Fiber Restistant Fiberglass Pipe

Fire-resistant fiberglass is already used in off-shore oil wells. It's only a matter of time before the new technology is used in the petroleum marketplace. Professional engineer Sullivan D. Curran reports.

"Insulating material advancements make it practical to insulate the entire surface of the pipe and fitting system."

The photos in this article are courtesy of Ameron International.

This article discusses state-of-the-art, fire resistance FRP piping and its potential applications for petroleum storage and handling facilities. These facilities can benefit from a transfer of the new technologies that have been developed for the piping materials used in marine chemical tankers, navy vessels and off-shore oil and gas platforms.

Fighting fire with FRP

Today, composite materials such as fiberglass reinforced thermostatic (FRP) pipe are being used in new ways, including sea water fire ring-mains and deluge applications; sea water cooling; produced-water handling; potable water and waste drain lines. The greatest breakthrough has been in the emerging application of non-metallic FRP for both underground and aboveground fire main and water spray piping applications.

Initially, of course, the reader has to question if it is appropriate to use fire protection piping that may burn up in the fire it was intended to extinguish! However, new technologies can provide some FRP piping with sufficient protection to ensure that the piping will stay intact during a fire. The use of this technology will: (1) reduce the spread of flames in FRP piping when directly exposed to fire; and (2) enable FRP piping to withstand direct fire exposure for more than three hours.

It is no secret that there are problems with the traditional use of steel piping. Experience with steel piping in marine fire main and water spray applications shows that internal corrosion can plug the nozzle and sprinkler heads and, thus, render them ineffective. For metallic piping systems, the solution is to provide continuous maintenance to reduce the effects of corrosion and internal scaling. Even so, it is questionable as to how much of the metallic system will be in an effective operating condition at any given moment.

Burning tests

Material Flame Spread, Fuel Contribution and Smoke Generation requirements are established in the fire and building codes. To comply with these codes, burning tests are conducted in accordance with ASTM E84-81a, “Standard Method of Test for Surface Burning Characteristics of Building Materials” or other similar test methods specified in ANSI No. 2.5, NFPA 255, UL 723 and UBC 42-1. Flame test results are expressed in terms of Indices for Flame Spread, Fuel Contribution and Smoke Developed during ten-minute exposure to flames.

The results are recorded as a ratio, with glass-reinforced-cement board being 0 and red oak flooring being 100. While building codes such as the Uniform Building Code generally call for a flame spread rate of less than 200, specific requirements depend on the location of the material in the building, occupancy and other criteria. As a result, model building codes and local jurisdictions need to be referenced to determine approved materials that may be used based on the results of flame tests.

When the pipe is tested for its fire resistance, the fire reaches 1100 degrees C. It gets so hot that the floor is flooded with water so the concrete won’t break down.

Indices			
Test Specimen	**Flame Spread**	**Fuel Contribution**	**Smoke Developed**
FRP Pipe	40	0	755
Coated FRP Pipe	5	0	30
Index Improvement	35	0	725

In the initial phase of the jet fire test, note the sections of pipe and fittings in the center of the flames.

Further into the test, you can barely see a ghostly image of the pipe.

Unprotected FRP pipe performance

Fuel Contribution Index: Unprotected FRP pipe made with epoxy resin systems will be consumed when exposed to fire. However, the piping is self-extinguishing when the flame is removed. Under continuous fire exposure and with water flowing through the pipe, the unprotected pipe tends to degrade at a given level and then maintains that performance level. The movement of fluid inside the pipe remains cool (i.e., FRP pipe is a low conductor of heat) and gives an extinguishing effect to the structural wall of the pipe. As a result, the FRP Fuel Contribution Index is zero, and there are certain applications where unprotected FRP pipe may be used for fire main systems.

Flame Spread and Smoke Development Indices: The Flame Spread Index differs for the various resins used in the manufacture of FRP pipe. In addition, additives may be used to retard flame spread. For example, one epoxy resin pipe Flame Spread Index is 40 and the Smoke Index is 755. Flame retardant additives can be added to the resin and will reduce the Flame Spread to less than 25, which

is optimum for building code applications. However, smoke generation is another consideration that may limit the pipe application in occupied building areas.

Coated FRP pipe performance

Coatings have been developed that will reduce the rate at which fire exposure will affect FRP pipe. One product is PPG Fire Retardant Latex 42-7 Paint, which can be applied to the installed piping system. This is known as an intumescent coating. Intumescent is defined in Webster's Dictionary as "swelling and charring when exposed to flame." What happens to the coating is consistent with Webster's definition for intumescent. When exposed to fire, the coating will blister and form a heat shield to reduce the rate at which fire will affect the pipe.

The table to the left shows that coating the same epoxy resin pipe referred to in the first example will reduce the Flame Spread and Smoke Developed Indexes significantly.

Dispenser sump applications

One place that coated FRP piping can be used is with dispenser sumps. The evolution of sumps located under petroleum fueling dispensers has become a concern for fire jurisdictions.

The Uniform Fire Code and the National Fire Protection Association (NFPA) codes reflect the old practice of filling pits "with a noncombustible inert material" to suitably protect low melting point materials and protect against the ignition of vapors. However, fire marshals recognize that filling a dispenser sump defeats the ease of cleanup required for pollution control purposes, and they are looking for an alternate means of protection. If a clean sump with adequate ventilation is not a vapor ignition source, then one way to protect the FRP piping would be with an intumescent coating.

Insulated FRP pipe

Insulating material advancements make it practical to insulate the entire surface of the pipe and fitting system. This is typically done with a thick intumescent coating such as Pitt-Charr© or its equivalent. This coating system has proven to be successful in enduring jet fire exposure, in both wet and dry conditions, consistent with Norwegian Fire Research Laboratory test requirements conducted by Southwest Research Institute. Intumescent coatings are typically applied by spray coating. This is an effective method to protect large surfaces but not small diameter pipe.

Furthermore, in the case of a fire, once intumescing occurs it must remain on the pipe when the pipe is impacted by the water hose streams used to fight the fire. As a result, a new development incorporates the intumescent coating into the filament winding process. The filament winding process provides an intumescent coating that is of consistent thickness and a smoother texture. It is also void-free and cannot be removed inadvertently. The end result is a FRP pipe capable of maintaining the serviceability of the piping in a fire for a minimum of three hours under flow conditions.

Currently available in diameters up to 40 inches, with an operating pressure rating of 150 psi at 200 degrees F, intumescent piping has achieved acceptance in the marine industry. This is because it combines the corrosion resistance historically provided by stainless steel and copper-nickel materials

with the light weight, which is so important in marine construction.

During the cool down following the test, the pipe is intact

The resin on these Ameron pipes is an integral part of the filament winding system, not coating

Pipeline to the future

Phenolic pipe: The use of phenolic resin as the polymer matrix in FRP pipe is being investigated as a fire resistant non-metallic pipe. The features provided by phenolics include low toxicity, low Flame Spread and low Smoke Developed Indices. A recent technological breakthrough in this area will allow the use of this previously difficult-to-handle material for fire resistant piping.

An example of the burner configuration for the IMO Level 3 test. The “marshmallow” in the middle is an intumesdent wrap applied to the simulated valve.

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