EXPEDIENCY OF USING MULTIFUNCTIONAL GAS DISTRIBUTION STATIONS IN TRANSPORT INFRASTRUCTURE

ЦЕЛЕСООБРАЗНОСТЬ ИСПОЛЬЗОВАНИЯ МНОГОФУНКЦИОНАЛЬНЫХ ГАЗОРАСПРЕДЕЛИТЕЛЬНЫХ СТАНЦИЙ В ТРАНСПОРТНОЙ ИНФРАСТРУКТУРЕ

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Abstract: *The article is discussing the possible options for the implementation of potential energy, which is contained in the gas pipeline in the form of pressure, which is actually lost when the gas is reduced at the GDS. Improving energy efficiency is a major challenge for Bulgaria's economic development. The extensive development of Bulgaria's gas pipeline network and the increase in the level of gasification also increases the energy that is actually released into the atmosphere. Are considered various options for the implementation of overpressure for the purpose of increasing energy efficiency, the realization of which will not only improve the efficiency of the construction of the distribution network of gas pipelines, but also will partially solve the problem of the widespread introduction of road transport on electricity and liquefied gas.*
KEYWORDS: *GAS DISTRIBUTION STATION, ENERGY EFFICIENCY, TURBO EXPANDERS, SMALL SCALE LNG, GASIFICATION OF BULGARIA*

1. Introduction

Bulgaria is implementing a project to develop its gas transmission network, including the possibilities offered by projects of interconnection with neighbouring countries through the construction of Interconnector gas pipelines. Works on them are in different degree of readiness. The construction of the gas intersystem connection between Bulgaria and Romania was completed in the autumn of 2016, until the end of 2020 it is planned to be put into operation interconnectors Greece-Bulgaria and a similar gas pipeline with Serbia. In perspective is considered the increase in the volume of gas supplies to Bulgaria when would be implemented the projects "Southern gas corridor" and "Turkish stream".

Today, the consumption of natural gas in Bulgaria is about 3 billion m3 per year, of which about 10% is natural gas extracted in Bulgaria, and 90% is imported gas. The structure of consumption of primary energy resources in Bulgaria today is dominated by coal-37% and nuclear energy — 22%, as well as oil — 21%. Natural gas pertains about 12%, while the territory of Bulgaria is gasified by about 3% [1]. As the costs of using coal resources increases, Bulgaria's need for natural gas will increase significantly.

2. Results of discussion

The concept of the implementation of promising projects for the development of the Bulgarian gas industry, including the implementation of the gas hub project, should be based on the most effective solutions at all stages of the creation of the gas transportation infrastructure. Gas in the main gas pipelines contains a significant amount of potential energy of the excess pressure of the gas flow, which is irretrievably lost when reducing gas at gas distribution stations to pressures in distribution networks.

At present time the technologies of complex use of energy of gas on GDS for power generation are known.

On GDS is made a pressure drop of the transported natural gas from 7.5 to 1.2 MPa. For use of physical energy of gas received at the expense of decrease in pressure of gas on GDS, instead of using traditional throttle devices it is supposed to use expander-generator aggregates (EGA), the schematic diagram of work is specified in figure 1.

The use of EGA provides not only a reduction in pressure, but also the generation of electricity, which is produced by an electric generator installed behind the expander. The potential for energy production due to excess pressure is directly proportional to the energy potential of the gas, which is determined by the technical work of adiabatic expansion.

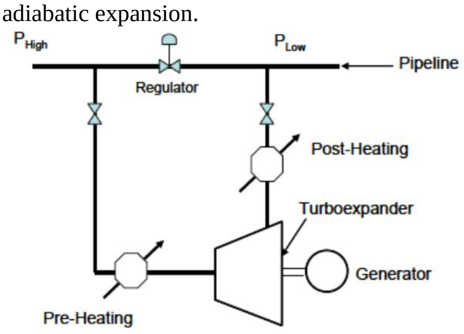

Fig 1. *Schematic diagram of EGA*

From the point of view of energy saving in the gas transportation system is promising the utilization of this potential energy. EGA are produced by many manufacturers, for example, ABB and Atlas Copco, Corporation "Rotoflow", the RMG company, JSC "Turbogaz", LLC "Kriokor", STC "MTT".

The first experiments on the installation of turbo expanders in Europe began in the mid-70s of the 20th century in Germany, the Netherlands and France. For the first time, a EGA was set in commercial operation in the USA in 1983 (table 1).

Table 1*. The first implementation projects of EGA in the industry [3]*

Location	Application	Size, Hp, (kW)	Design Flow and Pressure Drop	Year Installed
San Diego, CA (SDG&E)	City Gate	365 (260)	11 MMCF/D (810 – 390 psia)	1983
Memphis, TN (Memphic Light)	Chemical Plant	600 (450)	15 MMCF/D (450 – 87 psia)	1983
Stockbridge, GA (Transco Pipeline)	Compressor Station	400 (300)	7 MMCF/D (555 – 85 psia)	1984
Hamilton, NJ (Starmark Energy)	City Gate	3,862 (2,800)	36 MMCF/D (635 – 70 psia)	1987

In 2010 was launched in London an ambitious project to equip the main gas pipelines around the city with a mini-EGA network, the total installed capacity of the network is expected to be 20 MW [4].

