

---

# Creation, design improvement, development prospect of vehicles for liquid hydrogen

© O.Ya. Cheremnykh

Uralcryomash JSC, Nizhniy Tagil, 622051, Russia

*The study reports on the hydrogen transport products development on the basis of analysis of previously created structures for transporting liquid hydrogen to implement modern promising hydrogen technologies used in the rocket, space, marine and other industries. In the research we looked for optimal solutions in choosing thermal insulation of transport products for liquid hydrogen. We opted for screen-powder-vacuum heat insulation and justified this choice, as well as the amount of vacuum in the tank interstitial space per the amount of hydrogen losses in the transport product. The analysis of liquid hydrogen purity during transportation made it possible to identify the main impurities and to assess the change of their concentration in hydrogen during transportation. We also made the choice of criteria for technological operations ensuring the preservation of liquid hydrogen quality in a transport tank. According to findings of these studies, we suggest a technological operation of “draining off” hydrogen at the rocket-space complex without tank pressurizing from an extraneous source of pressurizing gas, using only its “pure” hydrogen vapor. The work is the first to present the results of experimental studies on the effects of vacuum loss in a tank on the full-scale sample of a hydrogen tank of the ZhVTS-100M model in the emergency situation. Based on these studies, it was possible to justify the choice of material and the construction of the cryogenic transport tank shell with respect to the tank itself, as well as to ensure the protection against the tank undercarriage damage in case of vacuum loss in the emergency situation. The presented recommendations formed the basis for designing the majority of transport cryogenic products for transportation of liquefied (cryogenic) gases: oxygen, nitrogen, argon, liquefied natural gas. The study is the first to give the description and technical characteristics of a prospective transport product — container-tank for liquid hydrogen for multimodal transportations.*

**Keywords:** liquid hydrogen, railway tank, tank-container, automobile tank, thermal insulation, evaporability, safety-drainage device, drainless transportation, hydrogen purity, container platform, railway platform

## REFERENCES

- [1] *Raketo-kosmicheskaya korporatsiya “Energiya” im. S.P. Koroleva 1946–1996 gg.* [S.P. Korolev Rocket and Space Corporation Energia in 1946–1996]. Moscow, Menonsovpoligraf Publ., 1996, 670 p.
  - [2] *ОАО “Uralkriomash” “Malaya zemlya Vagonki”* [Uralcryomash JSC. Small land of Vagonki]. Ekaterinburg, SV-96, 2001, 208 p.
  - [3] Arkharov A.M., Kunis I.D. *Kriogennyye zapravochnyye sistemy startovykh raketno-kosmicheskikh kompleksov* [Cryogenic refueling systems of launch rocket and space complexes]. Barmin I.V., ed. Moscow, BMSTU Publ., 2006, 252 p.
  - [4] Kozlov S.I., Fateev V.N. *Vodorodnaya energetika: sovremennoe sostoyanie, problemy, perspektivy* [Hydrogen energy: current state, problems, prospects]. Moscow, Gazprom-VNIIGAZ Publ., 2009, 520 p.
  - [5] Zashlyapin R.A., Pavlenko S.T., Cheremnykh O.Ya. *Tekhnicheskie gazy — Technical Gases*, 2007, no. 4, pp. 15–20.
-

- 
- [6] Kuzmenko I.F., Rumyantsev Yu.N., Saydal G.I. *Tekhnicheskie gazy — Technical Gases*, 2008, no. 1, pp. 53–58.
- [7] Gelperin I.I., Ilinskiy A.A., Almazov O.A., Adugin I.A. *Zhidkiy vodorod* [Liquid hydrogen]. Moscow, Khimiya Publ., 1980, 228 p.
- [8] Cheremnykh O.Ya., Zashlyapin R.A., Chmel A.A. *Kriogennaya tsisterna* [Cryogenic tank]. Patent RF no. 2059147, 1996, bul. no. 12, 7 p.
- [9] Cheremnykh O.Ya., Zashlyapin R.A., Karlov I.A., Chmel A.A. *Sposob transportirovki zhidkogo vodoroda* [The method of transporting liquid hydrogen]. Patent RF no. 2064626, 1996, bul. no. 21, 6 p.
- [10] Cheremnykh O.Ya., Zashlyapin R.A., Nasibulin I.K. *Konteyner-tsisterna* [Tank-container]. Patent RF no. 2259312, 2005, bul. no. 24, 7 p.

**Cheremnykh O.Ya.** (b. 1950) graduated from Kazan National Research Technical University named after A.N. Tupolev in 1973. Cand. Sc. (Eng.), general designer of Ural-cryomash JSC. Research interests include cryogenic engineering.

e-mail: cryont@cryont.ru

---