CHEMICAL PROCESSING
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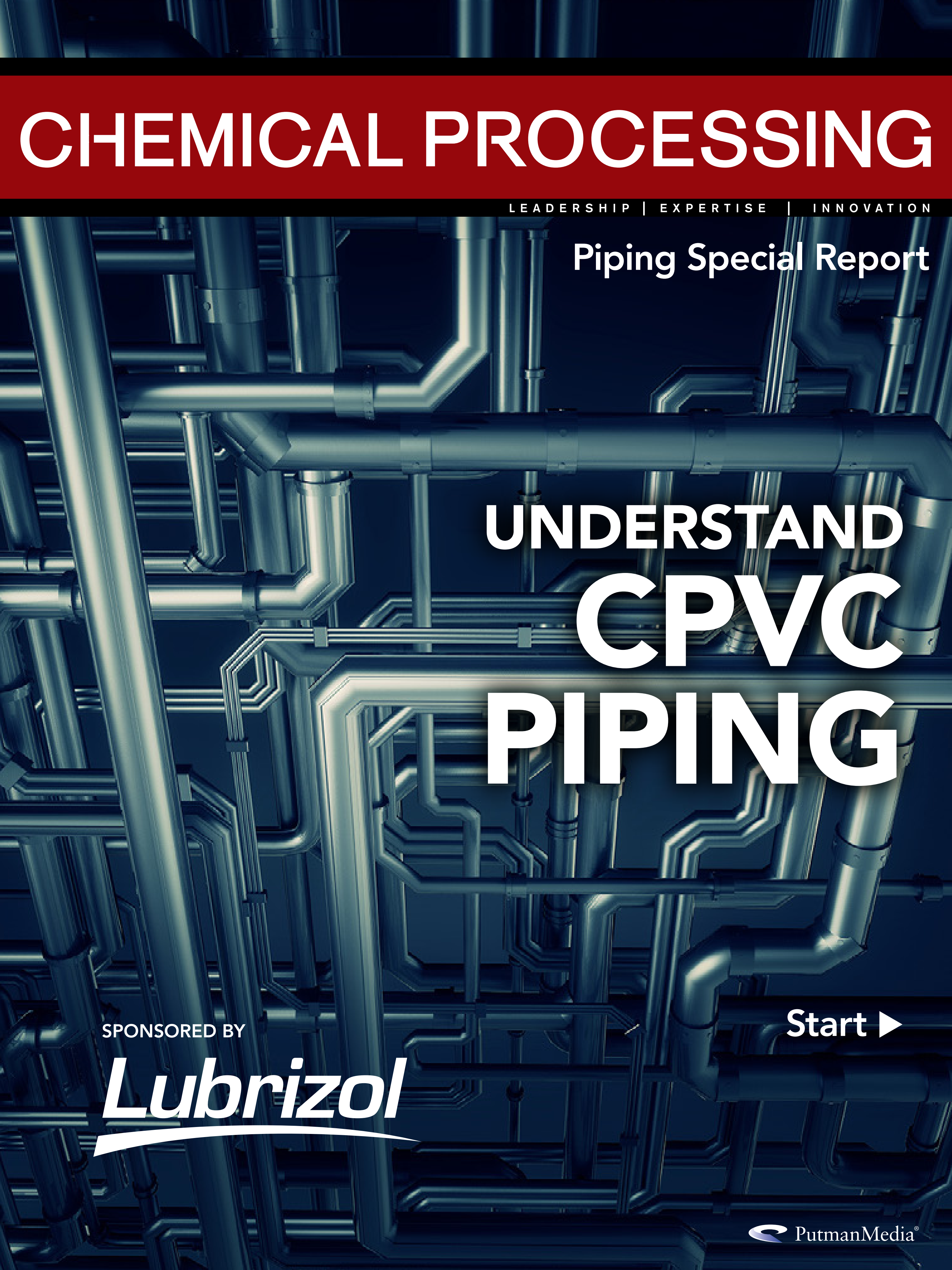
Piping Special Report

