thus, research of Sredne-Viluysk natural gas shows that it characterizes by the absence of sulfide and can become a proper raw material for GTL liquid fuel production.

GTL technology implementation to the Republic's Oil and Gas Complex will contribute to:

• the development of the Oil and Gas complex, which will positively affect the economy in general;

• solving fuel and energy problems of remote locations by developing remotely located fields;

• providing the Republic with its own motor fuels;

• creating a new market of pollution free fuels and will allow exporting products of refined products instead of raw natural gas.

REFERENCES

1. Arutyunov V.S., Krylov O.V.. Methane oxidations. – Moscow: Nauka, 1998 – p.361
2. Chalaya O.N., Kashirtsev V.A. Chromatography basics: Teaching aid. Yakutsk: Yakut University publishing house, 1997, p. 155
3. Chemical industry analytical portal. New chemical technologies. GTL: technologies, projects, prospects. – 2006.
4. Cost-effectiveness analysis of alternative projects of natural gas utilization. – Moscow: Institute for Financial Studies, 2007. – p. 40
5. Geology and geochemistry of oil in northeastern part of Nepa-Botuoba Anteclise. – Yakutsk: Yakutsk Science Centre, 1989. – p. 168
6. Leno-Vilyuskaya oil and gas pump province. – Moscow: Nauka, 1969. p. 278
7. Mordkovich V.Z. Past, present, and future of GTL // Chemistry and life. – 2007. - №8 pp. 5-9
8. Natural gas resources of Russia: http://vuzlit,ru /1051367 /resursy_prirodnogo_gasa
9. Nutchina M.A., Zakharova S.S. Modern tendencies of "GTL" technology development. Collection of articles from 'Role and place of information technologies in modern science' International science conference in 2 parts part 1/ Ufa; LLC "OMEGA SCIENCE", 2017 pp. 35-38
10. Prospects of gas to motor fuel and other chemical product conversion. Materials of JSC "Gazprom" Science and technology council 2000. – p. 76
11. Russian energy strategy for until 2030. Gas industry// Russian Business newspaper. - 2010. - №429
12. Safronov A.F. Prospects of the Oil and Gas Complex developents in the Republic of Sakha (Yakutia). "Scientific support of megaprojects implementation of the Republic of Sakha (Yakutia)." – Yakutsk: "Dani Almas" Company, 2009. – pp.35-40
13. Science and technologies / Petrochemistry [E-course]: Neftegaz.ru business journal [site]. – 2010. – URL: http://neftegaz.ru/science/view/725-GTL-tehnologii-po-perevodu-gaza-v-zhidkoe-sostoyanie (accesed 20.02.2017)
14. Ter-Sarkisov R.M., Stavkin G.P., Tsybulskiy P.G., Stepanov N.G. "Levels of production and reserves of low pressure gas in Nadym PurTazovskiy region" Materials of All-Russian scientific conference "Problems and prospects of complex use of low pressure gas in stable development of social spheres of gas producing regions' (Nadym, March 2003), Moscow, «Information and advertising centre GAZPROM» LLC, 2003, p.1.