Corrosion attacking a coated metal valve.

AN OVERVIEW OF THERMOPLASTIC VALVES AND THEIR PERFORMANCE

By **Rod Van**

Thermoplastic valves offer a dependable and economical way to handle corrosive chemicals in some of the harshest environments. When comparing non-metallic valves to metal valves, there are many criteria the specifier must consider, including: process pressure, temperature boundaries (high and low), corrosion resistance, abrasion resistance and cost.

COST

In many cases, clients want materials for a project at the lowest cost possible. However, this doesn't equate to total cost of ownership, which is the long-term value that addresses the performance and operating costs over a product's lifespan.

When evaluating costs, it is important to look beyond the initial cost of a material. Are there other material options that offer better long-term performance? What valve types will meet the client's performance criteria? The less maintenance and downtime incurred, the more profit there is on the client's bottom line.

A valve's weight must also be considered. There may be additional support costs and handling time required when installing metal body valves overhead. With shipping costs skyrocketing, it is more economical to ship a skid of plastic valves than a skid of metal body valves. Are the valves covered by a warranty, and if so, how long? Replacement cost is another factor to consider.

MATERIALS, PRESSURES AND TEMPERATURES

Non-metallic valves have excellent chemical resistance, and are not affected by galvanic and electrolytic attack. That means there is resistance to both internal and external corrosion.

The temperature range for molded thermoplastic valves can be as low as –40°C and as high as 150°C, with pressure capabilities up to 230 psi. Over 70% of all industrial applications fall within this range. In chemical applications where the pressure is above 230 psi, or temperatures are above 150°C, composite, lined steel, or metal alloys are best suited for the application.

Polyvinyl chloride (PVC) and chlorinated polyvinyl chloride (CPVC) are the most common valves used in industrial applications. These materials can handle most acids, strong alkalis, fats and oils. PVC and CPVC would not be recommended for chlorinated hydrocarbons, keytones (solvents), esters, and aromatics because those react by permeation, leading to swelling and loss of tensile strength.

The temperature range for PVC is between 0°C and 60°C, and CPVC is rated up to 91°C. Their relatively low cost and the simplicity of the joining method (solvent cement) make these two materials a popular choice. Solvent cemented to pipe and fittings, PVC and CPVC are the first choice for many installers because of the ease of installation.

Polypropylene (PP) has excellent chemical resistance to acids, strong alkalis and solvents. PP is a member of the olefin family and does not perform well when handling chlorinated hydrocarbons or strong oxidation agents. The temperature range for polypropylene valves is between –20°C and 91°C. The costs of PP valves are similar to CPVC. The primary joining method is heat fusion (welding), instead of solvent cement. Heat fusion can be performed using socket and butt fusion tools.

Polyvinylidene fluoride (PVDF) is the most popular fluoropolymer resin used for chemical and high purity applications, because the fluoride creates an extremely reliable bond within the other molecules in the plastic. The polymer has excellent chemical resistance to strong acids, organic solvents, weak alkalis and strong oxidation agents. PVDF has excellent abrasion resistance and dielectric properties, and has a temperature range of –40°C to 120°C.

Because of the reliable fluoride bond that is able to resist breaking apart in the presence of a wide range of chemicals, PVDF can also be used for critical applications where the leaching of unwanted molecules can cause disastrous effects within the system. The production of PVDF requires no stabilizers, plasticizers or lubricants. The essential absence of contaminants is another reason why PVDF is commonly used for semiconductor and pharmaceutical applications where ultra-pure water and chemically-pure fluids are used.

Ethylene chlorotrifluoroethylene (ECTFE) and perfluoroalkoxy (PFA) are the two additional fluoropolymers that can handle pHs from 1 – 14. ECTFE and PFA perform well where expensive metals (titanium, alloy 20, 316/304L stainless steel, or lined steel) do not.

Both are used for high concentrations of acids, such as 98.3% sulfuric acid, and can be used in highly oxidative applications like chlorine gas, ozone and chlorine dioxide with great success. ECTFE and PFA are also suitable for solvents and/or high pH applications at elevated temperatures. However, ECTFE and PFA are more costly than other non-metallic options, and should be reserved for critical applications.

Seal and seat materials are just as important as the valve body material. There are many options: EPDM, FKM, nitrile, hypalon, aflas, and PTFE, all of which offer varying degrees of chemical resistance, temperature ranges, abrasion resistance, and therefore sealing performance. Most thermoplastic valve manufacturers design their valves to meet the ANSI Class VI shutoff standard, which is commonly termed "bubble-tight shutoff".

THERMAL CONDUCTIVITY

Non-metallics have very low thermal conductivity and act as insulators, compared to metals, which do not. Polypropylene has a 1.2 BTU-in/ft^2-°F-hr. Carbon steel's thermal conductivity of 360 BTU-in/ft^2-hr is 300 times greater than polypropylene.

Does this mean thermoplastic valves will not crack in freezing temperatures? Of course not. What low thermal conductivity in thermoplastics does demonstrate, is the considerable amount of time it will take for a fluid to freeze in a thermoplastic valve. In this example, it takes three hundred times longer than carbon steel.

ABRASION CHARACTERISTICS

Another key benefit of thermoplastic materials is their abrasion resistance, specifically where most thermoplastic materials outperform steel. Because of the molecular structure and low coefficient of friction, PVDF is the best choice if abrasion resistance is the most important consideration. A solid PVDF diaphragm or butterfly valve with a PVDF disc are the two best options. Lined steel uses a liner that is generally 3-mm thick. This can limit the life and performance in an abrasive application compared to a solid-body valve.

The potential for external corrosion from vapours also exists. A solid-body thermoplastic valve has the same chemical resistance on the outside where a coated metal valve may not. Coatings are also commonly scratched and chipped from flanged bolts and tightening during installation.

TYPES OF THERMOPLASTIC VALVES

There are many types of thermoplastic valves: ball, butterfly, diaphragm, gate, sediment strainer, labcock, needle, relief, regulator, check, globe and flow control valves are all available. Pneumatic and electric actuators operate valves from 6 through 1,200 mm.

Extension stem on an Asahi/America Plasgear™ operated Type-57P butterfly valve that replaced a corroded metal stem and valve installed in a drain application.

VALVE OPERATION OPTIONS

If manual remote operation is required, extension stems and chain wheel operators are available. It is possible to actuate two butterfly valves with one actuator. Manual valves can be fitted with spring returns, or full electric and pneumatic actuation can be added to a non-metallic valve offering. These are just some of the many options available for thermoplastic valves. ■

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