UNDERSTAND CPVC PIPING



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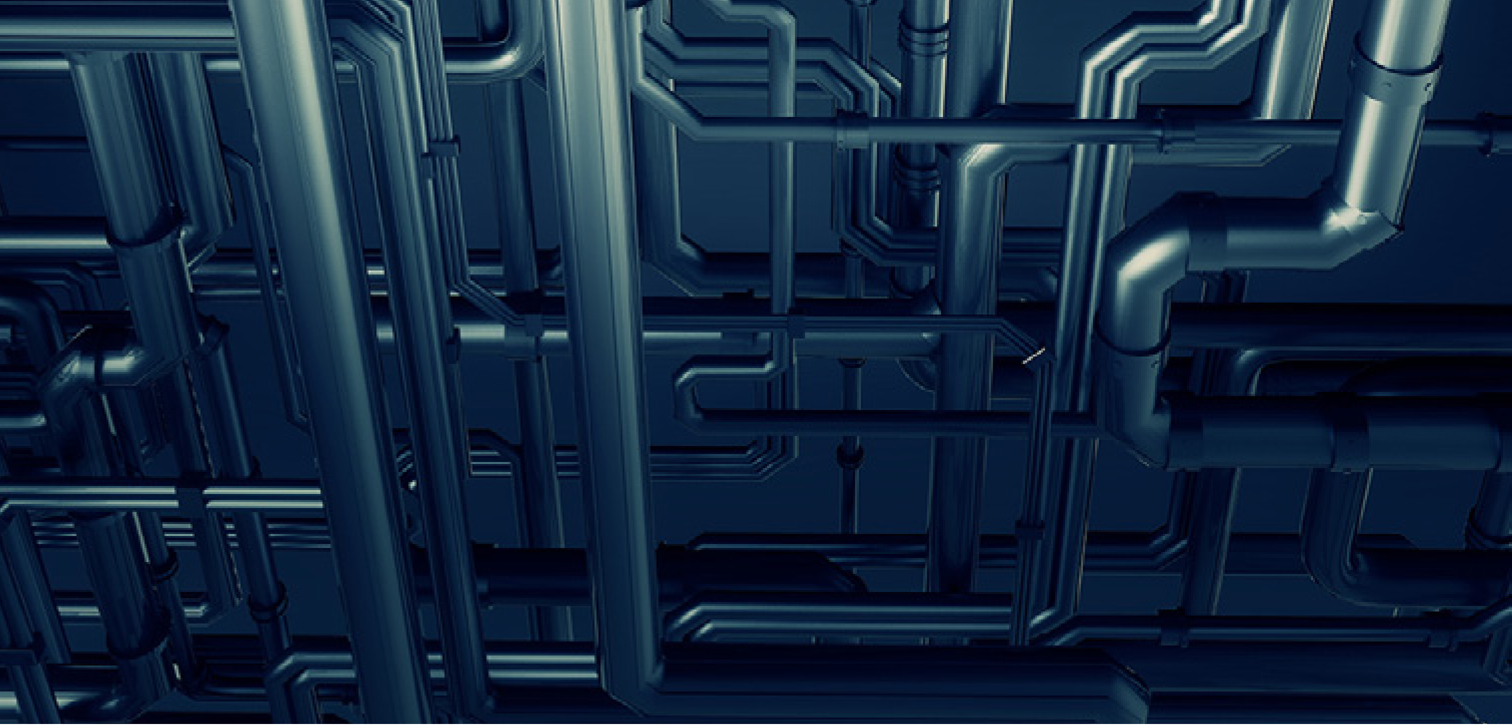

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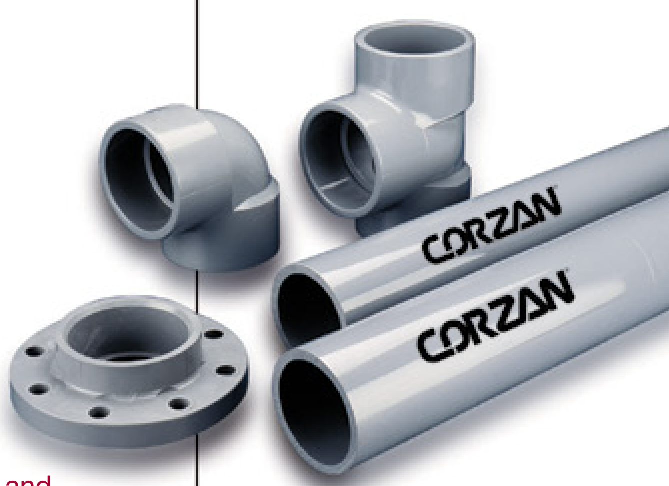
INDUSTRIAL SYSTEMS

THE RELIABLE PIPING SOLUTION FOR THE CHEMICAL PROCESSING INDUSTRY

Corzan Industrial Piping Systems inherently offer superior resistance to corrosive chemicals and high temperatures commonly found in the harshest of processing applications.

In fact, Corzan pipe, fittings and valves are inert to most acids, bases and salts, as well as aliphatic hydrocarbons.

