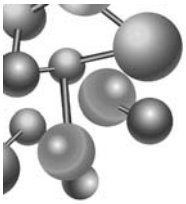

Chapter 4

PIPE, VALVES AND FITTINGS

Industrial Piping Systems

Pipe is a rigid hollow cylinder that, in conjunction with fittings and valves creates a system to convey a liquid or gas. Thermoplastic piping systems are more prevalent than thermoset by a wide margin, due to the "forgiveness" of the material. Because of its nature, you are afforded more time in joining and repair is easier. In general, the cure time before pressurization is also less.

Listed below are the most prevalent thermoplastic piping systems. They are in "general" order of chemical resistance, though each one has its own advantages and disadvantages.

- PVC – Polyvinyl Chloride
- CPVC – Chlorinated Polyvinyl Chloride
- ABS – Acrylonitrile-Butadiene-Styrene
- Polypropylene
- Polyethylene
- PVDF – Polyvinylidene Fluoride
- Fluoropolymers – PTFE, FEP, PFA, MFA
- ECTFE – Ethylene Chlorotrifluoroethylene

Drain Piping

Drain piping, also known as drain, waste and vent (DWV), is used in both residential and commercial applications. Because the liquid flows on its own, the systems are not pressure rated and the fittings are designed to promote the flow. Most systems are rated for 10 feet of head (water), which is 23.1 psi (a "foot of water" is 2.31 psi). The wall of the pipe is normally quite thin in drainage systems.

DRAIN PIPING SYSTEMS

- Acid Waste – PP, PVDF, CPVC
- PVC
- ABS

Schedule 40

Schedule 40 pipe is used in low pressure applications. The pressure rating for a schedule 40 piping system is dependent on the size being used; the limiting factor is the fitting or valve rating. The fittings have a compact design to reduce the amount of space. Schedule 40 has the same outside diameter as iron pipe and is not recommended for threading.

SCHEDULE 40 PIPING SYSTEMS

- PVC – White and grey
- CPVC – Pipe only
- Polypropylene

Schedule 80

With schedule 80, just like schedule 40 piping systems, the pressure rating is dependent on the size being used, however, the system will be rated at the component with the lowest pressure rating. Usually a mechanical joint is the lowest rated fitting, flanges are only 150 psi at ambient temperature. Compact style fittings are used as well as threaded connections. Schedule 80 has the same outside diameter as schedule 40 and iron pipe and is used in pressure applications.

SCHEDULE 80 PIPING SYSTEMS

- PVC
- CPVC
- Polypropylene
- PVDF

Schedule 120

Although schedule 120 pipe is available, the fittings are not available. Most of this pipe is used in applications where a thick walled tube is needed. It has the same outside diameter as schedule 40 and 80 and is used in machining and threading applications.

SCHEDULE 120 PIPING SYSTEMS

- PVC
- CPVC

Standard Dimensional Ratio (SDR)

Under this system the wall thickness changes with each size to allow the same pressure rating. The standard dimensional ratio (SDR) is determined by what pressure rating is needed for the application; the lower the SDR the higher the pressure rating. The fittings must be the same SDR because the fusion technique is normally butt fusion and the walls need to be equal to

ensure a proper joint. (All sizes are same psi rating with same SDR.) The outside diameter of pipe is constant; the inside diameter changes with changes in SDR.

SDR PIPING SYSTEMS

- Polyethylene
- Polypropylene
- PVC

Bar Rating

A bar rated piping system is just another way to describe the pressure rating. Just like the SDR system, the pipe wall varies depending on the size to ensure an equal rating. Bar rated piping systems are normally stated in metric sizes, as they are used primarily in Europe. One bar is equal to 14.5 psi; 16 bar is equal to 232 psi.

BAR RATING PIPING SYSTEMS

- PVC
- Polypropylene
- PVDF
- Polyethylene

Valves

Ball Valve

The ball valve is the standard in plastic piping systems, though it should be used only for clean, on/off service. A plastic ball with a hole through it rides in a "seat" of PTFE or polyethylene. This seat can be damaged by particles being caught when the valve is closed or opened. The term true union means that the carrier or main part of the valve can be removed from the piping system and be either repaired or replaced. Configurations for ball valves include single union, true union and compact. Actuation is available of true union valves. Precautions should be taken in using ball valves in situations with suspended particles, high velocity and modulation.

