The ultimate piping material

by David A. Chasis

Plastics are the fastest growing and most popular piping material in the world. Polyvinyl chloride (PVC) is the dominant material with over two-thirds market share, followed by the polyolefins — polyethylene, polypropylene and polybutylene. However, for those special hard-to-handle applications, few piping systems can match the performance of fluoropolymers.

A little background

In the mid-1960s, chlorinated plastics, PVC and CPVC, were just starting to hit their stride. Yet, for temperatures above 210°F/98°C and/or chemical resistance to many inorganic and organic fluids, no plastic pipe was readily available. For a short period of time there was a branded chlorinated polyether material that could handle higher temperatures and had better chemical-resistant properties than vinyls, but due to difficulties experienced in manufacturing, installation and high costs, it never dented this special engineered portion of the piping market. In the later part of the '60s there were new materials that entered the piping market — fluorinated plastics.

Several engineered fluoropolymeric piping compounds were introduced to the marketplace over four decades ago: ethylene-chlorotrifluoroethylene (E-CTFE), perfluoroalkoxy (PFA), polytetrafluoroethylene (PTFE) and polyvinylidene fluoride (PVDF). Other fluoropolymers were also introduced — polychlorotrifluoroethylene (PCTFE), ethylenetetrafluoroethylene (ETFE) and fluorinated ethylene-propylene (FEP), but they were rarely used in solid-wall piping applications. All of these compounds are hydrophobic, can handle temperatures exceeding 280°F/137°C (PFA and PTFE can be used in some applications exceeding 400°F/204°C), have excellent chemical resistant properties and have very low fire and smoke development indices. However, due to physical properties, durability, ease of use and cost effectiveness, two fluorinated solid-wall piping compounds have made the most impact in the marketplace — E-CTFE and PVDF.

Benefits of E-CTFE and PVDF

E-CTFE and PVDF have emerged as the two most popular rigid solid-wall piping systems mostly due to their cost effectiveness and chemical resistance to highly troublesome aggressive fluids. In addition, both of these piping compounds have excellent physical properties such as excellent abrasive resistance, hardness, impact strength, burning rates, brittleness resistance at low temperatures and high mechanical strength.

With these inherent properties, E-CTFE and PVDF have made inroads into the chemical processing industry, high-purity semiconductor industry requiring very low extractable values, pulp and paper industry in handling halogens and acids, nuclear waste processing in handling radiation and hot acids, water and waste treatment plants for handling high concentrations of sodium hypochlorite and membrane filtering systems, pharmaceutical and food and beverage industries requiring low extractables and FDA-approved compounds. In addition, E-CTFE and PVDF are ideal piping materials for use in air plenums due to their low fire spread and smoke development. Although these piping compounds can be pigmented (added color) or natural color, nonpigmented is the material of choice where low extractables are required.

When do you choose PVDF or E-CTFE? Assuming both materials can handle the conditions of service for a particular application, it seems that PVDF has an edge over E-CTFE for several reasons:

1. There is the breadth of product line. PVDF offers complete piping and ducting systems in pipe diameter sizes from 1/2-inch to 12-inch while E-CTFE piping systems are normally limited to 4-inch diameter and below. E-CTFE piping systems are also limited in its offering of valves, flow monitoring devices, filters, strainers, pumps and other fluid handling products compared to PVDF.

2. There are more manufacturers of PVDF compound and processed products than with E-CTFE, keeping pricing and product availability more price and delivery competitive.

3. PVDF is much more publicized and specified in the engineering community through the decades of marketing efforts of the compound and product manufacturers. For example, PVDF is the only fluoropolymer being offered as a complete chemical waste drainage system.

4. PVDF is more cost effective in most applications due to its much higher tensile strength than E-CTFE, which allows thinner walled-PVDF piping to have the same working pressure ratings as thicker-walled E-CTFE pipe.

Natural, pigmented and lined-steel PVDF fittings. (Photo courtesy of Arkema.)

There are conditions of service where chemical resistance of hard-to-handle fluids such as hot amines or molten alkali metals and/or continuous temperatures above 300°F/149°C can only be handled by the materials of PTFE and PFA. Both of these materials have limited solid-wall piping lines but are extensively used as liners for flanged-steel pipe in a variety of pipe diameters (PVDF and E-CTFE are also available as liners). Due to the high cost of these compounds (on a per pound-product basis) and/or the special installation techniques required, it is safe to say that the PTFE piping systems are to be explored usually as the last resort (and maybe the only resort) in selecting a piping systems for extreme conditions of service.

There are few piping systems having the features and benefits capable of handling aggressive fluids and/or fluid temperatures up to 280°F/137°C in a durable, safe and cost-effective manner than fluoropolymers — the ultimate piping material. ■

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