As a result of their corrosion resistance and durability, Corzan Industrial Systems have over 50 years of success in a wide array of processing applications around the world.



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Put CPVC Piping in Its Place

Understand where it fits in terms of cost and performance

By Donald Townley, Lubrizol Advanced Materials, Inc.

SAVVY SPECIFIERS know it's not just the purchase price that matters when choosing a product that's designed for long-term performance. When evaluating a piping system this certainly is the case. The key is to identify the best value for today, as well as tomorrow and beyond. And that typically requires a lifecycle cost analysis tailored to your specific plant, to reflect its fluid temperatures, line pressures, chemical environments, etc.

For such an analysis for piping materials, start by calculating the cost to install the system. Don't focus only on the direct material costs — labor and related installation expenses can account for more than one-half of the total investment made in a piping system.

Then consider the cost to maintain the system and how maintenance requirements affect productivity, downtime and lost opportunity. Also evaluate expected service life — how long the system should last before a total repipe will become financially or operationally necessary — and its impact on profitability.

Here's how chlorinated polyvinyl chloride (CPVC) piping typically stacks up.

MANY CHOICES

Depending on the demands and environment of the operation, you could consider dozens of materials for a plant's piping system. On the low end of the cost spectrum are PVC, CPVC and carbon steel. At the other extreme are high performance metals such as nickel, titanium and zirconium and alloys. Combination systems such as steel lined with rubber, polyvinylidene fluoride (PVDF) or glass fall in the middle.

Metals. Historically metals have dominated the industrial piping market, largely because they've been used longer than any other material in such applications. In general metal offers higher pressure-bearing capabilities than alternative materials. Additionally, metal systems' pressure-bearing capabilities aren't significantly reduced by increases in temperature. And metal's rigidity allows hangers to be spaced farther apart to save on installation costs.

However, metal poses numerous disadvantages — the most serious of which is vulnerability to internal and external corrosion. Certain substances may cause metal to corrode from within, while elements such as salt in the air or low pH levels in the ground (for underground applications) can prompt external corrosion. Even high-end pricey metals such as titanium, which generally resist corrosion, are susceptible to degradation in certain environments.

Metal also is subject to flow-restricting scale buildup, which increases pressure drop and can contaminate the process. In addition, compared to plastic piping systems, metal is heavier and more expensive to install, both in material and labor

cost. And, because metal has poor insulating properties, it sweats more when handling cold fluids, can create a burn hazard when transporting hot fluids, and is less energy-efficient — all of which create the need to add costly insulation.

Plastics. Today many different plastics successfully serve in industrial environments. In general one of the greatest benefits of plastic pipe is its corrosion resistance. Various types of plastic piping can be buried in alkaline or acidic soils without requiring any paint or special coating. Plastics containing TiO_2 for ultraviolet protection strongly resist weathering.

Most plastic pipe also isn't susceptible to scaling — so, such piping systems maintain their full fluid-handling capability throughout their entire service life. This means it's often possible to downsize the diameter of the pipe when converting from metal, reducing material costs, and to opt for smaller pumps, saving energy.

Of course, the various plastics differ in cost and capabilities. PVC, for example, offers significant economic advantages but can't handle high-temperature applications. CPVC, on the other hand, provides superior chemical resistance as well as a high heat distortion temperature, due to its molecular structure — large chlorine atoms surround the carbon backbone to protect it like armor plating. So, CPVC has grown in popularity in both corrosive and high-temperature applications.

Hybrids. In recent years, manufacturers have been able to increase CPVC's temperature and pressure-bearing capabilities by wrapping it with fiberglass. Other hybrid systems include various plastic-lined metallic pipe, which combines the advantages of metal and plastic while minimizing many of their disadvantages. This type of piping system eliminates scale buildup concerns while offering the same superior pressure-bearing capabilities as metal. Such pipe is immune to internal corrosion but still subject to external corrosion. A major disadvantage of plastic-lined pipe is cost. In addition, it requires a difficult labor-intensive joining process. And, any break that occurs in the lining can become a source for future pipe failures.

Of course, cost always is an overriding factor in pipe selection. An authoritative study documented that when allowing for direct and indirect costs — material cost, labor, maintenance, productivity, etc. — CPVC was the bottom-line best choice. Its nearest rival, strictly from a total-installed-cost standpoint, was carbon steel. At the extreme high end were PVDF and titanium.

