Chlor-Alkali Process Systems

Design considerations to ensure a safe, effective piping system

A naturally occurring element, chlorine serves as the basic building block for some of the most critical health and safety items used in everyday life, such as drinking water treatment, waste water treatment and a wide range of disinfectant products. Although chlorine is a naturally occurring substance, it must be processed to meet the current market demand. That's where the Chlor Alkali industry comes in. The Chlor-Alkali industry takes salt water or brine, and transforms it into chlorine, hydrogen, caustic soda or potash, and sodium hypochlorite, through the process of electrolysis.

Design Considerations for Chlor-Alkali Plants

Chlor-Alkali process systems require careful design consideration, due to the high temperatures and corrosive properties of the fluids that pass through them. Many of these corrosive fluids are incompatible with metal piping systems, which is why Chlor-Alkali facilities rely on thermoplastics, dual laminates, lined pipe and exotic alloys.

Of these options, thermoplastics offer the best cost effectiveness and availability, as well as long service life and high performance. For example, CPVC, Chlorinated Polyvinyl Chloride, is an excellent option for applications such as ultrapure brine, sodium hypochlorite, anolyte and catholyte handling, with enhanced non-corroding properties and resistance to these chemicals. When choosing a thermoplastic material for an industrial process, it is important to know that not all plastics are created equal.

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Comparing CPVC Products

Each manufacturer has its own distinct compound to produce their CPVC products. Additives to the resin are used to create a compound with more desirable traits. Below is a short list of important additives that create high functioning, reliable thermoplastic products.

Heat Stabilizers
Protect against thermal degradation

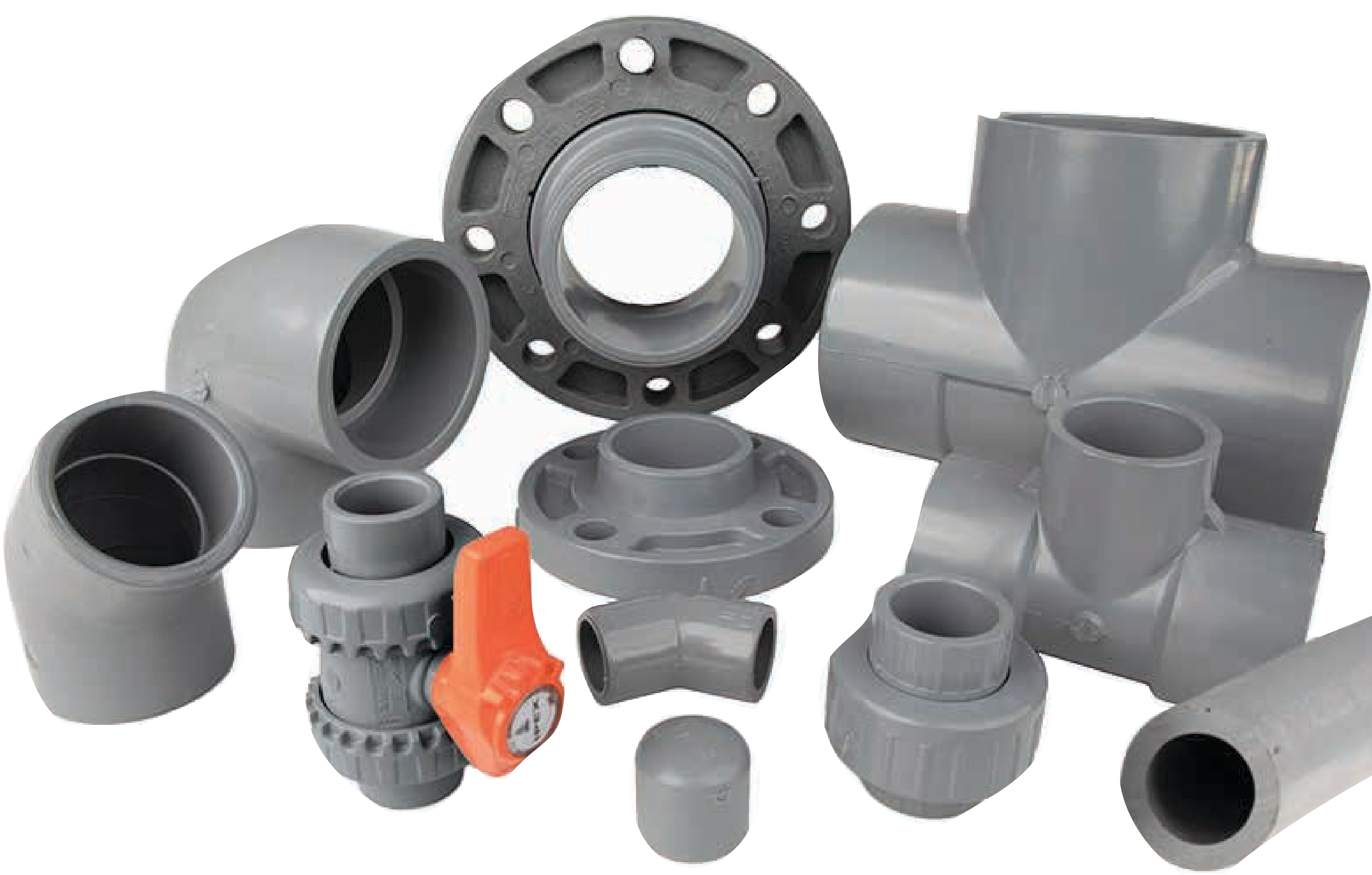
Antioxidants
Protect against oxidation and weathering

