Designing with Thermoplastics: Fluid Handling

Fluid Handling

by Alex Gambino

Thermoplastics are widely used to transport many different media including water, gases and chemicals; however, it can be challenging to convince new users that thermoplastics offer benefits over traditional metallic piping. Continuing to educate non-plastic users as to the safety that thermoplastics offer is our industry's most basic challenge. Let's consider why a designer might choose thermoplastics.

Advantages of thermoplastics

In general, thermoplastics are more economical than metallic systems for many reasons. Thermoplastics possess a smoother inner surface and require less power to transmit the fluid. The friction factor will remain the same for the lifetime of the pipeline because it's inherently corrosion resistant; therefore, a smaller diameter pipe might be used since accounting for additional friction due to future corrosion is not necessary. Plastics are lightweight and can often lower the cost of installation due to their ease of handling. This is realized through lower freight charges, less manpower or simpler hoisting and rigging equipment onsite, or simpler trenching requirements, if buried.

Thermoplastics are non-conductive and are therefore immune to galvanic or electrolytic erosion. They do not require cathodic protection and can be installed in a range of corrosive environments from non-threatening applications such as salty air to extremely dangerous EPA superfund sites with high volumes of toxic or lethal chemicals. Thermoplastics are impervious to many chemicals and offer a wide variety of material choices that are available to suit many applications. Understanding different materials' strengths and weaknesses is the key to choosing the best material for the application.

Asahi/America's Ultra Proline® ECTFE for sulfuric acid distribution.

Asahi/America's large diameter Proline® PP for chemical transport.

Material options

Now that designers are considering thermoplastics, it's beneficial to separate plastics into general families with similar characteristics. This is accomplished by separating them by their chemical makeup. There are vinyl materials, including polyvinyl chloride (PVC) and chlorinated PVC (CPVC), which are often the go-to material for chemical transport as they are well accepted and widely available. Another group of thermoplastics is polyolefins such as polyethylene (PE) and polypropylene (PP). PE is also very available and well regarded in many applications such as gas distribution and water supply. PP is recognized as the material of choice for many applications with varying pH levels as it handles acids and bases very well. Fluoropolymers make up the final group of thermoplastic materials. Fluoropolymers are high molecular weight thermoplastics that offer incredible chemical resistance for strong acids. Polyvinylidene fluoride (PVDF) is a particularly good material for transporting acids. For the most extreme chemical transport applications, materials such as perfluoroalkoxy (PFA) or ethylene chlorotrifluoroethylene (ECTFE) are used with extreme confidence. ECTFE is far less permeable than thermoplastics and can be used in applications like chlorine dioxide and 98 percent sulfuric acid where other fluoropolymers will typically start to fail soon after exposure.

With all the available materials on the market, it can be overwhelming for many designers. In addition to technical requirements, there are often other obstacles to overcome such as availability and price. These have to be balanced with the desired system lifetime. Designers will often rely on mere internet search engines to figure out compatibility of chemicals. While there

Asahi/America's Chem Proline® Advance PE safely transporting bleach.

are general rules that apply to materials, each manufacturer has varying degrees of risk tolerance that will lead to different chemical recommendations. When in doubt, asking the PVF manufacturer for a chemical compatibility statement is the best practice.

Within these families each material can be broken down into classifications based on material properties such as mechanical or thermal characteristics. The industrial capabilities of thermoplastics are constantly improving and thanks to resin supplier competition new resins are being developed that offer both new application areas and additional safety to existing fluid flow solutions. It is increasingly critical to offer well-substantiated market claims through test data or beta sites. Unexpected failures of new materials will cause designers to stop considering plastics.

Polyolefins have seen the most improvement in the past decade. Advancements in PE resins have led to new application areas due to the increase in stress crack resistance. By focusing on this material property there are now advanced polyethylene systems that offer extreme resistance to oxidizing agents like sodium hypochlorite, which is the critical failure mode of oxidizing chemicals. Previously only able to choose from high-end materials including exotic alloy metals, customers now have an option to specify thermofused advanced polyethylene.

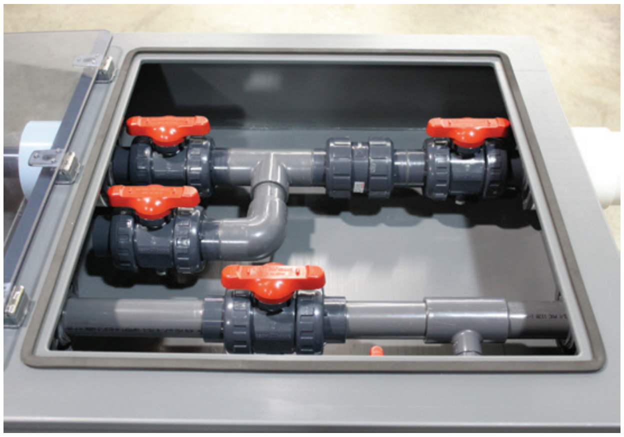
Joining techniques

Selecting a joining method is a critical step that cannot be overlooked. Joining of plastics can be done through mechanical connections, chemical bonding or heat fusion. Mechanical connections such as threads, grooved joints or flanges should be limited to applications requiring frequent disassembly. Chemical bonding through the use of solvent cement has many advantages because it is readily available and doesn't require additional equipment; however, in some applications it is a disadvantage to rely on solvent cement to join the materials. For the most robust and stable long-term installations, only heat fusion should be allowed.

Heat fusion is the process of heating the thermoplastic to a molten state and pressing two components together to form a molecular bond. The advantage of heat fusion is that there is nothing separating the two components. For industrial applications there are three main thermofusion options:

Socket fusion typically consists of an interference fit fitting that is slightly smaller than the pipe diameter. When the inside of the fitting and the outside of the pipe are heated they become molten and can be pushed together to form a molecularly bonded joint.

Butt fusion is the standard method of joining polyolefins and fluoropolymers because it has no size limitation and offers the strongest joints for the



Type-21 PVC ball valve box by Asahi/America.

Super Proline® PVDF by Asahi/America.

most demanding applications. The principle of butt fusion is to heat two surfaces to a molten state, make contact between the two surfaces and then allow the two surfaces to fuse together by application of force. The force causes the flow of the melted materials to join. Upon cooling, the two parts are united. Nothing is added or changed chemically between the two components being joined.

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Asahi/America's Ultra Proline® for sulfuric acid distribution with T342 diaphragm valves.

Electrofusion is a simplified and safe method of joining pipe or fittings based on melting the outer surface of the pipe and the inner surface of the electrofusion coupling by using an integral electric wire. Electrofusion is an effective method for joining PP and PE. As an alternative to butt fusion, electrofusion can be used for repairs and difficult connections in hard to reach locations. While electrofusion is desirable because of the simplicity, most serious installations choose butt fusion because it doesn't require specialty fittings.

Poly-Flo® Advanced PE and PP double containment piping system by Asahi/America.

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