SPECIFYING CPVC

Due to its high heat distortion temperature, chemical inertness and outstanding mechanical, dielectric, flame and smoke properties, CPVC likely can serve a role in nearly any chemical plant today. Indeed, wherever corrosion resistance and mechanical strength are crucial, consider CPVC. Applications extend beyond processing operations — the material often is the most effective choice for cleaning systems involving high temperatures and harsh cleaning agents.

CPVC piping can handle chemicals that cause

PLANT INSTALLATION

Figure 1. CPVC piping has a proven itself at plants for about 50 years; new formulations extend the applicability of the material.

process leaks, flow restrictions and, ultimately, premature failure in metal systems. CPVC withstands most mineral acids, bases and salts, as well as aliphatic hydrocarbons.

However, not all CPVC compounds on the market perform similarly. You can gauge how well your specific CPVC piping system will perform from its cell class, which is defined by ASTM D1784 and certified by NSF International. There're now two cell classifications — 23337 and 24448. A large majority of CPVC pipe falls into the standard 23337 level. Pipe systems that meet the 24448 classification — all are made from second-generation CPVC formulations — exhibit three times the impact strength of standard CPVC, resulting in fewer breaks and fractures, a lower scrap rate and easier cutting. They also provide a higher heat distortion temperature, 230°F compared to 212°F for standard CPVC. This translates into a lower probability of sagging or bending.

EASY JOINING

Figure 2. Solvent cement creates a permanent bond stronger than either the pipe or fitting.

Second-generation CPVC systems also uniquely feature fittings made from pressure-rated compounds. These fitting compounds carry the same pressure-rating classes as the pipe compound. The fittings provide improved creep resistance and can better withstand long-term high-temperature hydrostatic pressure.

It's important to check with the manufacturer of the pipe and fittings being specified to confirm how well they will perform in a specific application.

MATERIAL LIMITATIONS

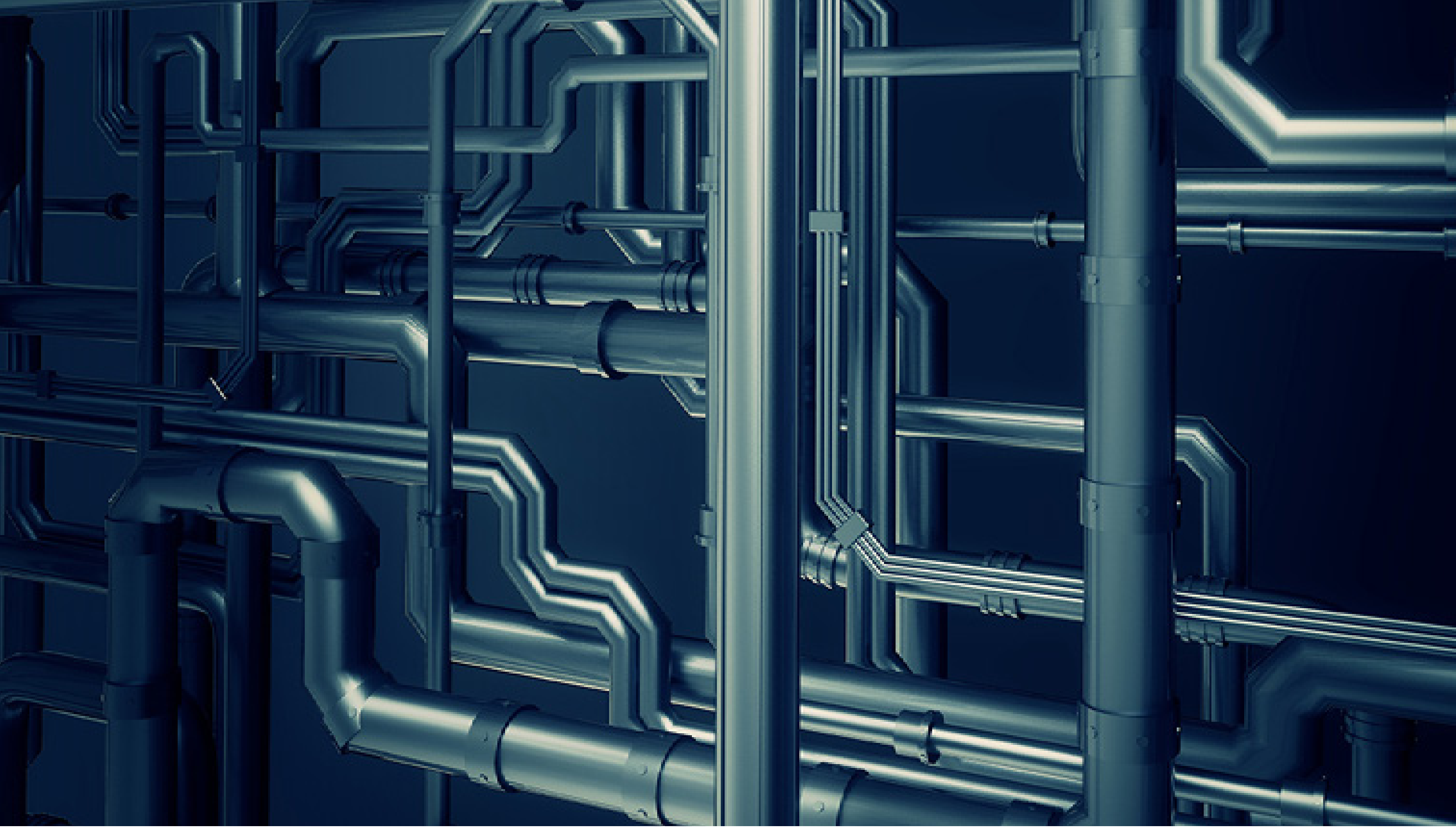
No single material is ideal for every application. CPVC isn't recommended for use with most polar organic materials, including various solvents. CPVC test samples exposed while under stress to surfactants, certain oils or grease have shown signs of environmental stress cracking, softening and swelling.

