Fire Resistant Fiberglass Pipe

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I. Introduction and Scope

This paper discusses state-of-the-art fire resistance FRP piping designs and potential applications for petroleum storage and handling facilities. There is an opportunity to transfer technology because of new developments in the piping materials used in marine chemical tankers, navy vessels and off-shore oil and gas platforms. Composite materials such as Fiberglass Reinforced Thermosetting Plastic ("FRP") pipe are being used in sea water fire ring-main and deluge applications, sea water cooling, produced water handling, potable water and waste drain lines. The real breakthrough is the emerging application of nonmetallic FRP for both underground and aboveground fire main and water spray piping applications. 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, there are design developments to both reduce flame spread in FRP piping for direct fire exposure applications and withstand direct fire exposure for over three hours.

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 render them ineffective. For metallic piping systems, the solution is continuous maintenance to reduce the effects of corrosion and internal scaling. Even so, it is questionable how much of a metallic system is in effective operating condition at any given moment.

II. Indices: Flame Spread, Fuel Contribution and Smoke Generation

General: Material Flame Spread, Fuel Contribution and Smoke Generation requirements are established in the fire and building codes. To meet 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 10 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 will need to be referenced to determine approved materials that may be used based on the results of flame tests.

Fuel Contribution Index: Unprotected FRP pipe made with epoxy resin systems will be consumed when exposed to fire, but it is self-extinguishing when the flame is removed. Under continuous fire exposure and with water flowing through the pipe, it tends to degrade to a given level and then maintains that performance level.

The movement of fluid inside the pipe remains cool (i.e., FRP 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 Developed Index is 755. Flame retardant additives can added to the resin and reduce the Flame Spread to less than 25, which is optimum for building code applications. However, smoke generation is another consideration which may limit the additized pipe application in occupied building areas.

III. Coated FRP Pipe

Coatings have been developed which 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 as "swelling and charring when exposed to flame."

Consistent with Webster's definition for intumescent, the coating when exposed to fire will blister and form a heat shield to reduce the rate at which fire will affect the pipe. The following table shows that coating the same epoxy resin pipe used in the foregoing example, will reduce the Flame Spread and Smoke Developed Indexes significantly.

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

There are potential applications of coated FRP piping for use in distribution terminal and warehouse fire mains and sprinkler systems. In addition, there may be an opportunity to apply this technology to motor vehicle refueling facilities. The evolution of sumps located under petroleum fueling dispensers was initially an area of concern for fire jurisdictions. At that time, the Uniform Fire Code(UFC) and National Fire Protection Association (NFPA) codes reflected 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 recognized that filling a dispenser sump defeats the ease-of-clean-up required for pollution control purposes. It has been accepted that a clean sump with adequate ventilation is not a vapor ignition source and non-metallic FRP piping is currently a common application.

IV. Insulated FRP Pipe

Insulating material advancements make it practical to insulate the entire surface of the pipe and fittings system. This is typically done with a thick intumescent coating such as Pitt-Charo or 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, which is an effective method to protect large surfaces, but not small diameter pipe. Further, in a fire scenario, once intumescing occurs it must remain on the pipe when impacted by water hose streams used to fight the fire. As a result, the intumescent coating is incorporated into the filament winding process. The applicable filament winding process provides an intumescent coating that is of consistent thickness, void-free, smoother texture 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 *intumescent* coated piping is available in diameters up to 40 inches, with an operating pressure rating up to 362 psi at 200° F.

Intumescent piping has gained acceptance in the marine industry because it combines the corrosion resistance historically solved by using stainless steel and copper-nickel materials with the light weight important in marine construction. While replacing alternative high cost materials, there may be an opportunity for technology transfer to the petroleum industry in applications where life cycle costs include the maintenance required to ensure that a fire main and sprinkler system will perform when needed.

V. Future Developments

***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 phenolic resins include a low toxicity, Flame Spread and Smoke Developed Indices. A recent technological break-through in this area will allow the use of this previously difficult material for fire resistant piping.

References

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rev. July 30, 2013