Ultraviolet Stabilizers
Protect against UV degradation

Pigments
Add a distinctive color and further protection against UV

Property Modifiers
Enhance a particular material property

Process Aids
Assist material mixing/ fusion during processing



High Impact CPVC: Improved Durability & Reduced Risk

In real world applications, the use of high-impact CPVC translates to improved durability and system confidence. Industrial system designers seek to reduce risk wherever possible. Specifying a high-impact CPVC helps safeguard against unexpected damage in the field, reducing the risk for unplanned releases.

One method to distinguish among CPVC products is to examine cell classification, which is determined by ASTM D1784, the Standard Classification System and Basis for Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds. Each digit in the cell classification corresponds to a physical property rating as shown below:

	GENERIC CPVC	IPEX XIRTEC® CPVC
Material Designation	2	2
IZOD Impact Strength	3	4
Tensile Strength	4	4
Modulus of Elasticity	4	4
Heat Deflection Temperature	7	8

IZOD Impact Strength

Engineers can specify CPVC with a higher cell class for their most challenging applications by requiring cell classification of 24448. This higher cell class CPVC pipe exhibits increased impact strength and an improved heat deflection temperature rating compared with CPVC with a cell class of 23447.

Impact strength is measured using the IZOD impact test described in ASTM D256. Materials are rated based on energy lost per unit of thickness at the notch. As can be seen below, a cell class of 3 requires a minimum of 1.5 ft*lb/in, while a cell class of 4 requires a minimum of 5.0 ft*lb/in, which is more than three times higher.

MATERIAL	CELL CLASSIFICATION	IMPACT RESISTANCE (ft*lb/in. of notch)
Generic PVC	3	1.5
Xirtec® CPVC	4	5.0

Heat Deflection Temperature

Material service temperatures are commonly rated based on their heat deflection temperature, which is a measurement of the temperature reached under load when the sample has deflected 0.010 in. Heat deflection temperature rating is obtained using ASTM 648 Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position. CPVC with a cell class of 24448 has a heat deflection temperature of 230°F, which is higher than most thermoplastics, including the 212°F heat deflection temperature of generic CPVC with a 23447 cell class.

In practice, a material's heat distortion temperature should be higher than a system's acceptable operating temperature. CPVC with a cell class of 24448 typically lists a maximum operating temperature of 200°F, allowing for a considerable safety factor.

MATERIAL	CELL CLASSIFICATION	DEFLECTION TEMPERATURE UNDER LOAD (min 264 PSI)
Generic CPVC	7	212
Xirtec® CPVC	8	230

When comparing IPEX Xirtec® CPVC against generic CPVC products, it's easy to see that the IPEX product performs favorably. CPVC is made with a compound technology known as Corzan®. IPEX partners with Lubrizol, the Corzan compound manufacturer, to create a higher quality, consistent product compared with generic CPVCs. Corzan technology has a proven reputation for performance in demanding environments such as Chlor-Alkali applications.