CPVC can safely handle certain organic solvents that are soluble in water, such as alcohols, below a specific concentration. (The acceptable concentration level varies with the type of solvent — consult the CPVC manufacturer for specific recommendations.) However, solvents insoluble in water, such as aromatics, likely will be absorbed by the piping system over time, even when they're present at very low levels in the water. This may lead to a decreased service life expectancy for the system depending on the operating conditions.

Temperature and pressure also pose restrictions. In general CPVC can safely be used at up to 200°F in pressure applications and up to 220°F in non-pressurized applications.

Pipe size and temperature determine the specific pressure rating — the smaller the pipe size, the higher the pressure rating allowed; the higher the temperature, the lower the pressure rating. For example, ½-in. pipe operating at room temperature can handle up to 900 psi., while 16-in. pipe operating at the same temperature only can withstand 200 psi. All pressure ratings are based on a 50-yr. service life with a safety factor of two.

Another limitation relates to hanger spacing. Because CPVC piping systems aren't as rigid as metal, hangers must be installed closer together, resulting in more hangers. In certain situations,



space limitations may preclude the additional hangers required for CPVC installations.

JOINING METHODS

It's impossible to accurately assess the cost to install a piping system without considering the joining system. That's because the joining method directly impacts labor costs and productivity.

CPVC offers a number of benefits over metal with regard to joining. Because no welding is involved, no hot work permits or specialized, cumbersome equipment are required. In the majority of situations CPVC pipe is joined with solvent cement. This is a fast, easy and highly reliable process that produces a joint that's actually stronger than either the pipe or fitting alone. This contrasts with other piping systems, in which the joint typically is the weakest part of the system and the most likely to fail.

Although some people liken solvent cement to glue, it's very different — the solvent cement actually creates a welded permanent bond. The solvents in the cement soften the surfaces of the pipe and fitting socket. Because the socket is tapered, the softened surfaces bond once they are fit together. CPVC in the solvent cement fills in any gaps that might otherwise exist in the joint. As the solvent cement cures, the solvents flash off.

Only CPVC solvent cement should be used. For applications in exceptionally harsh chemical environments, check with the manufacturer regarding the performance of the solvent cement.

Although solvent cementing is the preferred joining method for CPVC piping systems, there are alternatives. If it's necessary to connect to an existing metal pipe or if the system needs to be disassembled for any reason, the CPVC pipe can be joined via flanges or threading. Full lines of transitions, threaded connections and flanges are available — as are CPVC valves. It's possible to create an all-CPVC system that facilitates maintenance in the future.

CHOOSE WISELY

An analysis of piping should go beyond initial price to consider lifecycle costs. The challenge is choosing a system that meets the performance and budget criteria at installation and over the long term. On that basis, CPVC has proven to be a highly viable option for many chemical processors.

CPVC offers a material cost highly competitive with most other options, especially high-end metallics. Its fast and easy joining system reduces labor costs. And its corrosion resistance and ability to withstand harsh chemicals, high temperatures, pressure and impact lead to reduced maintenance requirements, less downtime and greater productivity over an extended service life. ●

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Challenge Pipe Specifications

Opting for alternative materials or designs may offer significant benefits

By Dirk Willard, Contributing Editor

INEOS HIRED Organic Technologies (OT) of Coshocton, Ohio, to toll manufacture synthetic lubrication oil. I think part of the reason why Ineos' engineers visited during commissioning was to see how the toller undercut the competition by a quarter. As a consultant hired by OT to help with the campaign, I was curious myself.

