TECHNOLOGICAL PROGRESS IN THE FIELD OF SYNTHETIC LIQUID FUELS: A PATH TOWARD CLEANER ENERGY

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Abstract. This article emphasizes the growing importance of synthetic liquid fuel production in the modern world. As the number and variety of land, air, and water transport modes increase globally, fuel consumption continues to rise. To meet this growing demand, various energy-efficient and environmentally friendly synthetic fuel production methods are being introduced. In this context, the use of local raw materials to produce synthetic fuels has become a key priority for chemists, technologists, and engineers working in this field. In Uzbekistan, GTL (Gas-to-Liquid) technology is being used to produce synthetic diesel fuel, offering several advantages over traditional diesel. This technology not only meets international standards but also represents a major achievement in the country's oil and gas sector. The launch of GTL diesel production contributes significantly to Uzbekistan's energy independence and ensures the domestic market is supplied with high-quality fuel products.

Key words: GTL (Gas to liquid), Synthetic liquid fuel, jet fuel, diesel, naphtha, sulfur.

Аннотация. В данной статье подчеркивается актуальность производства синтетического жидкого топлива в современном мире. С увеличением количества и разнообразия наземного, воздушного и водного транспорта во всем мире наблюдается постоянный рост потребления топлива. Для удовлетворения этого спроса внедряются энергосберегающие и экологически чистые технологии производства синтетического топлива. В этом контексте получение синтетического топлива из местного сырья является одной из приоритетных задач для химиков, технологов и инженеров, работающих в данной области. В Узбекистане осуществляется производство синтетического дизельного топлива по технологии GTL (газ в жидкость), которое обладает рядом преимуществ по сравнению с традиционным дизельным топливом. Эта технология не только соответствует международным стандартам, но и является одним из крупнейших достижений страны в нефтегазовой отрасли. Запуск производства GTL-дизеля значительно укрепляет топливную независимость Узбекистана и обеспечивает внутренний рынок высококачественными топливными продуктами.

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Ключевые слова: GTL (газ в жидкость), синтетическое жидкое топливо, авиакеросин, дизельное топливо, нафта, сера.

Annotatsiya. Ushbu maqolada zamonaviy dunyoda sintetik suyuq yoqilg'i ishlab chiqarishning dolzarbligi ta'kidlangan. Yer usti, havo va suv transportining miqdori va xilma-xilligi ortib borishi bilan butun dunyo bo'ylab yoqilg'i iste'molining doimiy o'sishi kuzatilmoqda. Ushbu talabni qondirish uchun sintetik yoqilg'i ishlab chiqarishning energiya tejaydigan va ekologik toza texnologiyalari joriy etilmoqda. Shu nuqtai nazardan, mahalliy xom ashyodan sintetik yoqilg'i olish ushbu sohada ishlaydigan kimyogarlar, texnologlar va muhandislar uchun ustuvor vazifalardan biridir. O'zbekistonda GTL (gazdan suyuqlikka) texnologiyasi bo'yicha sintetik dizel yoqilg'isi ishlab chiqarilmoqda, bu an'anaviy dizel yoqilg'isiga nisbatan bir qator afzalliklarga ega. Ushbu texnologiya nafaqat xalqaro standartlarga javob beradi, balki mamlakatning neft va gaz sanoatidagi eng katta yutuqlaridan biridir. GTL-dizel ishlab chiqarishni yo'lga qo'yish O'zbekiston yoqilg'i mustaqilligini sezilarli darajada mustahkamlaydi va ichki bozorni yuqori sifatli yoqilg'i mahsulotlari bilan ta'minlaydi.

Kalit so'zlar: GTL (suyuqlikka gaz), sintetik suyuq yoqilg'i, aviakerosin, dizel yoqilg'isi, NAFTA, oltingugurt.