Secondary Containment Offers Added Protection

Industries need durability built into a system but also fail-safe protection for the unexpected. Designing a system that meets or exceeds requirements and protects the environment, people and property is the responsible choice.

For added protection, and to mitigate risk, secondary containment should be considered. Concrete basins and drip pans used to protect systems have limitations. Concrete basins are limited by a large installation footprint and are typically open to the environment. Drip pans are still used extensively but are limited in their ability to contain spills. Double-contained pipe (pipe within a pipe) not only catches an unplanned release, it contains it safely within the secondary pipe.

Typically, double-contained pipe will be installed to satisfy federal EPA requirements for protecting groundwater from potentially hazardous substances. It is also used increasingly for personnel safety and property protection. Double containment, for example, is used extensively in applications such as water treatment, industrial manufacturing and protection of valuable equipment. These lines can run overhead, inside and between buildings, or underground.

Engineered double-containment systems offer flexible design options as well. A system can be modular, with double-contained sections installed over high-risk areas, transitioning to single wall pipe in areas of less risk. Pipes of different materials can also be used in the same system. The primary pipe, which carries the process fluid, needs to be compatible with the system temperature, pressure and chemical – like any single wall system. The secondary (containment) pipe must meet the requirements of the environment while still being able to temporarily contain the process fluid if there is a failure.

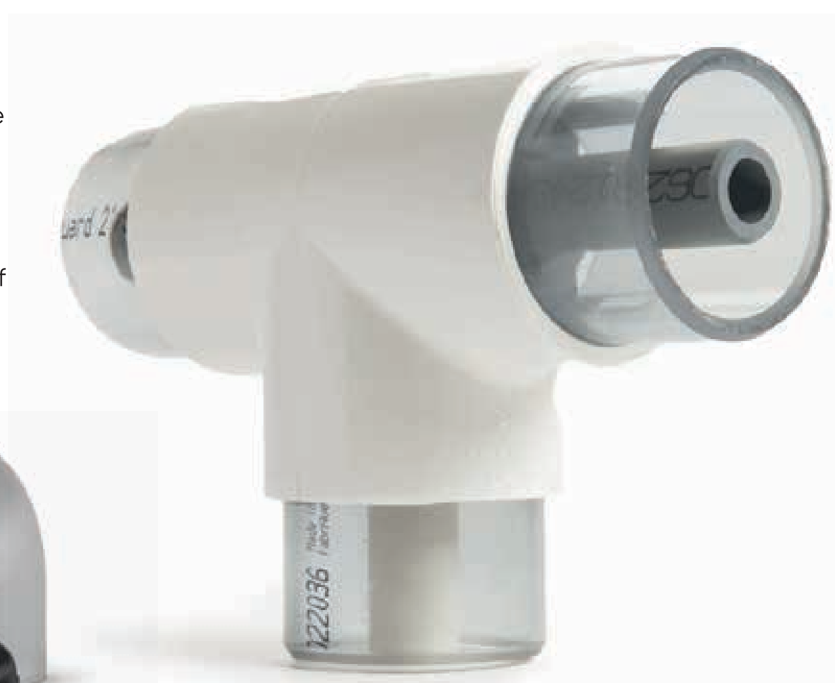
Double-contained systems give owners increased confidence in their infrastructure while reducing the risk of costly remediation. It is important to consider that even when the secondary containment is not mandated, it is good practice.

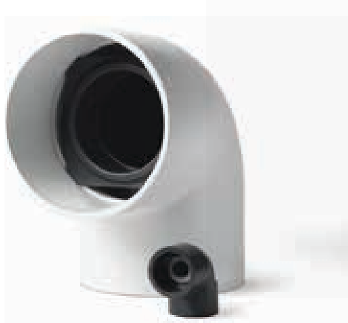
Piping Support Systems in Chlor-Alkali Plants

When working with thermoplastics in high temperatures like the Chlor-Alkali industry, support spacing is critical to ensure the longevity of the system. For example, electrolytic cells often run as hot as 205°F. Plastic pipe requires more support than metal pipe at these elevated operating temperatures.