OT's secret, or at least one of its secrets, was tubing: the company used 1-in.-dia. tubing for the process pipe. Strong, easy to assemble, and ideal for small processes, i.e., ones below 25 gpm, the tubing significantly speeded up construction; it only took days instead of weeks. No welding was required, which meant no qualification tests for welders. OT didn't even need isometrics because the whole thing would be torn down after the campaign. This is but one example of safely cutting corners in pipe specifications.

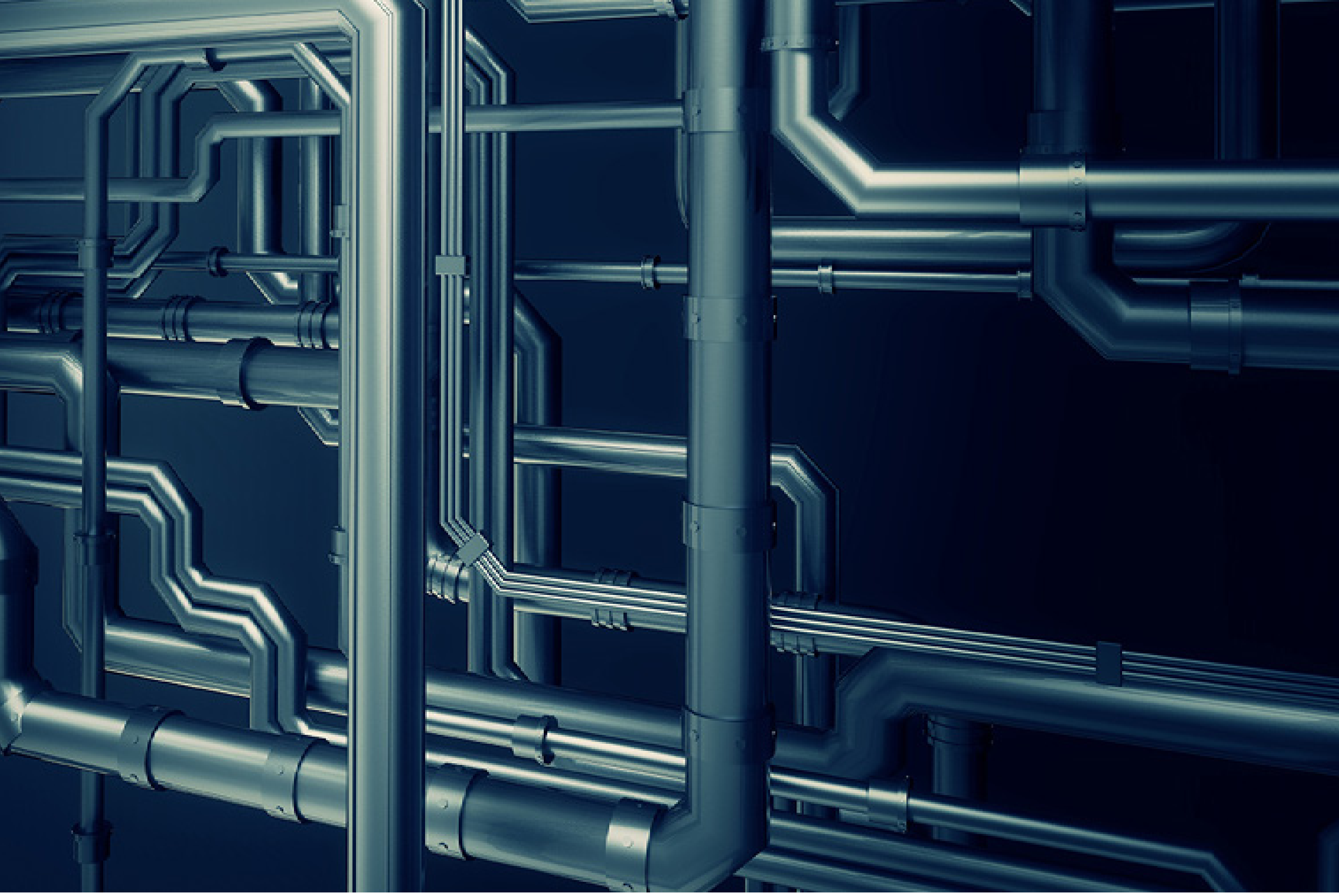
Let's consider some others.

