SINGLE WALL CHEMICAL PIPE SYSTEM DESIGN

When properly designing a single wall pipe system for the transport of chemicals, several factors need to be reviewed. A properly designed thermoplastic system will provide years of reliable service without the headaches of corrosion problems. At the time of design, consider and plan for the following items:

- Materials of Construction
- Thermal Expansion
- System Sizing
- UV Considerations
- Insulation
- Hanging
- Welding Methods

Materials of Construction

The first and foremost item in any system design (metal or thermoplastic) is the media that will be running through the pipes and parameters of operation. Using accurate data for the system design will transfer to years of reliable operation. When considering the system design, answer the following questions:

- What is the chemical(s) to be in contact with the system?
- What are the chemical concentrations?
- What temperature will the system operate at?
- What pressure will the system operate at?
- What is the flow of the media in the system?

By answering these questions, the proper material of construction can be selected for the project. To assist in the material selection, refer to the chemical resistance tables in Section E, *Chemical Resistance*. A thermoplastic system's ratings for temperature and pressure are based on water. The addition of certain chemicals will add stress to the system and may reduce the recommended operating parameters. For less aggressive chemicals, the use of printed resistance tables in Section E is perfectly suitable. For more aggressive chemicals or mixtures of chemicals, the manufacturer of the pipe system should be consulted.

After verifying the standard operating conditions, it is necessary to examine other operations that might affect the piping. The following is a sample of items to investigate prior to specifying a material.

- Will there be spikes in temperature or pressure?
- Is there a cleaning operation that the piping will be exposed to?
- If yes, what is the cleaning agent? What temperature will the cleaning be conducted at?
- Will the system be exposed to sunlight or other sources of UV?

Each of the these questions should be answered and the desired material should be checked for suitability based on these factors, as well as any others that might be special to the system in question.

Finally, in addition to verifying the temperature, pressure, and media with the thermoplastic pipe material, it is also necessary to verify other components in the system, such as valves, gaskets, valve seat and seals, etc. These should be examined in the same manner as the pipe material.

Thermal Expansion

Based on your operating criteria, thermal expansion must be considered. For systems maintained at consistent temperatures, compensation for thermal effects may not be required. It is, however, important to review all aspects such as the operating environment. Is it outdoors where it will be exposed to changing weather? Is the system spiked with a high temperature cleaning solution? Will the system run at a significantly higher temperature than the installation temperature? The occurrence of any thermal change in a plastic system will cause the material to expand or contract. As an example of the effect, polypropylene will grow roughly one inch for every 100 linear feet and 10 ΔT.

Thermoplastic systems can be used in hot applications and applications where the temperature is cyclical; it just requires analysis of the thermal expansion effects. Section C walks through the steps of calculating thermal expansion, end loads, and expansion compensating devices. In most cases, the use of expansions, offsets, and proper hanging techniques are all that is required to ensure a proper design.

Hot systems also reduce the rigidity of thermoplastic piping, which, in turn, decreases the support spacing between pipe hangers. In smaller dimensions, it is recommended to use continuous support made of some type channel or split plastic pipe.

Finally, the use of hangers as guides and anchors becomes important. As the design procedures in Section C indicates, certain hangers should be used as guides to allow the pipe to move back and forth in-line, while other hangers should be anchoring locations used to direct the expansion into the compensating device. The anchors and hangers should be designed to withstand the end load generated by the thermal expansion. Figure D-10 is an example of an anchor type restraint fitting that is available from Asahi/America, Inc.

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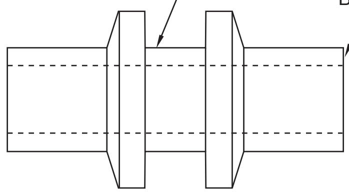

Figure D-10. Restraint fitting

For calculation of allowed stresses and design of expansion compensation devices, refer to Section C, *Engineering Theory and Design Considerations.*

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System Sizing

In Section C, there is a detailed discussion on fluid dynamics and determination of flow rates and pressure drops. When using any thermoplastic with a hazardous chemical, it is recommended to maintain flow rates below a velocity of 5 ft/second. High velocities can lead to water hammer in the event of an air pocket in the system. Water hammer can generate excessive pressures that can damage a system. For safety reasons, high velocities should be avoided.