Manufacturers provide general recommendations on the appropriate support spacing for different sizes of pipe at different operating temperatures. These recommendations are usually based on allowable stress and limiting sag. Selecting the support style is also important. Supports should allow for axial movement and restrain lateral movement, allowing the pipe to expand and contract naturally with temperature fluctuation. The supports need to offer a smooth surface that enables pipe movement while ensuring there are no pressures or stresses inflicted on the pipe.

Continuous support is required at temperatures greater than 200°F. Although more support may be required, plastic pipe may still cost less than a metallic system, as the pipe is significantly lighter. Some manufacturers offer support spacing design assistance to support thermoplastics using existing steel pipe support structures. These recommendations are based on the allowable stress for the specific application.



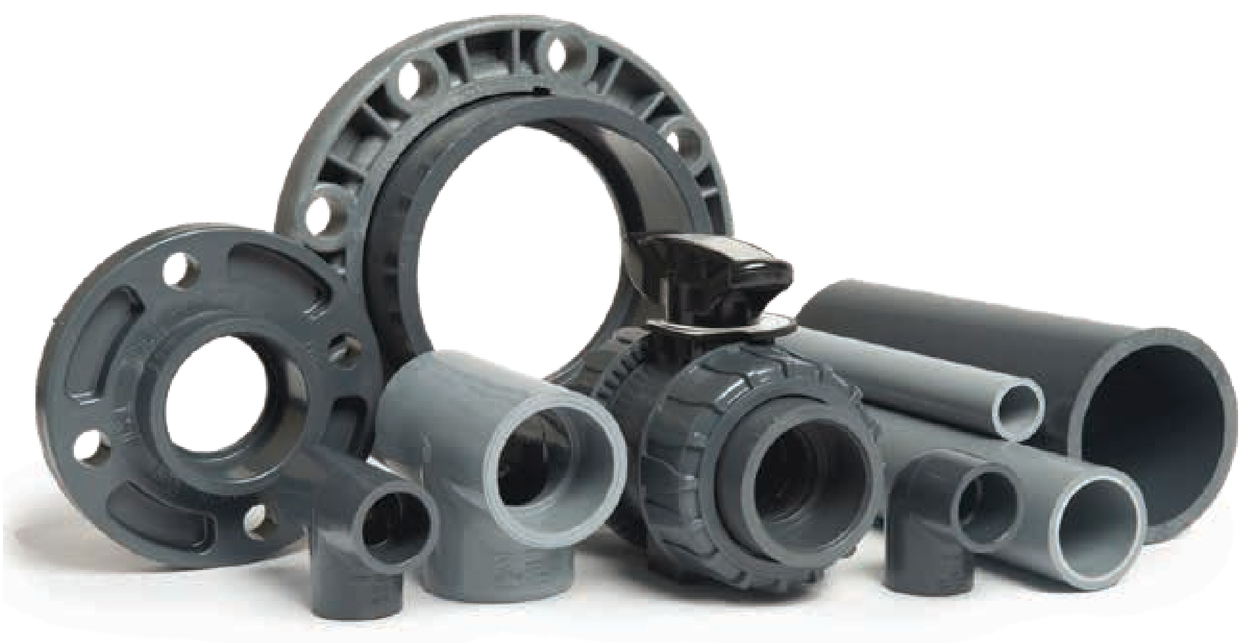


Joining Pipes With Solvent Welding

CPVC piping systems are typically installed using solvent welding. Solvent welding is a relatively simple process, but must be done correctly to achieve the desired joint integrity. Solvent welding is not simply "gluing" joints together. It is a chemical weld process. Solvents are used to chemically attack and penetrate the material, softening the surface to allow the pipe and fitting to fuse as the solvent evaporates, forming a permanent bond. A joint that is properly solvent welded will be stronger than the pipe itself.

In the same way that welding metal pipe requires training, solvent welding installers should complete bonder qualification training to ASME B31.3 to avoid costly mistakes.

Designing a system involves picking the right material based on pressure, temperature, and chemical compatibility, but also, getting the installation right. A faulty installation can be an expensive or potentially hazardous mistake, so it is critical to enlist an installer experienced in solvent welding.



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