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Original Research Article

Transport and Distribution of Liquefied Natural Gas

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Transport and storage of liquefied natural gas (LNG) require special equipment that keeps the temperature within the tank less than 164 °C and at a pressure of not more than 8 bar, with all modes of transport. The storage containers used have a special design that allows the transport (road, rail and water transport) of LNG and also serve as a temporary storage. Storage of large quantities is carried out in large tanks with a capacity of 100 m^3 or more. Equipment storage tanks include devices for control and maintenance of LNG in the prescribed conditions. It must be certified by the regulations (national and international standards) governing this area. By using LNG, motor traffic and agricultural machinery technology, can be translated into promising a safe, environmentally friendly and cost effective form of fuel.

Keywords: Transport, storage, liquefied natural gas (LNG), temperature, pressure, control, maintenance, equipment, environment, fuel.

INTRODUCTION

For transportation and storage of liquefied natural gas (LNG) require special equipment that allows to keep the temperature in the tank at 164 °C at a pressure of not more than 0.8 MPa during the entire transportation and storage. LNG applies containers that have a special design that allows the delivery of LNG to customers through any type of transport (road, rail and waterways) and serve as a temporary storage warehouse-high capacity tank (from 100m^3) equipped with special devices designed to control and maintain the LNG in predetermined limits as well as for receiving and issuing LNG to consumer in liquid and gaseous.

THE WORLD'S LARGEST GAS EXPORTERS

The world's largest gas exporters are presented in the table. 1. Figure 1 shows the transmission system of Europe.

TECHNOLOGICAL CHAIN OF LIQUEFIED NATURAL GAS

Trucks and semi-trailer-tank are designed for transportation and storage of liquid equipment and fueling their various systems and appliances. Semi-trailer (tank PPCP-16/1.6) is intended for the storage and transport of other LNG cryogenic equipments. Figure 2 and Table 2 shows the specifications and appearance of the mobile air tankers respectively. [1] [2] [3]. Figure 3 represents a 45ft container for LNG, intended for transportation of LIN- LOX-LAR-LNG (liquid nitrogen, oxygen, argon, liquefied natural gas). They are available with nominal volume of 54.8 m^3 with insulation (vacuum + perlite). [4]

Cryogenic natural gas technology is able to compete with the traditional pipeline technology. In addition, the factors that increase the benefits from the use of cryogenic technology are as follows:

- Cryogenic technology allows the supply of natural gas to one set of liquefying several settlements or farms, located at a considerable distance from the complex and from each other. This increases the benefit of using cryogenic technology;
- Installation of additional equipment pays for itself within 2-3 years savings of expensive gasoline or diesel fuel.

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Table 1. The world's largest gas exporters

Country	Export (billion m^3)
Russia	202.8
Canada	102.1
Norway	86.2
Algeria	64.4
Netherlands	54.7
Turkmenistan	50.0
Indonesia	34.9
Malaysia	31.2
Qatar	31.2
USA	20.5
Other countries	206.5
Total	**884.5**

Figure. 1. Gas Infrastructure Europe (GIE)

Figure. 2. Appearance of tanker

Table 2. Technical data

Product name	STR-25/0,8	STR-8/0,8	STR-16/0,8
Capacity, m^3	25	8	16
Pressure for extradition, MPa	0,8	0,8	0,8

Figure. 3. Intermodal container for LNG (United States)

TRANSPORT OF LIQUEFIED NATURAL GAS

Liquefied natural gas abroad (France, United Kingdom, Netherlands, Germany, Japan, United States) is used in diesel vehicles, tankers. In particular, the United States firms - Ford, Pontiak, Oldsmobil, Peugeot France, Gaz de France, Germany's Man, Deimler-Benz, Linde dealt with the introduction of CNG vehicles. In the United States on CNG employs more than 600 dump trucks, up to 25% of the municipal transport; in France and Italy operated bus lines. The EU is projected to 2020 suggests to bring vehicle fleet of natural gas vehicles (NGVs) to 23 million. units [5] [6].

