**THE USE OF COMPOSITE MATERIALS TO IMPROVE THE EFFICIENCY OF TRANSPORTATION OF LIQUID AND LIQUEFIED CARGO BY RAIL**

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**Abstract**

The paper investigates the use in the production of a tank container to make a vessel from polymer composite materials, which bring this container for transportation to a new qualitative level. This makes it possible to increase the service life of containers and the frequency of their circulation, ensures the safety of the properties of the transported product and increases the environmental safety of transportation.

**Keywords:** service life, material, polymer, container, tank, epoxy resin, operation, physic-chemical.

**Introduction**

To date, Uzbekistan has a huge transport potential and unique opportunity to meet the needs of the Republic in the movement of various goods and passengers in all directions and by all possible modes of transport. JSC UTY (Uzbekiston temir yullari) has a modern fleet of freight cars for the transportation process. The main goal of the strategies for the development of railway transport in the Republic of Uzbekistan is to create a new generation of rolling stock with increased axle load at high speed and lower tare weight. Today, research laboratories of leading universities and industry enterprises are working on solving the tasks set. According to the specialists of JSC UTY, the main changes should concern the technology of manufacturing wagons and the use of innovative composite materials in their design. Based on this goal, the following tasks of this article are considered for the manufacture of a tank container with a polymer vessel for the transportation of liquid and liquefied cargo by rail in the conditions of the Republic of Uzbekistan. The advantage of a tank container is that they are convenient for the transportation of goods by multi-modal communication using several modes of transport (road, rail, water and air transport). In addition, the tank container can be transported without reloading the cargo when changing vehicles, unlike railway and auto tanks. These properties of the tank container ensure the safety and security of cargo transportation. A vessel made of PCM is a closed cylindrical product with an internal volume designed for storage and transportation of liquid aggressive substances, chemical and petrochemical products. Today, there is an active use in the production of a tank container to make a vessel from polymer composite materials, which bring this container for transportation to a new quality level. This makes it possible to increase the service life of containers and the frequency of their circulation, ensures the safety of the properties of the transported product, and increases the environmental safety of transportation. Today, advanced projects are underway in a number of countries for the production of tank containers with a PCM boiler.

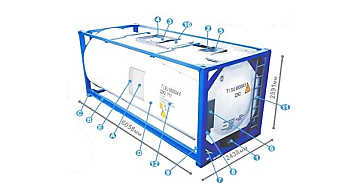


Figure 1. Construction of a tank container with a polymer vessel

1-lower drain; 2-place for installing the upper drain; 3-cargo hatch; 4-safety valve; 5-air valve; 6-identification plate; 7-frame supports; 8-thermometer; 9-pencil case for storing documents; 10-transitional bridges; 11-lifting ladder; 12- stencil.

The manufacturing technology of polymer tank boilers is carried out by the method of continuous winding of glass material impregnated with a binder resin on the rim. Filament winding is a method of manufacturing high–strength reinforced shells from PCM by continuous winding of filler (roving, tapes, fabrics) impregnated with a polymer binder onto a rotating mandrel.

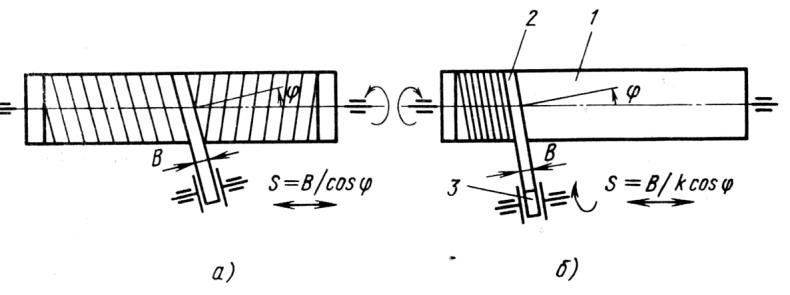


Figure 2. Diagram of spiral-helical tape winding:

a - in one layer in one pass, b - in / k layers in one pass, 1 - mandrel, 2 - wound tape, 3 - coil with tape

In this method, a tape formed by a system of threads or formed from a fabric is impregnated with a polymer binder, fed to a rotating mandrel having the configuration of the inner surface of the product, and placed in it in various directions. There are several technological methods for obtaining products by winding, depending on the method of applying the binder to the fibrous reinforcing material and ensuring the necessary content of it in the product material. After obtaining the required thickness and structure of the material, then the mandrel is cured and removed. The method of continuous winding makes it possible to obtain shells of rotation of a complex shape and to implement with high accuracy a large number of reinforcement schemes for products made of polymer composites.