Introduction

The recent increase in global oil product prices has created challenges related to the availability and cost of fuels and lubricants. In the case of synthetic fuels, not all materials are equally effective — careful selection of the most suitable and efficient components is essential.Above many times being emphasized synthetic fuel ”Synthetic” the term “fuel” descriptive if we are, someone product oil or oil from products prepared if so, it synthetic product is called. If a product is made from something unrelated to oil, it is called a natural product. However, when it comes to fuel, this rule is reversed. That is, if the fuel is made from oil, it is natural, on the contrary, fuels made from something other than oil are called artificial, that is, synthetic. So, when we say "synthetic fuel", we mean a fuel that can completely replace fuels obtained from oil, but is not itself made from oil. For example, if gasoline is obtained not from oil, but from coal or gas, then that gasoline is a synthetic fuel [1-3].

Synthetic diesel is a neutral substance, it does not contain various toxic substances, resins, aromatics, and therefore it does not poison humans. This is a very important aspect. The most prestigious chemical and technological research institutes in the world are currently working hard to develop the most effective technological methods for obtaining environmentally friendly synthetic fuel. The questions of which reactions will produce the highest quality and cleanest synthetic

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fuel, and the possibility of bringing such technology to an industrial scale, are the most urgent tasks for chemical technologists and engineers who are currently working on synthetic fuel issues [4].

With the depletion of oil reserves, the aggravation of environmental problems, as well as the constant increase in the cost of traditional energy resources, interest in alternative fuels has increased significantly worldwide in recent years, and solving such issues serves as one of the solutions to energy and environmental problems in our Republic [5].

The GTL plant in Uzbekistan, with a total cost of more than $ 3.61 billion, is one of the most innovative production enterprises in the region, expanding the capacity of deep processing of natural gas, reducing the import of hydrocarbons, meeting the country's need for modern, high-quality and environmentally friendly fuel, as well as providing the market with strategic products produced from its own raw materials. Our opinion is confirmed by the fact that such a large complex has been built in only 4 countries in the world so far - Qatar (2), Nigeria, the Republic of South Africa and Malaysia. In a word, this plant is the largest enterprise in the oil, gas and chemical industry in our country and, in general, in our region. These products will cover $500 million in imports annually, ensure $200 million in exports, and generate 2 trillion soums in tax revenues for the budget [6].

The basis of GTL technology is a Fischer-Tropsch reactor, where the main product is paraffin’s from synthesis gas, and by adjusting the necessary parameters, synthetic liquid fuels are extracted [7]

The possibilities of solving the problem of using associated petroleum gas using GTL technologies. The most important difference between hydrocarbon products of Fischer-Tropsch synthesis and petroleum products is that they do not contain sulfur, nitrogen, and in some cases aromatic compounds, which determines their environmental significance. Synthetic oil is a mixture of normal and isotropic C5-C19 hydrocarbons used as a raw material for the processing of paraffins and motor fuels, for the chemical and petrochemical industries, or as a commercial product [8].

Methods. The GTL technology is based on the three- stage Sasol Slurry Phase Distillate Process™. In the first stage, natural gas is combined with oxygen to produce synthesis gas. The synthesis gas is then converted to a paraffinic synthetic crude oil by the Fischer-Tropsch conversion process. In the final stage, this synthetic crude oil is cracked to produce a finished product [9].

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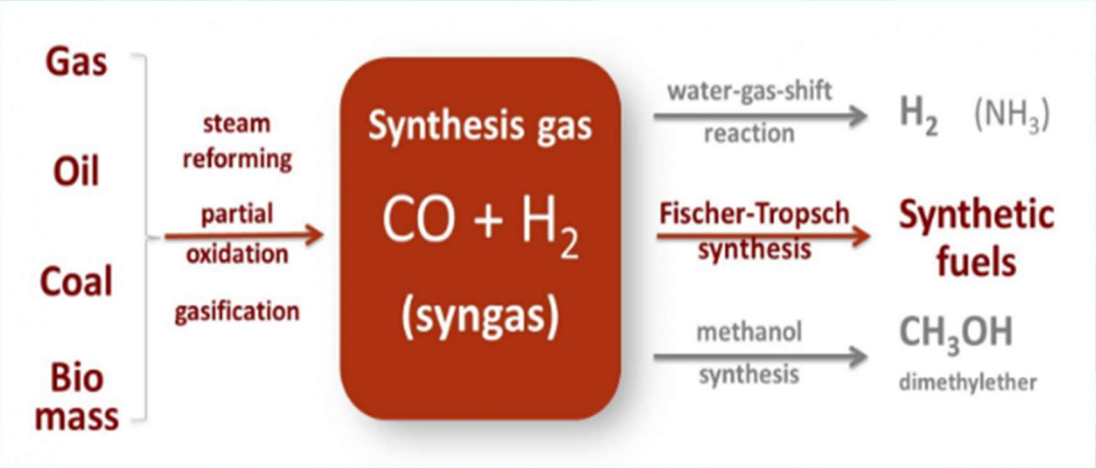