MATERIALS

- PVC
- CPVC
- PP
- PVDF

Butterfly Valve

Butterfly valves utilize a disc that is turned to open or close the flow. Plastic butterfly valves are available up to 24 inches, and are used for larger diameter applications. Lever, gear or actuated operators may be used. On the larger sized valves, a gear operator is recommended due to the amount of torque needed to open or close the valve. The term lug style refers to threads being integral to the valve and allows the valve to be used at the end of a piping system. Otherwise, flanges on each side of the valve must be used. With butterfly valves, you must take precaution against the over tightening of mating flanges. If there is a "full" liner, only wetted parts are the liner and disc; this also eliminates the need for gaskets. The recommended uses for butterfly valves are on/off and modulating service, suspended particles and high velocity systems.

MATERIALS

- PVC
- Polypropylene
- PVDF

Diaphragm Valve

The diaphragm valve (EPDM, FPM, PTFE) uses a weir type (dam-like) design to control the flow. This means that the relationship between percent opened and percentage of flow is very close to being equal with this valve. Also because of this weir design, particles that are trapped between the diaphragm and the weir when closed are released and cleaned out once the valve is opened again. For this reason, they are recommended for these applications: control or modulating, slurry and suspended particles.

Diaphragm valves can be actuated; pneumatic is the most common method. These valves have excellent throttling characteristics and are self-cleaning by design, as they are used in high purity applications.

MATERIALS

- PVC
- CPVC
- Polypropylene
- PVDF

Gate Valve

A gate valve is exactly as it is named. It is a gate that is brought down into the flow to close the valve. It has little pressure drop because the gate can be fully retracted out of the flow stream. Gate valves are recommended for slurry and suspended particles.

MATERIALS

- PVC

Ball Check Valve

A ball check valve allows flow around the ball in one direction and when the flow reverses, it seats itself and closes. Because the flow has to go around the ball, it creates a large pressure drop in the piping system. A spring assist can be used when low back pressure is present, it will keep the valve closed when no pressure is present. A ball check valve can be mounted vertically or horizontally. They are often used as a foot valve to keep a pump primed. Ball check valves are recommended when minimal back pressure is required and there are space limitations. Certain precautions must be taken against suspended particles and the distance from pump, as well as a large pressure drop.

MATERIALS

- PVC
- CPVC
- Polypropylene
- PVDF
- PTFE

Swing Check Valve

A swing check valve utilizes a swinging disc to prevent backflow. The disc swings out of the way and thus creates a lower pressure drop than the ball check and seals with minimum back pressure. A spring assist can also be used. Swing check valves can be mounted vertically or horizontally and are recommended for suspended particle or high velocity applications. You should be sure there is sufficient head pressure to seat the valve.

MATERIALS

- PVC

Pressure Regulator Valve

A pressure regulator is not a valve that turns the flow on or off, it is a valve that will only let a preset amount of pressure into the piping system downstream of the valve. The regulator cannot increase pressure in system. It is a great method to protect the piping system from a run away pump.

MATERIALS

- PVC
- Polypropylene
- PVDF
- PTFE

Pressure Relief Valve

A pressure relief valve deals with the pressure of the piping system upstream of the valve. It will remain closed until the preset pressure is achieved, then open relieving pressure downstream. It prevents over pressurization of piping systems upstream of the valve and relieves pressure over a preset set point, bleeding pressure downstream. The pressure relief valve also maintains backpressure upstream of the valve (backpressure valve).

MATERIALS

- PVC
- Polypropylene
- PVDF
- PTFE

Vacuum Breaker Valve

In some applications air is needed to prevent damage and in other applications air is unwanted as it creates a siphoning effect. The key is in which direction the valve is installed. In tanks it allows air to replace liquid to prevent the inward collapse of tank walls and eliminates the siphoning of liquid through the piping system. You must be sure to install the vacuum breaker valve in the correct position.

MATERIALS

- PVC
- CPVC
- Polypropylene
- PVDF
- PTFE

Fusion Techniques

Solvent Cementing

Solvent cementing is the easiest and most widely known fusion technique for plastic pipe. It can be used when joining PVC, CPVC and ABS piping systems. Other joining technologies must be used when joining more chemically resistant materials because the solvent has no effect on them. Even though it is the most common known method, it is rarely done properly to ensure the most secure joint. The cement contains the appropriate resin to fill the gap between pipe and fitting. The pipe should be beveled to allow the cement to stay in between the pipe and the fitting socket. The sockets of the fittings are tapered to provide a fused surface at interior of socket. A primer should be applied to properly prepare the surface.