A chemically resistant layer on the inner surface of the multilayer shell of the vessel made of PCM, which protects the structural layer of the vessel from the chemical effects of the cargo being transported. A tank container is a container consisting of a

frame (frame elements) and a polymer tank equipped with drain fittings and devices for unloading, both under gravity and under pressure. Rules for the manufacture of a tank container with a vessel made of polymer composite materials (PCM), performed according to the interstate standard GOST 33549-2015.

The main parts of the tank container such as fittings, safety screws of the tank filling and unloading devices must be made of steels according to GOST 5520, corrosion-resistant steels according to GOST 5632, GOST 7350 or double-layer steels according to GOST 10885, aluminum and its alloys, titanium and other materials. The multilayer shell of a vessel made of PCM should include the following three elements: an inner chemical resistant layer (yaener), structural layers, and an outer layer. The mass content of fiberglass in the manufactured vessel from PCM must comply with the ISO 1172 standard, the orientation and location of the reinforcing layers of fiberglass. Fiberglass of class, E and ECR in accordance with ISO 2078 standard should be used as the reinforcing material of the structural layers of the vessel. It is allowed to use reinforcing fibers of other types that provide equivalent characteristics. For the inner surface of the liner, type C fiberglass can be used in accordance with the standard.

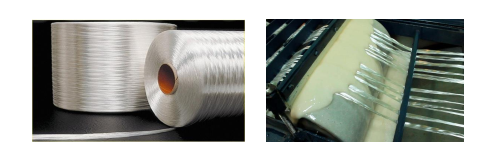


Figure 3. The reinforcing material of glassmaking and the binding resin

The cost of epoxy resin in the Republic of Uzbekistan in bulk for 1 kg is 129950 soums. The price of one glassmaking coil weighing 6 kg is approximately 51,000 soums. The resin consumption per 1m3 for the production of a polymer tank, taking into account the loss of resin in the process of winding by the filamentous method, is approximately 3kg. Knowing the full volume of the vessel, it is possible to calculate the total consumption of polymer material for the production of one vessel of a tank container.

Table 1. Mechanical properties of various resins

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **№** | The name of the indicator | unit of m. | The value of indicators of various resins for winding a vessel from PCM | | | | |
| Polyester | Epoxy | phenol formaldehyde | Polyamide | Silicon organic resin |
| 1 | Density | g/cm2 | 1,4-1,8 | 1,3-2 | 1,5-2 | 1,4-1,8 | 2-3 |
| 2 | Tensile strength | MPa | 240-400 | 400-600 | 300-500 | 300-400 | 300-450 |
| 3 | Flexural strength | MPa | 150-500 | 400-800 | 200-600 | 400-600 | 400-450 |
| 4 | Compressive strength | MPa | 150-300 | 200-400 | 200-300 | 280-350 | 300-400 |
| 5 | Tensile modulus of elasticity | GPa | 10-30 | 20-35 | 15-30 | 18-35 | 28-35 |
| 6 | Operating temperature | Тс,°С | +180 -40 | +130 -40 | +80 -20 | +250 -40 | +300 -40 |

Table 2. Mechanical properties of glass fittings of class E, E6 and E7

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Features** | **Unit of m.** | **EDR 17-2400-312** | **E6DR 17-1200-306А** | **E6DR 24-2400-386Т** |
| The Chapel of strength | MPa | 2513 | 2732 | 2741 |
| Tensile modulus of elasticity | MPa | 79164 | 80132 | 81232 |
| Shear strength chapel | MPa | 67 | 67 | 70 |
| Preservation of shear strength | % | 93 | 91 | 94 |
| Resin Type | Epoxy Polyester | | Polyester Epoxy | |
| Test method | ASTM D2343 | | ASTM D2343 | ASTM D2343 |

The design and design characteristics of the strength and rigidity of a PCM tank, obtained on the basis of the test results of elementary samples, taking into account the regulatory requirements for the safety margin and stiffness coefficients, criteria, strength taken into account when designing the vessel, is carried out in accordance with the rule of manufacturing and monitoring containers during operation.

**Conclusion**

A comparative analysis of metal tanks with tanks made of polymer composite material was carried out. As a result of the investigation of metal and composite materials and their mechanical properties, including the cost of the material, it is proposed to manufacture a tank container with a vessel made of polymer composite material by the method of filament winding in the conditions of the Republic of Uzbekistan.

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