

Polyethylene High-Pressure Pipes

(Tekhnologiya Kompozitov, Perm)

Steel gas pipelines and oil pipelines in Russian cities and towns always require care and worry operating entities. Corrosive damages due to vagabond currents and corrosive soils are the root causes of their failure.

In Russia this problem is dealt with by means of switching the facilities of gasification, oil production, oil transportation, and oil gathering systems to polyethylene pipes as soon as that offers a number of advantages:

- low gas permeability;
- resistance to constituents of gas, to corrosion and crack formation;
- high ductility property and freeze resistance

Ease of welding, secure coupling, ease of assembling and construction process is specific to them.

Service durability and strength of gas and oil pipelines are substantiated by research and development work and operation experience.

The geographic location of the Russian Federation (the dimension of its territory and harsh environment) leads to the need to transport gas and oil for long distances.

Economically feasible conditions of gas transportation require increasing pressure (up to 1.2 MPa) at the same time meeting industrial safety requirements.

It is evident, that in such conditions there is need for pipes offering advantages of polyethylene pipes in combination with high bearing strength.

Developing the pipes of the specified field performance is based on meeting the two principal conditions. The guideline is to combine components of the pipe material assuring new properties of the material, which are not specific to each component taken separately. Another guideline is to develop the composition and structure of the material depending on the application. For instance: a sample manufactured from polyethylene fails under 20-25 MPa tension stress (as soon as the tensile strength of polyethylene is 20-25 MPa and relative elongation is 250-350%). If extra strong reinforcement yarns (3000-3500 MPa tensile strength and 4-15% relative elongation) are incorporated into the sample and a load is applied to the sample in the direction of the yarn setting, the polyethylene will not take up the load, as soon as the entire load will be born by the yarn. It is evident that the failure mode and the strength of the reinforcement material differ significantly from those of standard polyethylene. So, we obtain a new material with new performance which is referred to as a composite material.

Compared to standard filling, the reinforcement of thermoplastic materials implies a conceptually new way of changing their mechanical, thermophysical, and other properties. Controlled reinforcement in the process of manufacture assures the designed anisotropy of mechanical-and-physical properties of the material regarding the direction and range (relative to anisotropy axes). In case of reinforcing polymers with filament reinforcements of the lengths which exceed critical values of the particular composite material composition, the deformation and failure mode changes, moreover the increase of resistance of thermoplastic composite materials to external load can reach hundreds per cents.

As a result, thermoplastic materials compete with widely used expensive thermosetting composite materials (fiber-glass plastics, organic plastic composites, carbon-fiber reinforced plastics, basalt-fiber reinforced plastics). Taking into account the fact that thermoplastic materials have low gas permeability, high chemical stability, and low manufacturing costs, the use of reinforced thermoplastic materials will grow each year. Our Company has developed Russian process technology and the machinery to manufacture reinforced polyethylene high-pressure pipes and obtained respective patents of the Russian Federation.

TU2248-001-55038886-01 was developed and approved with the State Committee for Industrial and Mining Supervision (Gosgortekhnadzor) of the Russian Federation.

The following documents were issued:

Permit for use No. PPC 00-19707 (in underground pipelines, up to 1.2 MPa working pressure),

Permit for use No. PPC 00-20719 (in oil and gas industry, up to 4.0 MPa working pressure)

The pipes are manufactured from PE-80 polyethylene by extrusion and the load-bearing structures made of extra strong synthetic yarns are set in the direction of maximum stress axes. The pipe consists of three layers:

- inner layer made of thermoplastic material resistant to impact of the transported medium;
- load-bearing layer made of extra strong reinforcement yarns set in accordance with a definite reinforcement procedure;
- outer layer made of thermoplastic material resistant to environment impact

The layers are put one after another in the course of a single process cycle; as a result, we obtain a monolithic pipe with a pressed-in load-bearing structure made of extra strong synthetic yarns to which the entire load is applied in operation.

This process technology permits to manufacture pipes from polyethylene as well as from other thermoplastic materials depending on the performance requirements to pipelines, for instance: polypropylene - polyethylene.

As of today, at Tekhnologiya Kompozitov in Perm, batch production of reinforced polyethylene high-pressure pipes has been mastered.

The pipes are available of the diameters ranging from 63 to 160 mm.

The pipes of up to 110 mm diameter can be delivered in reels and that

-improves pipeline assembly process;

-reduces costs;

- increases labour efficiency;

-improves reliability due to minimizing the number of couplings. In the process of pipeline construction, the pipes are assembled by means of butt-welding with the use of heating elements and afterwards, after removing external flash, the welded joint is reinforced with an electrofusion sleeve. Butt-welding and electrofusion sleeve welding are performed in automatic mode and the record of welding parameters is obligatory. The fittings are manufactured of the composite material as well and their strength performance is similar to that of the pipe.

Damaged pipelines are repaired in a way similar to the repair of gas pipelines constructed of standard polyethylene pipes.

That means that due to high strength performance, chemical resistance, ease of assembling process and repair, reinforced polyethylene pipes have a great future in construction of high-pressure pipelines.