First, check if fiberglass pipe can handle the service. Such pipe doesn't require welding, is easily cut and glued, and stands up to most chemicals. I reckon the total construction cost — i.e., materials, labor and profit — of a 2-in.-dia. fiberglass pipe is 46% of a schedule-40 stainless steel one. Some sources give less-favorable material cost comparisons, sometimes even showing stainless steel cheaper than fiberglass. However, they don't consider construction and lifetime costs.

Part of this lifetime savings comes from reduced friction losses — and, thus, lower pumping costs. For new pipe, fiberglass can cut energy costs 25% versus steel. When replacing old steel pipe, the savings could reach up to 200%. This might allow a designer to use a smaller line size for fiberglass compared to steel, thereby making construction easier or reducing construction costs further. However, under no circumstances use fiberglass pipe less than 1½ in. in diameter because it's difficult to prevent glue globs from restricting flow at small fittings.

Limit ordinary fiberglass pipe to operating temperatures no higher than 150°F, pressure below 200 psig and vacuum no more than 500 torr abs. Some high-temperature resins can handle services of 250°F or more.

Other plastic pipe such as PVC and CPVC can offer alluring savings compared to steel but at the expense of lower operating temperatures and pressure. Never use PVC if the maximum operating temperature can rise above 140°F. Instead, consider CPVC because it



can operate up to 200°F at an allowable pressure of 50 psig for 2-in. schedule-40 pipe. Hybrid materials, such as CPVC wrapped with fiberglass, can provide higher temperature and pressure capabilities. (For more on using CPVC piping, see the article,"Put CPVC Piping in Its Place.")

You can cut costs in construction in other ways besides choosing plastic pipe. Why not avoid heat tracing and insulation by burying pipe? This could raise a red flag with environmental regulators — but there are ways to construct reliable double-pipe systems that avoid costs and spill problems.

Here's another thought. For product isolation, use a double-isolation-and-bleed (DIB) valve with internal relief instead of two double-block-and-bleed (DBB) valves. A DIB valve is more compact; you're buying two valves in one. It utilizes bidirectional seats that provide isolation, without contamination, from either direction.

DBB valves typically have unidirectional seats and, so, provide isolation only from one side, allowing contamination when the body cavity relieves to the low-pressure side. If a flammable, volatile liquid is present, this could pose a safety issue. If a heated liquid is present, this could result in seal rupture if the liquid fouls or thermal relief is insufficient. (For more about DIB and DBB valves, see: http://goo.gl/YYqcNs; and http://goo.gl/n9mN7X.)

Early in my career I ran into a dilemma over material standards. Millennium Inorganic Chemicals required a nickel/copper alloy for control valves used in pure oxygen service. It turns out that Union Carbide blew up an O_2 furnace a century ago and the leading cause was rust rushing through a control valve at high velocity; Carbide's solution was a nickel/copper alloy (Monel). The trouble is that it takes six months to get a 4-in.-dia nickel/copper-alloy control valve. There had to be a better solution — there was. I knew steel makers used pure O_2 in their furnaces, so I started making calls; the steel companies had changed to type-316 stainless decades ago. Type-316 stainless steel valves are off-the-shelf items. The moral of this story is to always challenge pipe specifications and design practices. They could be obsolete.

In addition, always remember that good pipe specifications are crucial both for economics and safety. (See: "Get Pipe Specifications Right in the Beginning," http://goo.gl/b5mIEX.)

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Understand CPVC Piping

Carefully consider this material for industrial process water applications

By Jorge Solorio, Lubrizol Advanced Materials, Inc.

THE SAFETY performance of industrial piping material cannot be overstated — these environments have hundreds, often thousands, of lives at stake, causing them to be closely monitored and regulated by government bodies, such as the U.S. Occupational Safety and Health Administration and the Environmental Protective Agency (EPA). Add cost and reliability to the list of important factors when considering industrial piping choices, and it's clear why material selection for process water applications is such an important one. Among the many piping choices in the industry, the superior strength, performance and safety of chlorinated polyvinyl chloride (CPVC) make it an ideal system for industrial process water applications.

