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ПРОБЛЕМА ГАЗИФИКАЦИИ ОТДАЛЕННЫХ РЕГИОНОВ И МЕТОД ЕЁ РЕШЕНИЯ ПУТЕМ ПРИМЕНЕНИЯ КОМПРИМАННОГО ПРИРОДНОГО ГАЗА

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Статья описывает современное состояние энергообеспечения потребителей природным газом в России. Приводятся преимущества использования газового топлива в электро- и теплоснабжающей сфере, поднимается проблема обеспечения энергией жителей отдаленных регионов и районов. Излагаются альтернативные пути газификации в сравнении с традиционными методами. Приведены преимущества и недостатки возможной газификации компримированным природным газом (КПГ). Описана технология производства такого топлива, а также сделан вывод о целесообразности её развития и применения.

Ключевые слова: Компримированный природный газ (КПГ), сжиженный природный газ (СПГ), газификация, природный газ, АГНКС, компримирование газа, транспорт газа.

THE PROBLEM OF REMOTE REGIONES GASIFICATION AND THE METHOD OF ITS SOLUTION BY THE USE OF COMPRESSED NATURAL GAS

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The article describes the current state of natural gas energy supply of consumers in Russia. The advantages of using gas fuel in electricity and heat supply are given, and the issue of providing energy to consumers of remote regions and districts is raised. The paper presents alternative ways of gasification in comparison with traditional methods. Benefits and drawbacks of possible gasification by compressed natural gas (CNG) are provided. The technology of production of this fuel is described, and the conclusion about the practicability of its development and application is made.

Keywords: Compressed natural gas (CNG), liquefied natural gas (LNG), gasification, natural gas, CNG filling station, gas compression, gas transport.

Nowadays, hydrocarbon resources (oil, natural gas, coal, peat, etc.) are main fuels for heat and electricity generation almost all over the world. In 2023, the proportion of heat and power stations in the structure of the UES of Russia is about 66%, which is quite a significant value [7]. At the same time, according to the forecast data, by 2028 the decrease of TPPs energy production ratio in Russia will be insignificant - about 2% [8].

Traditional raw hydrocarbons (including oil, coal) in the modern energy sector most commonly are giving way to natural gas. Thus, according to the International Economic Agency (IEA), the total world share of gas in power generation by 2021 has increased from 16% to 22% [3]. It is more environmentally safe; gas reserves are several times greater than the world's oil reserves. In addition, the prime cost of natural gas (including production and transportation) is much lower than other hydrocarbons, which makes it more economically attractive for supply companies.

The most serious issue is a supply of energy to consumers (industrial and individual) living in under-populated and remote regions of our country. The large area and low density of population in Russia lead to energy isolation of certain settlements. Consequently, the urgent task of the Russian energy industry is to identify ways to supply such consumers with cheap and high-quality energy resources.

The Russian Gasification Program of PJSC “Gazprom” for 2021-2025 complies such requirements. According to [6], the project involves 72 regions, including low-populated and harsh climatic area, including: the Republic of Sakha (Yakutia), Yamalo-Nenets Autonomous Okrug, Khanty-Mansiysk Autonomous Okrug - Yugra, Kamchatka Kray, and others. The main gasification method is the expansion of gas distribution plants and natural-gas networks. In addition, the program includes the transfer of local boiler houses and TPPs from coal (fuel oil) to natural gas. As of 2023, the level of gasification in Russia is 73-74% [6].

Nevertheless, the existing gasification program in Russia is based on the Unified Gas Supply System, which was mainly built in the USSR and does not meet modern requirements of safety and high-quality gas transportation to consumers. Furthermore, meteorological conditions and the terrain of remote regions often result in higher capitalized expenses for pipelining and the prime cost of the gas pipeline network developing. In this case, the construction of the gas-transport system becomes economically inexpedient. Consequently, it is necessary to focus on alternative ways of supplying consumers with natural gas.

The following ways of gas supply to remote regions are known:

- off-grid gas supply (from cylinders or gas holders);
- gas supply by liquefied natural gas (LNG);
- use of compressed natural gas (CNG) [4].

Off-grid gas supply is common in European countries as well as in the USA and Canada. However, its disadvantages are high initial capital investments for individual consumers (owner-occupied households), as well as high quality requirements for gas boilers. Moreover, such equipment may occupy large space on the adjacent territory, which reduces the possibility of its beneficial use.

LNG gasification is a more technological and promising line of research. This method allows to supply remote regions with gas quickly and efficiently by producing fuel at gas distribution stations (GDS) and transporting it by tank trucks. However, LNG differs from conventional gas in its high production costs and low production capacity. Producers have to rely on large consumers (power plants, boiler houses) to offset prices due to the limited fuel production. Usually, they choose either off-grid gas supply or gas pipeline transportation [4].