Figure 1. Synthetic liquid fuel production process

Synthesis gas (syngas) can be produced from a variety of sources and is a versatile intermediate for production of chemicals and fuels. Gas-to-Liquids (GTL), Coal-to-Liquids (CTL), Biomass-to-Liquids (BTL) all rely on the catalytic conversion of syngas.

Steam reforming of methane.

$$CH_4 + H_2O \rightarrow CO + 3H_2 \quad \text{(endothermic)}$$

Partial oxidation of methane. *

$$CH_4 + \tfrac{1}{2} O_2 \rightarrow CO + 2H_2 \quad \text{(exothermic)}$$

Dry reforming of methane.

$$CH_4 + CO_2 \rightarrow 2CO + 2H_2 \quad \text{(endothermic)}$$

Synthesis

$$(2n+1)H_2 + nCO \rightarrow CnH(2n+2) + nH_2O$$

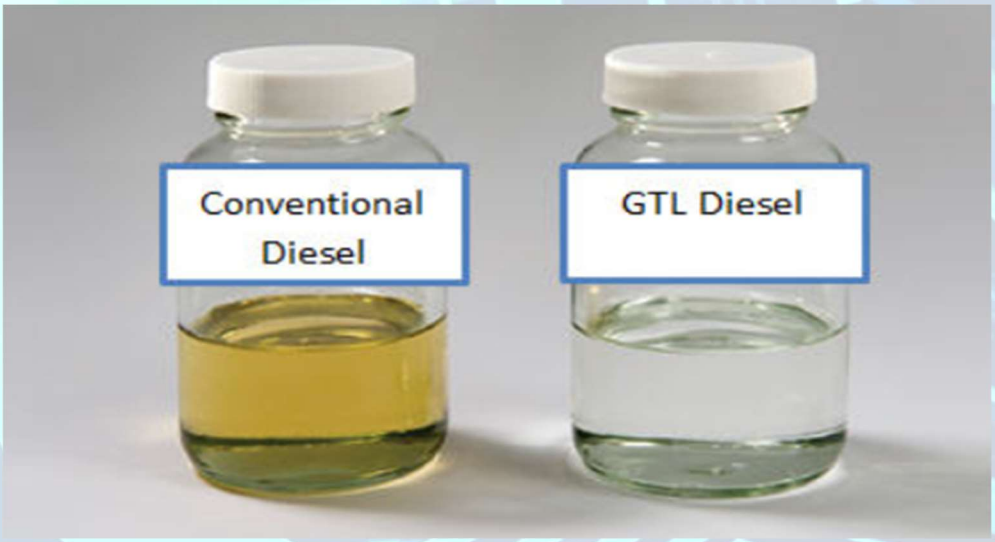


Fig 2. Synthetic liquid fuel diesel fuel traditional to diesel comparison official.

GTL fuel has shown excellent thermal stability, clean and efficient combustion. High cetane number (>70) The property makes the engine easier to start, reduces engine noise and improves engine efficiency. Aromatic hydrocarbons

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are almost zero (<0.5 %). Almost odorless and colorless. Meets all requirements of the European standard EN 15940 [10].