In addition, high velocities also mean added pressure drop, which, in turn, increases demand on the pump. If the flow velocity is not required, it is recommended to size a system with minimal pressure drop. It is also recommended to oversize a design to allow for future expansion or chemical demand. Once a system is in place, it is difficult to add capacity to it.

UV Considerations

All thermoplastic materials react to the exposure of UV differently. PVDF and E-CTFE materials are almost completely UV resistant over the course of its design life. However, certain chemicals containing Cl anions exposed to UV light can create a free radical Cl, which will attack the PVDF pipe wall. For more information on these chemicals, refer to *UV Exposure and Weatherability* later in this section.

Polypropylene is not UV stable. In direct exposure to sunlight it will break down. The effect can be seen in a noticeable color change in the pipe. In a pigmented PP system, the color change will actually create a protective shield on the outer layer of the pipe and prevent further degradation. For PP pipes with a wall thickness greater than 0.25", the effect of UV is reduced and can be used outside. However, it is still recommended to protect it from UV exposure for added safety. Natural PP will not self create a UV shield as the pigment PP does; therefore, UV protection is required all the time on natural PP systems.

Other materials, such as HDPE, may or may not be UV stabilized. PE containing carbon black are generally UV stable and can handle direct exposure. Other HDPE materials may require protection. Use of protection should be based on the individual grade of the polyethylene. Consult the manufacturer for details.

Insulation

Insulation is a good method of protecting a pipe system from UV exposure, as well as providing required insulation for the system or media being transported. A serious difference between plastic and metal is plastic's thermal properties. A metal pipe system will quickly take the temperature of the media being transported. A system carrying a media at 150° F will have an outer wall temperature close to or at 150° F. In contrast, thermoplastics have an inherent insulating property that maintains heat inside the pipe better than a metal system. The advantage is that a plastic pipe has better thermal properties, which translates into improved operating efficiencies and reduced insulation thickness.

Hanging

See Section C for hanging details and proper placement distances. Since plastic reacts differently than metal, varying hanger styles are required. The designer of a system should specify the exact hanger and location and not leave this portion up to the installer.

Welding Methods

The system designer should specify the welding method to be used in any given project. Asahi/America offers several choices for joining PVDF and PP together. The choice of a particular method should be based on the following concerns:

- Installation location
- Size range
- System complexity

PVDF can be installed using butt fusion, IR fusion, socket fusion, and beadless HPF fusion. All methods are proven in chemical systems and each has its own advantages. Polypropylene is weldable using butt, IR, or socket fusion. In addition, Asahi/America offers electro-fusion couplings for PP that are ideal for repairs. (Electro-fusion PP couplings may have reduced chemical resistance. Consult factory.) E-CTFE can be welded using butt or IR fusion. It is recommended to assemble Halar with IR fusion, as special heating elements are required for welding Halar with conventional butt-fusion equipment.

Socket fusion is ideal for small, simple, low cost systems. In small diameters, 1/2"–1 1/4" socket fusion can be done quite easily with a hand-held welding plate and a few inserts. With just a limited amount of practice, an installer can make safe and reliable joints. For larger dimensions, up to a maximum of 4", bench style socket fusion equipment is available for keeping joints aligned.

For systems that have larger dimensions above 4", butt and IR fusion make a logical choice. Butt fusion is available in every pipe size made available by Asahi/America. Welding can take place in a variety of climates and conditions. In addition, butt fusion offers the widest variety of welding equipment options. Tools are available for bench welding, trench welding, and

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welding in the rack, making it completely versatile for almost all applications. Refer to Section F for guidance in tool selection.

IR fusion is available for welding 1/2" to 10". IR is an extension of the butt-fusion method. The operation is the same with the exception that material being joined is not in contact with the heat source. Rather, the material is brought in close to the heating element and the heat radiates off to the components. The advantage of this method for chemical systems is the elimination of molten material sticking to the heat source.

IR fusion is better suited for indoor applications. IR fusion equipment is highly sophisticated, providing the operator with detailed information on the weld process and quality. For critical applications with dangerous media, IR fusion may be best suited due to the quality assurance built into each piece of equipment.

For a more detailed analysis of welding methods and equipment, refer to Section F, *Installation Practices*.

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