American railway company Berlington-Norden carries out regular service locomotive running on CNG on the route length of 2000 km. The use of CNG on the railways can provide replacement of at least 1.5 … 2.0 million tons/year of diesel fuel.

LNG can operate successfully as sea and river vessels, barges, "Kometa", "Raketa", with gas turbine, diesel engines. Particularly effective, you can use LNG in cars-refrigerators, where LNG can first be made to the cooling circuit to maintain the preset temperature in the cooling Chamber and then into the engine. Compared with liquid nitrogen at the LNG in 3 times higher evaporation temperature, which makes it a more technologically efficient as a refrigerant.

LNG can be used effectively in small geographically dispersed energy consumers. It has an advantage compared to the traditional way of gas supplies piped in from distances the main gas pipeline more than 5 ... 10 km for small consumers and at a distance of more than 30 ... 50 km- for medium, as well as compared to delivery of natural gas in cylinders under pressure. In this case, the cost of production and transport of liquid methane below than onto the gas pipeline. For example, the construction of the gas pipeline in the Leningrad region (2000y.) at a distance of

143 km cost 7.1 million dollars, and capital costs for the production of LNG to 1.7 million dollars. Technical and economic advantages of using liquefied natural gas builds up power consumption reduction and increasing distance from the source of the gas.

After the gas pipeline LNG cryogenic equipment can be moved to a new location. Such a scheme has been operating for many years in France. The first steps in the use of LNG in energy conservation in industry and communal services made in St. Petersburg and the Leningrad region, where it already employs 2 pilot LNG installations (UIS Vyborg, Nikolskaya), and several remote boiler in the field working on imported LNG. Fully uses all the advantages of LNG as fuel.

LNG is used to obtain electrical and thermal energy generators with gas-driven piston. At the expense of 1 Nm3 natural gas is liquefied, you can get up to 3.5 kWh of electrical energy and at the same time 4.5 kWh of thermal energy in the form of hot water with a temperature of 900C. Octane number of natural gas, which has a value of 104 units, unreachable for any brand of gasoline (better grade of gasoline –95). On the heat of combustion 1m3 of natural gas (1.5 l of liquefied) is equivalent to 1.00 … 1.12 liters of petrol. Their application can be easily adapted to conventional petrol and diesel engines.

We know that road transport consumes more than 70 percent of motor fuels and is a major source of air pollution pools industrial centres. So in the United States at its 84 per cent of the total accounted consumption of motor fuels in Western Europe – 82%, Japan – 76%. The share of aviation in USA have 13% in Western Europe – 10%, Japan – 5% of the total consumption of motor fuels.

Figure. 4. Truck Tractor KAMAZ-65116-34 on LNG with kriotank

Road transport in Russia (Russia's fleet of 27 million, of which 4.57 million trucks and 650 thousand buses) annually is thrown more than 17 million tons of pollutants or 40% of all contaminants. In Moscow, for example, annual emissions of harmful substances by vehicles reach 586,000 tons, which corresponds to 85% of industrial air pollution. Up to 30% of the diseases of the townspeople are associated with air pollution.

The economic damage caused by the operation of the transport complex is 3.4 billion dollars. Therefore, the use of natural gas in vehicles is justified not only on the technical and economic, but also from an environmental point of view (overseas, such as in the United States and Germany, the latter factor is decisive in gasification of vehicles).

It is transport with his overwhelming dependence on oil generally determines the severity of today's energy situation in the world. Figure 4 represents the tractor KAMAZ-65116-34 with kriobakom to LNG. The use of natural gas as motor fuel substitute for transport has a number of aspects in part of the environment:

- natural gas has the lowest "global warming index" (Global Warming Index)-GWI: gasoline – 212 g/km; diesel – 192 g/km; natural gas – 164 g/km; the lowest CO_2 emissions: AI-95 – 100%; AI-76, diesel fuel – 88%; natural gas – 72%;
- the weakest impact on ozone layer depletion: gasoline – 950 mg/km of ozone; natural gas is 30 mg/km of ozone;
- absence of toxic and carcinogenic components (compared to gasoline): aldehydes and formaldehyde – 42%; aromatic and butadienes-about 1%;
- the lowest emissions of carbon monoxide (CO): diesel – 7 g/km: natural gas – 4.5 g/km;
- the lowest emission of nitrogen oxides (NOx): diesel – 22 g/km; natural gas – 4.0 g/km.