In addition, toxic gases emitted from vehicles not only cause drastic climate change, but also have a significant impact on human health. Carbon dioxide (CO carbon monoxide (CO), nitrogen oxides (NOx), sulfur dioxide (SO_2), hydrocarbons (HC), benzene (C_6H_6) and other harmful and toxic gas particles have a negative impact on the health of humans and living beings [11].

Synthetic fuel advantages

✓ Ecological Cleanliness: Traditional oil to their products relatively lower harmful waste produces .

✓ Quality Stability: Internal combustion engines for high good quality fuel as possible use .

✓ From resources effective Application: Oil was dependence reduce and alternative from sources use opportunity gives.

Conclusion. In conclusion, synthetic liquid fuels are not only important as an environmentally friendly and sustainable energy source but also represent a reliable and cost-effective solution in the context of declining traditional fuel reserves and rising prices. Therefore, synthetic liquid fuels will play a key role in the future energy landscape, contributing significantly to energy security and economic stability.

Based on my research, I would like to offer the following suggestions:

1) Uzbekistan natural gas from reserves effective use GTL installations for this purpose power increase

2) Environmental impact reduce for alternative fuel sources more attention focus and waste-free working release technologies current be

3) Scientific and technical research reinforcement through synthetic fuel working release processes further effective do

4) World trends analysis do for advanced countries experience study and from them come outside Uzbekistan for suitable strategy working exit

At this point, we consider it appropriate to conclude our article with the slogan of the Uzbekistan GTL company: “WE CREATE PURE ENERGY”.

REFERENCES

1. Bahronov, Javohir Shokir oglu and Khamro Bozorovich Dostov. "The Advantages of Gas-Based Fuels over Oil-Based Fuels." Science and Education 4.2 (2023): 620-624.

2. Timko, M.T., Herndon, S.C., De La Rosa Blanco, E., Wood, E.C., Yu, Z., Miake-Lye, R.C., Knighton, W.B., Shafer, L., DeWitt, M.J. and Corporan, E., 2011. Combustion products of petroleum jet fuel, a Fischer–Tropsch synthetic fuel,

ISSN 3030-3907

and a biomass fatty acid methyl ester fuel for a gas turbine engine. Combustion Science and Technology, 183(10), pp.1039-1068.
3. San, Mexico City Milan New Delhi, and Singapore Sydney Toronto. "SYNTHETIC FUELS HANDBOOK."
4. Hutchings, G., Davidson, M., Atkins, P., Collier, P., Jackson, N., Morton, A., Muskett, M., Rosseinsky, M., Styring, P., Thornley, P. and Williams, C., 2019. Sustainable synthetic carbon based fuels for transport: Policy Briefing.
5. Arutyunov, V.S. and Lisichkin, G.V., 2017. Energy resources of the 21st century: problems and forecasts. Can renewable energy sources replace fossil fuels. Russian Chemical Reviews, 86(8), p.777.
6. Uzbekistan GTL : The Miracle of the New Uzbekistan. Qudratilla Rafiqov. - Tashkent: "Akademnashr" 2022.
7. The Fischer-Tropsch (FT) process. Paul Guerrero and Selena Pineda. Texas A&M University; CHEM 362-500
8. Tsukanov, M.N., 2021. MODERN ENVIRONMENTAL REQUIREMENTS FOR SYNTHETIC FUEL. JOURNAL OF TECHNICAL RESEARCH, 4(1).
9. Ram, V. and Salkuti, S.R., 2023. An overview of major synthetic fuels. Energies, 16(6), p.2834.
10. Ismael, M.A., Rosli, M.A., Aziz, A.R.A., Mohammed, S.E., Opatola, R.A. and El-Adawy, M., 2024. Gas to liquid (GTL) role in diesel engine: Fuel characteristics and emission: A review. Cleaner Engineering and Technology, 18, p.100706.
11. Hajderi, A. and Bozo, L., 2023. The air pollution from vehicles and health risks in the city of Tirana. Advanced Engineering Days (AED), 7, pp.116-119.

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