Butt Fusion

Butt fusion is the process where the end of the pipe and the end of the fitting are the same size and each are heated at the same time, then put together and held until it cools to form a joint. There are two methods of butt fusion: conventional and infrared. The conventional method employs a heater head that is coated to prevent the material from sticking, while the infrared method uses a heater that radiates the needed heat outward.

In butt fusion the components are heated and compressed together by overlap pressure. This forms a bead of melted material on the interior and exterior of the weld. The critical steps to help ensure a proper joint are clean surfaces, heat soak time, joining pressure and cooling time. The surface of the pipe and fitting must be free of all potential contaminates. The heat soak time is the amount of time the pipe and fittings are allowed to heat up. If not allowed to heat up enough a cold joint is produced. The pressure used to push the pipe and fitting together is critical as you can potentially squeeze out all the heated material and again create a cold joint. The last item to ensure a proper joint is allowing the joint to cool while in the fusion unit under pressure and properly aligned.

Butt fusion is used for joining polyethylene, polypropylene, PVDF and PFA. In parts of the world it is also used to fuse PVC. It is also available for polyolefin and fluoropolymer materials.

Socket Fusion

Socket fusion is one of the strongest fusion techniques because you are melting and reforming the pipe and fitting together. Just like solvent cementing, the pipe must be beveled to prevent a plowing effect. Then the pipe and fitting are pushed into a set of heater bushings that have been heated to the proper temperature for the material. This heats the outside diameter of the pipe and the inside diameter of the fitting. Remove the parts from the heater bushings and quickly, while they are still in a molten state, push the two together and cool while still under pressure. A bead of material is formed on the outside and inside where the pipe and fitting meet. The whole contact area between pipe and fitting are fused together. Socket fusion is available for polypropylene, polyethylene and PVDF piping systems.

Bead and Crevice Free Fusion

This fusion technique is called different things by different manufacturers: bead and crevice free, reduced bead and smooth inner bore. The fusion process creates little to no interior bead. This is important to many using ultra pure water systems, as there is no area in which bacteria can grow and contaminate the water system. The offset of getting this smooth surface is that the amount of time to produce the joint is considerably longer than other methods. This technique is equivalent to stainless steel orbital welding technology (used to weld high purity stainless steel tubing). It allows for complete drainability of the piping system. It is available for natural polypropylene and PVDF materials.

Electrofusion

Electrofusion utilizes the electrical property of resistance that generates heat that in turn melts the pipe outside diameter and the fitting inside diameter together. A metal coil is in the inside diameter of the fitting socket, this metal coil is attached to a machine that puts the proper electrical power to that coil depending on the size of pipe being fused. The pipe is then scraped, cleaned, then installed, and a clamp is applied to create the necessary fusion pressure. Once the joint is prepared, the fusion process is begun and the machine will automatically end at a preset time. The clamps are then retightened and allowed to cool to ensure a proper joint Again each manufacturer has a recommended procedure that must be followed. Electrofusion can be used to fuse polypropylene, polyethylene and PVDF.

Stick Welding

Stick welding is primarily used in the fabrication of tanks and duct fittings. It is the process in which additional material is heated and applied to the base material to create a bond between two surfaces. One of the keys to this technique is to properly heat the base material so that the additional material and the base actually melt together and become "one." For piping systems, it is employed as a repair technique.

A small stick of like material is heated at the same time as the "base" material. Pressure is applied while both components are molten. This technique is used to weld plastic sheet and to repair piping system welds.

Epoxy Cementing

Because of the properties of a thermoset, you are unable to affect the pipe or fitting, so additional material must be added in order to put the two together. The epoxy cement is a two-part system that must be mixed thoroughly and applied within a specific amount of time prior to hardening. It is applied to the outside diameter of the pipe and inside diameter of the fitting. The epoxy adheres to the surfaces and hardens in place to create the joint. In cold temperatures a heat blanket must be applied to ensure a proper joint, as well as in hot temperatures the set time is very short.

Mechanical Joining

The last type of joining method we will discuss is the mechanical joining of plastic. Because these methods can loosen over time, they should be used sparingly and only where access is available to allow for retightening if needed.

Mechanical joining incorporates a sealing device to ensure a leak proof connection. This can be a union with an o-ring, a flange with a gasket or a sanitary adapter with a gasket. It is used where future changes might be necessary or for joining dissimilar materials.