Application of Biomethane for Gas Supply Within the Settlements

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APPLICATION OF BIOMETHANE FOR GAS SUPPLY WITHIN THE SETTLEMENTS

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Abstract. The work is devoted to the problem of using bio gas fuel in gas supply systems. The analysis of the work of bio gas stations and bio methane plants in the countries of the European Union was conducted, the ways of using the produced bio gas were considered. The possibility and prospects of using bio gas in centralized gas supply systems have been studied. It is established that the total potential of bio methane production from agricultural waste of the Belgorod region is 465 million m3 / year, which is 14% of the annual volume of gas consumption in the region.

Recently, in developed countries, there has been a steady trend towards reducing the consumption of exhaustible energy sources and using alternative fuels. In most countries, state programs and laws have been adopted and are working to develop small-scale power generation and use of environmentally friendly renewable energy sources [1].

In the countries of the European Union (EU), the Unified Environmental Strategy till 2020 “Strategy 20-20-20” was adopted. According to this strategy, by 2020, the level of carbon dioxide emissions to the atmosphere should be reduced by 20% (compared to the level of 1999), the share of energy from renewable sources in the total energy consumption structure - grow up to 20%, and the total energy consumption - to be reduced by 20% [1]. One of the important sectors of renewable energy in the world is the production and energy use of bio gas. The share of bio gas in the total balance of energy consumption in Europe is 13%.

The aim of the work is to assess the feasibility and prospects of using bio gas in centralized gas supply systems.

Bio gas is a gaseous energy source, obtained as a result of anaerobic fermentation of organic substances of various origin and composition. Bio gas consists mainly of methane (CH₄) and carbon dioxide (CO₂), but also contains a small amount of other gases: hydrogen sulfide (H₂S), nitrogen (N₂), hydrogen (H₂) [2].

The total amount of energy received from bio gas in the EU countries in 2015 was 15.612 million toe. Most of this energy (77%) was produced in three countries: Germany (7.9), Great Britain (2.3) and Italy (1.9 million toe) [3].

Currently, there are 17,240 bio gas plants operating in Europe (Figure 1) [3]. At most stations, the bio gas produced is used in cogeneration plants for the production of heat and electric energy with its supply to centralized electric networks. At the same time, a small part of the heat energy is used for needs of the bio gas plant, and the rest of the heat is not used and is utilized. This leads to a decrease in the economic efficiency of the bio gas plant and an increase in the payback period.
In the last decade, the direction on the use of bio gas in the form of bio methane is actively developing. Biomethane is bio gas, brought to the quality of natural gas. However, for this purpose it is necessary to provide for the purification of bio gas from carbon dioxide, hydrogen sulfide and other impurities, which leads to an increase in the costs of its production. Installations for the production of bio gas with an increased content of methane have been called bio methane plants. In 2016, the number of bio methane plants in the EU countries is 367 units. The largest number of plants are in Germany (178 units), Sweden (59 units) and Great Britain (37) (Figure 2) [4].

In Sweden, most bio methane plants supply bio methane to automobile gas-filling compressor stations (AGNKS) for further refueling with compressed bio methane. It should be noted that in Europe the produced bio-methane is mainly used for supply to centralized gas supply systems (more than 200 plants) [4].
The receipt and use of bio methane is most promising in regions with a high level of development of the agricultural sector. This problem is most relevant for the Belgorod region, which produces about half of all meat products of the Central Federal District of the Russian Federation. In the Belgorod region, the annual amount of waste produced by the agro-industrial complex is more than 15 million tons. The total production potential of bio methane from waste generated is estimated at 465 million m$^3$/year, which is 14% of the annual volume of gas consumption in the Belgorod region.

The bio gas plants operating and being built on the territory of the Russian Federation use the produced bio gas in cogeneration plants for generating electric and thermal energy. When bio-gas is burned in cogeneration plants, it is previously cleaned of mechanical impurities, moisture and hydrogen sulfide. The main problem, restraining, growth of production of bio methane is the need to purify from carbon dioxide and, accordingly, the installation of expensive equipment.

In the Russian Federation, natural gas used in industry and the public utility sector is governed by state standard, which regulates the composition of the gas and the permissible content of non-combustible impurities (Table 1) [5].

Table 1. Physico-chemical parameters of gas combustible natural and municipal purposes

| Indicator                                      | Norm                                      |
|------------------------------------------------|-------------------------------------------|
| Componentcomposition, molar fraction, %        | Not standardized. The definition is mandatory |
| The lowest heat of combustion at standard conditions, MJ / m (kcal / m) | Not less than 31,80 (7600) |
| The range of the Wobbe (higher) number under standard conditions, MJ / m (kcal / m) | From 41,20 to 54,50 (from 9840 to 13020) |
| Mass concentration of hydrogen sulphide, g / m | No more 0,020 |
| Mass concentration of mercaptan sulfur, g / m | No more 0,036 |
| Molar fraction of oxygen, %                    | No more 0,050 |
| Molar fraction of carbon dioxide, %            | No more 2,5 |
| Mass concentration of mechanical impurities, g / m | No more 0,001 |

Given these requirements for the supply of bio methane in the gas supply system, it is necessary to achieve a reduction in carbon dioxide content of less than 2.5 mole. %.

In Europe, the following cleaning methods are used to remove carbon dioxide (CO$_2$) [6]:

- adsorption under variable pressure;
- absorption by water under pressure;
- absorption by amine;
- absorption by other substances;
- membrane cleaning method;
- cryogenic method of cleaning.

The most widespread application was obtained by water absorption, adsorption under variable pressure and absorption by amines.

The Russian Federation has accumulated considerable practical experience in the field of natural gas purification from carbon dioxide. Equipment for the removal of CO$_2$ is widely used in gas fields in the extraction of natural gas and oil. However, taking into account the high content of CO$_2$ in the bio gas produced, reaching 20-30%, it is necessary to conduct a complex of studies aimed at finalizing the equipment to achieve the required degree of purification.

After purification, bio methane can be fed to the gas transmission network for distribution and supply to consumers. Depending on the volume of bio methane produced, it is necessary to determine the method and place of supply to centralized gas networks. To supply bio methane to the main gas pipelines, it is necessary to provide large volumes of gas with a high over pressure (3-5 MPa), which will require the installation of an additional compressor station and lead to an increase in capital expenditures. Taking into account that during purification of bio methane the pressure of the gas leaving the treatment facilities reaches 0.3 Mph, it is more expedient to supply bio methane to the distribution pipelines of medium and low pressure.

It can be concluded that the use of bio gas as a bio methane for centralized gas supply systems is a promising direction for the development of the gas industry. It has been established that the use of bio methane is most expedient in regions with a high level of development of the agricultural sector. Thus, the potential for bio methane production from agricultural waste in the Belgorod region is 465 million m$^3$/year, which is 14% of the annual gas consumption in the region.
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