The General problems of the use of LNG can be attributed to the establishment of the concept of cryogenic system, how to blast fire security, how to manage cryogenic system, control of leaking fuel pumps work, way of maintaining the necessary pressure in the tanks, the fuel vapour recycling method, a way to drive the valves, ensure power of the engine, and way to fuel cryogenic fuel, long tubeless storage. The percentage of components will change the boiling point of LNG, density and critical pressure on border transition liquid-vapor, which need to be taken into account in the calculation of energy fuel feeding system [7] [8].

As an example, in Figure 5 represents dump truck BELAZ-75485 with cryogenic tank. The amount of methane, which is enclosed in a cryogenic tank capacity 560 l and the odds of it uses 0.8, equivalent to 25 ... 27 CNG cylinders under pressure of 20.0 MPa, that is, when using CNG as fuel gas must be placed on the career dump truck 25...27 cylinders volume to 50 l each, which would require not only complex constructive solutions, but also will reduce the useful payload dump of nearly 2000 kg. In recent years, the problem of LNG production and its use as a motor fuel for rail, water and air transport, as well as to municipal gas settlements as boiler fuel at the enterprises of the fuel and energy complex (FEC), to create the reservation systems of gas is actively discussed.

In rail transport, trunk and shunting locomotives operate on diesel fuel, so the increase in the price of fuel oil has a significant impact on the outcome of the economic activities of users of the services of the railways as a trademark, and passenger transport. The solution to the problem can be found in the translation of diesel engines of locomotives on a gas-and-diesel mode using natural gas (Figure 6). The translation engines to gas-and-diesel mode is only 25 ... 35% of diesel fuel as a spark, and the remaining 75 ... 65% of rated flow fuel is replaced by natural gas [9] [10].

When using LNG cryogenic tank with a capacity of 30 ... 40 m^3 is placed on open tender between the sections of the locomotive on the railway bogie (production of JSC "Ural vagon zavod", Nizhny Tagil, Russia) [11]. Figure 7 shows the advanced development company PSC Tupolev Tu-334, Tupolev Tu-330, using LNG as fuel. Figure 8 represents a joint draft PSC Tupolev and Deutsch A-310 aircraft Aerobus.

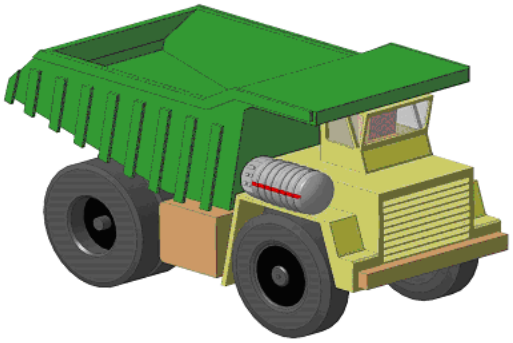

Figure 5. Location of the cryogenic fuel tank volume 560l on a dump truck BELAZ-75485

Figure. 6. Bulk cargo GT1 gas turbine

Figure 7. Aircraft TU-334K, Tu-330 K with LNG engines

Figure 8. A-310 Aircraft with engines to LNG

CONCLUSION

To ensure the most effective use of LNG, despite high scientific and technical level, continued research and development in the field of the rational use of their specific properties is inevitable. Based on the technology, it is possible to supply a liquid or gaseous methane to agricultural equipments directly in the field, which is extremely difficult to implement using pipeline technology.

Fuel gases have such advantages as good anti-detonation quality, favorable conditions of carburetion and ignition wide limits in mixture with air, a higher service life of the engine, high octane number and others Using LNG in railway transport facilitates the translation of main-line diesel locomotives for natural gas and reduces transportation costs. Vehicles and agricultural machinery can be translated into a promising safe, environmentally clean and cheap form of fuel.

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