Traditionally, engineers and procurement professionals have relied largely on steel and other higher alloys for industrial piping. However, an overall analysis reveals that CPVC often outperforms metallic systems, and is more cost-effective, over a longer period of time. Yielding an overall lower installation cost, fewer maintenance and safety concerns, and strong performance with a wide variety of chemicals, CPVC is a material that is gaining the attention of many. And the benefits don't stop there. CPVC offers numerous advantages that can and have improved the bottom line of industrial process water applications worldwide, such as:

Corrosion resistance. Corrosion is a common, ongoing problem in industrial environments. CPVC pipe and fittings demonstrate superior resistance to internal and external corrosion, virtually eliminating process leaks, flow restrictions and, ultimately, premature pipe failure. Unlike metallic systems, CPVC industrial piping will never pit or scale, as it is inert to most mineral acids, bases, salts, and aliphatic hydrocarbons. CPVC is formulated to stand up to many of the same aggressive chemicals that corrode steel, and it does so in very extreme temperature environments.

Ease of installation. Because CPVC is lightweight—roughly one-eighth the weight of comparably sized steel piping—and requires less complex tools, installation and maintenance are simplified, reducing labor time. CPVC pipe and fittings are installed using a simple two-step solvent cementing process, which creates a highly reliable joint by chemically fusing the pipe to the fitting. When properly installed, a solvent-cemented CPVC joint becomes the strongest part of the entire system, offering more durability than either the pipe or fitting alone.

Little or no maintenance. A CPVC piping system requires little or no maintenance when properly

installed. In addition, external pipe coatings are not necessary because CPVC remains unaffected by even the most aggressive soil and air conditions. However, should a portion of the piping need replacing, a repair can be made easily without the need for a welder or lifting device to hoist equipment into place.

Optimum flow rates. CPVC piping offers optimum flow rates, meaning more liquid can be moved using smaller pumps and less energy. This type of industrial piping has a smooth inner surface that resists scaling and fouling, which minimizes friction pressure losses in the fluid flow from the beginning. Superior Mechanical Strength Even at elevated temperatures at which industrial plants often operate, CPVC has exceptional mechanical strength, with a pressure rating 25% higher than standard CPVC at 180°F (82°C). In addition, most systems can be expected to maintain their pressure-bearing capabilities for 50 years or more, providing long-lasting performance.

Additional safety. Not only is CPVC safer than metal to install, but it is also often safer to operate. CPVC piping has a lower thermal conductivity; this not only reduces heat loss, but it keeps the surface temperature of the pipe lower, reducing the chance of burns to maintenance and operating personnel.

Low flame and smoke. CPVC has a flash ignition temperature of 482°C (900°F), which is the lowest temperature at which combustible gas can be ignited by a small, external flame. Not able to sustain combustion, CPVC has an exceptionally low limiting oxygen index (LOI) — the percentage of oxygen needed in the atmosphere to support combustion — of 60, performing exceptionally well in the harsh conditions of industrial plants.

Long service life. CPVC starts with a C-factor of 150 and maintains that interior surface smoothness throughout its life by resisting the effects of corrosives. This leads to greater efficiency and reduced costs to facilities because smaller pipes, smaller pumps and less energy can be used to move fluids at the same rate. CPVC industrial piping can also withstand long-term exposure to even the harshest environments without significant adverse effects, making it ideal for long-term outdoor installations.

NOT ALL CPVC IS EQUIVALENT

It's important to note that not all CPVC performs the same. CPVC products are made with base resins having different molecular weights and varying chlorine contents, as well as different compound additives that can affect compatibility and long-term performance. It's recommended that you check with your piping supplier to determine what specific tests the pipe manufacturer has performed on its finished product with regard to minimum burst pressure requirements, dimensional tolerances, residual stress requirements, drop impact requirements and fusion property testing to ensure the system's long-term performance.

CPVC industrial piping systems offer numerous benefits for industrial process water applications and can be safely used throughout nearly any industrial plant because of their durability, long service life and high-performance characteristics. With its excellent balance of mechanical strength, low thermal conductivity and limited flame propagation and low smoke generation, CPVC is a cost-effective material that provides an outstanding value in terms of safety.

While CPVC is resistant to a broad range of corrosive environments, it's important to note that not all chemicals are compatible for use with CPVC. Lubrizol CPVC, the manufacturer of the superior compounds that create Corzan Industrial Systems, and its customers, have tested hundreds of different chemicals to determine the system's chemical resistance with Corzan pipes and fittings and have developed a chemical resistance program to list the solutions that can be used with Corzan, providing installers confidence in the long-term performance of the system.

When choosing a material, it's important to look for support beyond the product. Lubrizol CPVC is dedicated to providing training and education for those who work with its CPVC piping systems, including its Corzan Industrial Systems. From job-site training, to cost-effective solutions, to market leadership, a partnership with Lubrizol CPVC can ensure project success.

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