PVDF Piping—Oh So Many Options

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This sanitary tubing system features a mechanical joining method made with Kynar® 700 Series fluoropolymer.

The polymer material polyvinylidene fluoride (PVDF) has been around commercially since 1964. What started out with targeted applications in the pulp and paper, nuclear and bromine industry has globally blossomed into millions of feet of PVDF piping and tubing, which is installed annually in chemical plant, offshore oil platform, underground fuel containment, high-purity semiconductor, biotech system, plenum-rated waste pipe, metal preparation, food- and beverage-handling, potable water, mining reclamation and wastewater treatment applications.

PVDF System Availability & Joining Methods

The study of PVDF has led to special polymer development and system design,

opening up a plethora of ways to use the material. Depending on the actual chemical service and grade of PVDF selected, a PVDF piping system can operate at up to 150°C (302°F). To boot, PVDF piping is lightweight, as well as fully corrosion resistant to nearly all non-pressurized drain-type chemical combinations, which makes it competitive with options like stainless steel and glass systems.

Original systems, such as socket-fused schedule 80 pipe and plastic-lined steel, still have significant applications today. Nevertheless, new developments often offer either more cost-effective solutions or higher performance than those tried and true technologies.
Thinner standard dimensional ratio PVDF pipes that can be socket-fused, butt-fused or mechanically joined are readily available. Furthermore, bead and crevice-free (BCF®) and smooth inner bore (SIB®) systems—which conceal weld bumps—are ideal for certain semiconductor and pharmaceutical applications. Some suppliers additionally offer other special joining techniques like electrofusion and radio frequency induction fusion. These methods permit reliable welding with minimal chance of human error during the controlled process.

PVDF and PVDF copolymer-based piping systems supported with fiber-reinforced plastic wrapping are available from several manufacturers due to etching technology that allows a bond to form between the PVDF and its fiber-reinforced plastic support layer. Large-diameter pipes can be fabricated, furthermore, by welding together large sheets backed with impregnated fabric and then being laid up with fiber-reinforced plastic as a support layer. This is called dual-laminate technology.

PVDF can likewise be bonded to other polymers in a thin layer to reduce costs by combining the chemical contact surface from a PVDF product, and the structural support from a less expensive and lower chemically resistant polymer. Potential bonding combinations include, but are not limited to, polyurethanes, flexible and rigid polyvinyl chloride, polyethylene, nylon and polyester.
Creative companies in the fuel-handling industry have designed composite flexible pipes using PVDF as sandwich layers on top of polyethylene to handle all kinds of fuels, including traditional unleaded gasoline, gasoline mixed with octane modifiers, biodiesel and gasohol. These systems meet strict UL 971 standards for permeation, chemical resistance and impact. While PVDF is the most critical part of the structure, it is not the only material in the whole flexible piping system.

PVDF piping applications that incorporate special flame and smoke-resistant technology into the polymer are emerging as well, especially for plenum-rated corrosive waste pipe. Some grades of PVDF meet the strict ASTM E84 (UL 723) 25/50 rating criteria for flame and smoke values, thereby permitting the material to be used in any form in the return air plenum area of a building.

This deionized water system is made from Kynar® PVDF.

PVDF Properties & Performance

The key properties of PVDF are:

- Chemical, permeation, thermal, sunlight and abrasion resistance.
- FDA, USP and NSF compliance.
- Physical strength.
- High purity in its natural form.
- High heat deflection temperatures.
- Ease of welding or forming.

In certain applications, these add-ons cannot be discounted and may very well be integral to unique design situations.
There are many types of special tubing fittings available—from threaded connectors to quick-disconnect, push-fit or weldable fittings, to small barbed fittings used on biotech systems. Fortunately, the size of the market for the PVDF polymer family has given birth to a vast amount of suppliers that can fill various niche needs and special regulatory requirements for the many industries already mentioned.

PVDF Chemical Resistance

It seems that the most common chemical applications for PVDF piping and tubing

systems are those involving:

- Halogens (bromine, chlorine and iodine).
- Strong acids (chromic, hydrobromic, hydrochloric, hydrofluoric, methane sulfonic, nitric, phosphoric and sulfuric).
- Chlorinated compounds (chlorobenzene, methyl chloride, sodium hypochlorite, sodium chlorate and chlorine dioxide).
- Water (mixed waste, salt, brine, deionized and injection).
- Fuels (gasoline, diesel, biodiesel and gasohol).
- Ozone sterilization.
- Low-pressure steam cleaning.

As it relates to the above chemicals, PVDF is one of the few polymers that performs well when compared to stainless steels and exotic metals in overall corrosion resistance. If a polymer like PVDF is used instead of exotic metal, concerns of rust corrosion can be eliminated, in addition to the fear of not being privy to complete system component availability. Also, during transitional phases, mechanical PVDF systems are available to directly connect to metallic pipe and fittings in lab environments, the benefit being that PVDF can be subjected to more highly corrosive liquids.

Since PVDF has been around so long, there is a whole fluid-handling system component base that is readily accessible as standard inventory in the form of pumps, valves, tanks, nozzles, flowmeters, fittings, membranes, bolts, rods and sheets to produce small-volume machined parts. Compared to any other fluoropolymer, PVDF support components are more plentiful, and therefore, easier to attain by quick delivery.

Special Considerations

PVDF homopolymers have been known, under stress and pressure, to raise issues regarding continuous pH that measures over 12, as well as very low pH levels in highly concentrated acids. In an effort to reverse that trend, Kynar Flex® copolymers strive to extend pH ranges with varying degrees of long-term exposure capabilities—up to 99 percent sulfuric acid on the low end of the pH scale and 10 percent caustic soda on the high end. Before choosing a particular system design or resin grade, however, it is recommended that a polymer manufacturer first be consulted.

While for first-time users, PVDF piping is considered a high-performance specialty product, the overall application for this material has become so enormous that the options on the market to build a system are quite extensive. Frequent users of PVDF have learned about the many system options available, but innovation continues at an exponential rate as more people aspire to design systems for low maintenance and long life.

Luckily, there are numerous system suppliers and technical distributors that can assist with determining the most cost-effective and safe-performing PVDF system

for a specific application. Moreover, PVDF material suppliers that boast of having many moons of experience in piping and tubing design selection can recommend or refer other preferred suppliers that specialize in the development of new joining technologies or even product training to facilitate final installation.

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[1] http://www.kynar.com/