Are also known technologies of complex use of gas energy from GDS for filling of vehicles equipped with engines on compressed and liquefied gas.

At low-tonnage LNG production, gas liquefaction is generated at local installations (capacity - no more than 10 t/ h) located near gas pipelines, for example: gas distribution stations (GDS), automobile gas-filling compressor stations (AGFCS), gas compression stations (GCS), - with delivery to consumers (within a radius of 200 km) for use as gas motor fuel for transport or replacement of diesel fuel or fuel oil at enterprises with energy-intensive technology.

If liquefied gas is used, the natural gas with the main line pressure is supplied to the drying unit, compressed in a turbocharger located on one shaft with the turbo expander up to 41 kgf/cm^2, cooled in a natural gas cooler and divided into liquefied (13.5%) and expanded (86.5%) flows. The liquefied stream comes through the cleaning unit, and, further, both streams pass through the advanced and basic heat exchangers. As a result of expansion in the turbine expander gas temperature is reduced to -50 º C. Since this decrease in temperature is not enough to liquefy the gas, further throttling is performed, as a result of which the temperature of the gas decreases to -140 º C. The gas-liquid mixture enters the separator to separate the liquid from the vapor phase; the steam phase passes through the heat exchangers, and the liquid enters the storage and distribution unit. The schematic diagram of the installation for liquefied natural gas with a throttle-expander cycle is shown in figure 2, the specified scheme was implemented at GDS-4 in Yekaterinburg [5].

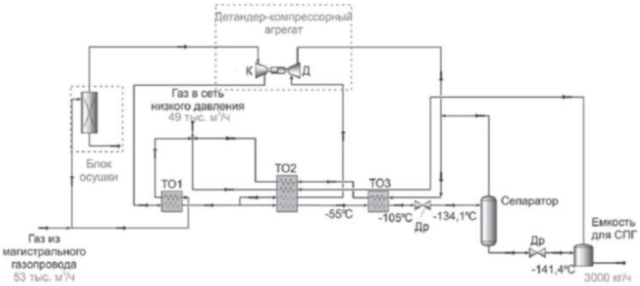

Fig 2. *Schematic diagram of LNG production plant with throttle-expander cycle*

In case of using compressed gas, natural gas purified from impurities and moisture comes from external networks (gas distribution substations GDSS) to the compressor inlet under pressure 0,3 – 0,6 MPa. In the compressor, the gas is compressed in series with a moisture separation. During the compressor operation, the pressure and temperature of the compressed gas are controlled by stages. After cooling, the gas is sent to the separator, where it is removed from the condensate and oil trapped in it during compression and cooling. Gas compressed to 25 MPa fills the inner cylinders (pressure compensators) in the volume of about 1120 liters. Compressed natural gas from the pressure compensator is fed to the filter connector located in the transfer column and then through the ball valve and solenoid valve, filter and enters the flow meter. After that, the gas flows through the pipeline to the filling connection and further — into the cylinders of the refueled car. The cost of production of CNG is much lower than the cost of production of fuel from crude oil: to prepare natural gas for use as a motor fuel, it does not require pre-processing, the gas is transported through pipelines directly to the gas station. According to the international natural gas vehicles association (NGVA), currently programs for the development of the gas motor fuel market are being implemented in 86 countries.

Work on liquefaction and compression of natural gas may also be executed partially or fully due to the transformation of energy of excessive pressure of main gas flow.

In principle, it is possible to implement the scheme of multifunctional gas distribution stations combined with gas filling and electric charging stations.

The use of electricity generated from autonomous sources is always faced with the problems of synchronization of these sources with existing electricity networks. In addition, in order to run a charging station on the gas station and start trading with electricity, it must enter into contractual relations with electricity supply organizations. These problems are sometimes intractable due to the expensive hardware for synchronization or unwillingness of the suppliers of electricity to prevent interference in the operation modes of their own networks. Therefore, when generating electricity by autonomous sources, it is desirable to have the same autonomous consumers. These consumers can be vehicles equipped with electric motors and the GDS itself. In this case the project of creation of the multipurpose gas-distributing stations providing not only reduction, but also complex use of energy of gas on GDS for generating the electric power for own consumption and gas station of vehicles, and also production of the liquefied and compressed gas as gas-engine fuel can be realized that will allow to utilize potential of pressure which is now bleached from main gas pipelines in the atmosphere and to provide direct additional profit. A special advantage in this case have GDS, located in close proximity to industrial enterprises and large settlements, thanks to the presence of potential consumers.

Conclusions: The new construction of a network of natural gas main and distribution pipelines in Bulgaria creates unique opportunities for the implementation of promising ideas, one of which is the idea of energy saving and increasing the efficiency of primary energy resources consumption. Electric drive and natural gas used as motor fuel, reduce the consumption of liquid fuels, provide energy saving, increase the life of motor vehicles, reduce environmental pollution.

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