NORPLEX MICARTA

High Performance Thermoset Composites

Fiberglass-based thermoset composites prevent temperature migration between the pipeline and support structure in LNG facilities.

Composite Insulation Shields Key Components from LNG

To satisfy the ever-growing thirst for energy around the world, increasing quantities of liquefied natural gas (LNG) are being shipped by sea from areas that produce gas to places where it is needed for purposes such as home heating, electricity generation, and industrial production. At both ends of the journey are plants that convert natural gas into liquid and vice versa.

Conversion facilities include special features for the handling of cryogenic LNG. One key feature is insulation that protects components from extreme cold and keeps ambient heat out of LNG tanks and pipes. Inexpensive wood- and paper-based composite materials can often provide adequate insulation, but they lack the strength to handle the loads placed on insulating materials at many crucial points in LNG facilities.

To meet the needs of the most demanding LNG applications, plant designers turn to special fiberglass-based thermoset composites. Besides superior insulation, glass-based thermoset composites offer much higher strength than their wood and paper counterparts. They also hold up better and last longer in corrosive coastal environments that can take a heavy toll on other insulation materials.

LNG Basics

When no pipeline runs between natural gas producers and users, the gas can be transformed into LNG and shipped in tanks. LNG is produced by cooling natural gas to a temperature of approximately -260°F at atmospheric pressure. This cooling process condenses the substance to about 1/600th of its gaseous volume, making it much easier and less costly to ship.

Overseas gas delivery requires a two-step conversion process. First, gas is cooled into LNG so it can be transported by tanker. Then the LNG is turned back into gas when it reaches its destination. These phase changes take place at conversion plants, which contain tanks and pipes equipped to hold and move cryogenic LNG.

A number of plant components are attached to LNG tanks and pipes. These components can transfer ambient heat into LNG-carrying vessels, thereby reducing the efficiency of the systems that chill and compress the gas. To block this troublesome heat transfer, insulating layers are placed between vessels containing LNG and attached components.

Besides stopping heat transfer, insulation shields plant components from the cold temperatures of LNG vessels. This prevents problems such as icing, which can endanger plant personnel climbing a ladder encircling an LNG storage tank. It also prevents extreme temperature fluctuations that can cause damaging expansion and contraction of metal components such as bolts and pipe supports.

In addition, insulating layers serve as an electrical barrier between metal parts. Electricity flows between metal parts in contact with each other, causing the parts to corrode. By blocking the flow of electricity, insulating layers prevent this phenomenon, known as galvanic corrosion.

Insulating layers are made of a number of different composite materials. Some of these composites combine wood or paper with epoxy or phenolic resin formulations. Wood- and paper-based materials provide adequate insulation for some components. But those exposed to the lowest temperatures require insulating layers with a woven fiberglass fabric substrate.

The Fiberglass Advantage

Though they provide better insulation than wood and paper composites, not all fiberglass-based materials offer equal protection. The coldest applications require special glass-resin combinations designed specifically for exposure to cryogenic temperatures. Some of these glass-and-epoxy products can withstand temperatures approaching absolute zero.

In addition to their superior insulation properties, glass-based composite materials offer much higher mechanical strength than wood and paper options and retain that strength at low temperatures. This extra strength is often needed to meet the requirements of common applications in the LNG plant.

For example, consider the steel supports placed along the length of an LNG pipe. These supports carry both the weight of the pipe and the LNG flowing through it. Plant designers try to economize by minimizing the number of supports under long pipes. This is done by widening the spacing between supports, thereby increasing the load on each support. For instance, a single support may have to carry the weight of 100 feet of a 4-ft-diameter steel pipe and the contents of that section of the pipe.

The loads placed on pipe supports are also placed on support insulation. When wood- and paper-based insulation materials cannot carry the load, designers opt for fiberglass-based composites, which are strong enough to handle the highest compressive loads along LNG pipelines.

In addition, the materials have ample strength to handle stresses caused by pipe movement during LNG transport. The length of a five-mile LNG pipeline can change by several feet due to temperature and pressure changes inside and outside the pipe. Such changes can put an enormous amount of shear stress on pipe supports and their insulation. Fiberglass composite insulation can withstand high shear stresses that would cause failure of wood- and paper-based materials. Despite the glass content that provides high strength, fiberglass composite insulation materials are machinable with commonly used tools.

Stresses are highest at connection points, so fiberglass composite materials are also used to make bolt insulators. Wood composite materials are a less expensive option for insulating bolts and washers, but these lower-strength materials are more likely to fail when subjected to connection loads, causing downtime and necessitating costly repair operations.

Longer Life

Located in coastal areas, LNG plants are exposed to salt water and high humidity. In this type of environment, wood- and paper-based materials absorb large amounts of water, which accelerates their deterioration and adversely affects their insulation properties.

By contrast, glass-based composite insulation absorbs relatively little water, so it lasts much longer and performs more consistently than wood and paper alternatives. By lasting longer, glass composites reduce replacement costs and downtime for repairs.

Deterioration can also be caused by caustic substances in the solutions used to clean LNG facilities. Glass products hold up to these solutions better than those based on cellulose, further reducing deterioration and extending the life of plant insulation.

Along with their other advantages, glass-based thermoset composites offer excellent dimensional stability when exposed to temperature changes. In addition, they provide high strength but weigh only about a quarter as much as steel.

Conclusion

In LNG facilities, fiberglass-based thermoset composite materials keep heat out of LNG vessels and protect plant components from the coldest temperatures. They also provide the strength to handle a variety of loading conditions and corrosion resistance that ensures long life and minimal replacement and maintenance costs. Offering crucial advantages over wood and paper insulation materials, fiberglass composites will play an expanding role in the growing LNG market.

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