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GELIIMASH – A TECHNOLOGICAL BREAKTHROUGH

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Helium Machinery Scientific-Production Association (NPO GELIIMASh) has developed and built the first domestic cryogenic transporting helium tank of the trademark TsTG-40/0.45 with a capacity of 40 m^3 – a key element of the logistic system of liquid helium delivery across Russia and to other countries. The TsTG-40/0.45 tank filled with liquid helium at the enterprise KRIOR was successfully tested at the Orenburg helium plant; the liquefying helium equipment was built at NPO GELIIMASh. The tank filled to the full capacity successfully passed the tests in conformity with the regulations of the Russian Marine Shipping Register, which provides the possibility of transporting liquefied helium all over the world on a par with the foreign-made helium tanks.
Keywords: *cryogenic engineering, cryogenic tank equipment, cryogenic tank, liquid helium.*

With an order placed by the Gazprom Company and Gazprom Dobycha Orenburg Company, Helium Machinery Scientific-Production Association (NPO GELIIMASh), the leading enterprise in the cryogenic field in Russia, *has developed and built the first domestic cryogenic transporting helium tank of the trademark TsTG-40/0.45 with a capacity of 40 m^3*, which is the key element of the logistic system of liquid helium delivery across Russia and to other countries (Fig. 1).

Helium is a strategically important gas used in high-technology productions, defence, power engineering, and research on fundamental properties of matter. The importance of helium stems from its unique physical properties, including its boiling point of –269°C.

GELIIMASh is called the pioneer of cryogenic engineering in Russia, being the builder of the Moscow helium machinery plant 80 years ago. On the example of the GELIIMASh, one can graphically trace the history of development of the branch from small air fractionating units to industrial helium liquefiers.

At present, the range of GELIIMASh products is quite wide – especially this is equipment for production of industrial gases, including helium. Most of the cryogenic units for scientific and industrial centers of the country are built by GELIIMASh; among the organizations where GELIIMASh cryogenic equipment are in operation are the Joint Institute for Nuclear Research (JINR) in Dubna, TVEL Corporation in Glazov, Institute of High-Energy Physics (IFVE) in Protivno, Kapitsa Institute of Physical Problems, Kurchatov Institute of Atomic Energy, Budker Institute of Nuclear Physics of the Siberian Branch of the Russian Academy of Sciences, Institute of High Temperatures (IVT) in Moscow, St. Petersburg Institute of Nuclear Physics (PIYaF) in Gatchina, Energiya conpany in Korolev, Lebedev Physics Institute of the Russian Academy of Sciences (FIAN) in Troitsk, and others.

Over the years 1980–1995, Gazprom and GELIIMASh developed large-scale Russian technologies for separation, purification, and liquefaction of helium at the Orenburg helium plant.

Today three GELIIMASh helium liquefiers of the trademark KGU-500 with a full capacity of 2000 liters/h rank among the largest helium centers in Europe. The actual output is as much as 10 million liters of liquid helium per year, which is as much as 30% of the helium demand in the European market.

In order to address long-term ambitions objectives relating to the development of helium-bearing deposits of Yakutia and East Siberia, it is necessary to build appropriate equipment for separation, purification, liquefaction, and transportation

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Fig. 1. Cryogenic transporting helium tank TsTG-40/0.45.

of helium, drawing up of a national helium plan associating leading domestic machine building enterprises since it is necessary to develop and build:

- large-sized cryogenic towers for ethane separation and methane liquefaction with feed-basis output of 3 bln m^3/yr and/or 5 bln m^3/yr;
- large-sized cryogenic coiled twisted heat exchangers with coil weights of 40–100 tons;
- units for fine purification of helium concentrate and production of commercial gaseous helium with unit outputs of 750–850 m^3/h;
- large helium liquefiers with unit outputs of 1000–1200 liters/h;
- large stationary liquid helium storages with unit capacity of 120 m^3; and
- 40 m^3 tanks for transporting liquid helium by truck and ship. Similar tanks are essential especially for Russia with her high potential of helium-bearing deposits and significant distance of natural gas treatment and liquid helium production centers from the helium-using facilities. Roughly 5–6 such tanks are required for export of only 1 million nm^3 of helium per year.

Precisely because of this, Gazprom and Gazprom Dobycha Orenburg entrusted GELIIMASh with the task of building the modern domestic cryogenic transporting helium tank of the trademark TsTG-40/0.45.

GELIIMASh was assigned highly complex and multifaceted tasks:

design – a large volume of strength and thermal calculations;

technological – development and fabrication of unique technological devices and stands, acquisition and commissioning of advanced equipment, optimization of welding conditions, installation of nitrogen screen, insulation, components of suspension device, and final assembly of the tank; special pride of the workers were fibreglass-reinforced plastic supports and shackle-type supports that withstand unit load of up to 40 tons; and

industrial – fabrication of large-sized shells with minimum deviations from cylindrical shape and coaxial alignment of the components, highly loaded composite support components.

The works were rendered difficult by the peculiar features of the articles, such as orienting the internal assemblies across a large length with stringent requirements for minimum gaps between the component parts of the tank with low rigidity of the components; for instance, a gap of 7 mm was maintained between the shell and the insulation for a design length of 12 m and a diameter of 2.4 m.

The designers, technologists, and manufacturers had to do a lot of things for the first time. However, intense work of the team, experience gained over decades, professionalism of the highest order, and application of advanced materials and technologies predetermined the natural outcome, which is that the first domestic helium tank of the trademark TsTG-40/0.45 was built to global quality standards. The specifications of the tank are listed in the table below.

Helium tank capacity, m^3	40.0
Weight of filled helium, kg	4500
Evaporation of liquid helium, kg/h (% days)	≤1.13 (0.54)
Leakage-free helium retention time, days	≥30
Nitrogen vessel capacity, m^3	1.5
Weight of filled nitrogen, kg	1200
Evaporation of liquid nitrogen, kg/h	≤1.5
Time of evaporation of entire nitrogen, days	≥33
Overall dimensions, mm:	
length	12192
width	2438
height	2591
Weight of tank, kg:	
empty	18500
filled-up	24200

The TsTG-40/0.45 tank filled with liquid helium at the enterprise KRIOR was tested successfully at the Orenburg helium plant; the helium liquefying units were built by GELIIMASh. The tank filled to the maximum capacity successfully passed the tests in conformity with the regulations of the Russian Marine Shipping Register, which provides the possibility of its transportation throughout the world at par with foreign-built helium tanks.

Building of the domestic helium tank provides the cryogenic branch of domestic engineering with the following advantages:

1) possibility of building liquid helium production and delivery infrastructure on its own rudimentary base in the gas-processing complex of Russia;

2) reducing overall expenditures and cost of product (liquid helium);

3) development of technologically highly effective industry, new advanced technologies and materials;

4) building new production capacities:

5) solving problems of employment and training of highly qualified personnel; and

6) augmenting prestige of domestic machine building complex in international market, which is particularly important because of Russia's accession to the WTO.