Compressed natural gas (CNG) is a promising alternative to traditional gasification methods. CNG is a natural gas compressed to a pressure of 20-25 MPa at CNG filling stations [1]. The volume of gas during compression is reduced by 200 times, which saves the capacity of reservoirs and tanks during its transportation and storing. It is used mainly as a motor fuel for combustion engines of motor

transport. CNG is non-toxic, its production is cheaper than LNG, and it does not require regasification in the process.

Russia has experience of CNG gasification of transport. Thus, according to the data of the Central Dispatch Department of Fuel and Energy Complex [5], the number of companies producing such fuel has increased more than 10 times since 1998. By 2022-2023 the volume of such gas networks in Russia should reach 1720 million m³. Most of CNG is produced in 5 regions: Krasnodar Krai, the Rostov Region, Republic of Tatarstan, Stavropol Territory, and Nizhny Novgorod region. However, these regions are known by more favorable climatic conditions and higher population density than remote areas of Siberia and the Far East. Therefore, the issue of technology choice and estimation of economic feasibility for low populated and remote areas is the main issue in the implementation of the gas supply project.

Let us consider the process of CNG production and its transport. The gas is supplied from the main pipeline and to the CNG filling station, where it goes through prepurification, after which it is sent to the compression unit. The pressure of the fuel is increased, after which the compressed gas is pumped into tanks or trucks. A necessary condition for the realization of the CNG-gasification project is the presence of a motor road system, where the gas will be delivered to the storage tanks.

The next step is to reduce the pressure of the CNG, because high pressure does not meet the requirements of the gasification rules and regulations (extreme pressure in residential buildings - 3000 kPa). After that, the gas is pumped into medium and low-pressure pipelines for its transmission to consumers [4] (Figure 1).

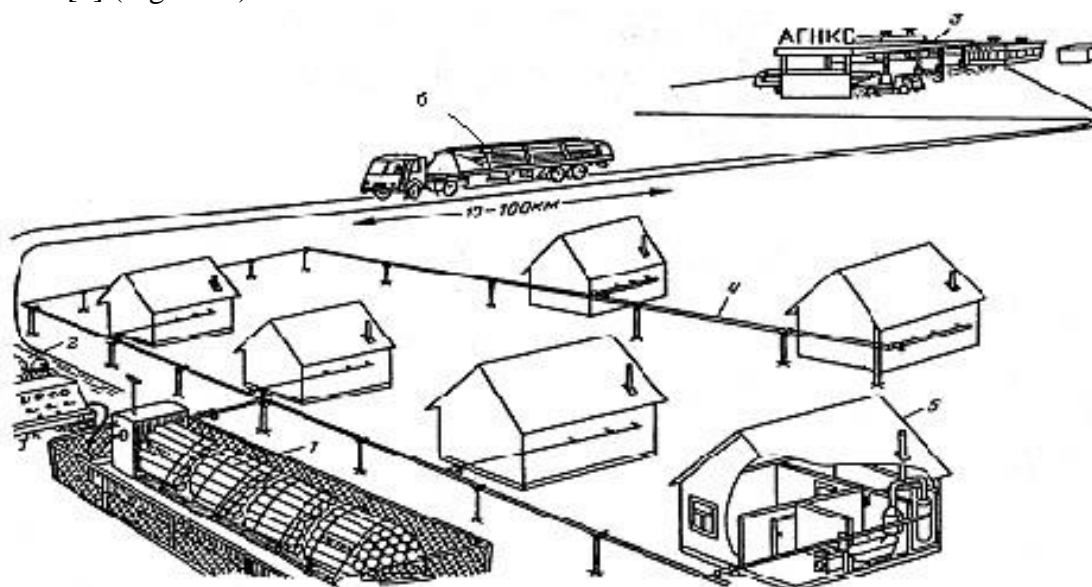


Figure 1 – Principle diagram of settlement's gasification by off-grid supply of compressed natural gas [4]:

- 1 - CNG storage; 2 - reducing device; 3 - CNG filling station;
- 4 - low-pressure gas pipeline network;
- 5 - gasified object; 6 - CNG transporter.

Source: Rachevsky B.S. LNG, LNG and CNG technologies for gasification of regional facilities // *Alternative Fuel Transportation*. 2016. №3 (51).

Low capital costs, fuel price and availability of CNG production technologies are its advantages over off-grid supply and LNG gasification. This technique does not require deep gas treatment and storages can be filled more efficiently. Nevertheless, its applicability is limited in remote regions, primarily due to low quality and poorly developed motor road network. Consequently, the issue of such gasification method is complex and demands more serious consideration. Taking into account the necessity of improving the road network in Russia and an implementation of such projects, CNG gasification may become more widespread in the future. Capital investments in compression utilities will not only allow the expansion of the gas supply to remote consumers, but will also lead to increased investments in the engineering of transport and logistics networks in Russia. Which, in itself, is one of the priority tasks of the Russian energy industry.

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