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BROOKS INSTRUMENT, a provider of advanced flow, pressure, vacuum, level and vapor delivery solutions, has launched the MT3809 armored variable area (VA) flow meter, an instrument designed to perform effectively in extreme conditions in chemicals, petrochemicals, oil and gas, and LP gas applications.

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The MT3809 can help simplify design and maintenance, reducing downtime and saving money. Installation is fast and easy, construction is of rugged stainless steel, and weldneck flanges provide long-term durability in all configurations. No back pressure is needed for gas applications, and ASME sealing specifications are met with a standard gasket, eliminating the cost of custom gaskets.

For more information, visit www.brooksinstrument.com/mt3809
New Sensor Platform Addresses Smaller Pipe Sizes

**EMERSON PROCESS** Management has added the Micro Motion ELITE CMFS sensor platform to its line of Coriolis flow meters. The new sensors were designed to deliver precise measurement to smaller line sizes (pipelines less than 2-in. or DN50).

The sensors are available in nine sizes in three compact footprints, from 1 mm to 50 mm in nominal diameter lines sizes (1/12 of an inch to 2 inches). This meter delivers ±0.05 percent liquid flow mass and volume accuracy, ±0.25 percent gas accuracy and ±0.0002 g/cc density accuracy for flow rates of 0.04 lb/min to 1,980 lb/min (1kg/h to 54,000kg/h).

The new ELITE CMFS platform features a compact, lightweight and fully drainable design. The meter offers a turndown ratio up to 30:1. In addition, the platform serves a wide range of applications, including chemical injection, production blending, process gas solutions and batching operations in various industries.

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Streamline Your Process
Removing complexities that creep in over time can enhance operations

By Richard J. Beaman, Jr., Eric Hopkins and Clifford Reese, SSOE Group

SOME CHEMICAL makers are missing opportunities to reduce operating costs and increase profits because they aren’t striving to re-engineer and streamline their processes. This doesn’t mean starting from scratch. Instead, a plant often can achieve substantial benefits through simplified steps that do more and work better with less complexity.

The KISS — Keep It Simple and Straightforward — strategy is one of the most effective yet underutilized approaches to optimize a chemical process that has become complex over time. The need for increased capacity, reduced unit cost and equipment replacement often should prompt a fresh look at the whole process.

Two effective KISS strategies to remove process complexities are to combine parallel operations and multiple functions, and to eliminate redundant or inefficient controls. Here’s how they can be applied.

COMBINED OPERATIONS
Many plants can simplify parallel operations. For example, one facility we looked at had two sets of sequential filling of tanks and unnecessary recycle, compromising efficiency and control.

Figure 1. Complexities, including sequential filling of tanks and unnecessary recycle, compromised efficiency and control.
of reactors, each with its own brine feed system. When built, the facility only had a single set of reactors and associated feed system. However, a few years later, demand for increased capacity prompted construction of a duplicate set.

Both reactor sets now were fed by a single flow of salt slurry (Figure 1). A cyclone separator and splitter box above the tanks diverted flow to one tank until it reached its operating level and then switched flow to the second tank. In addition, a third outlet in the center of the splitter box fed any excess salt to the dissolver tank that sent brine back to the brine treatment system, treating it twice unnecessarily. The bottom of the cyclone contained a filling hose with a chain hooked to the handrail. When one tank became full of solids, an operator detached the hose from the handrail on one side of the splitter box and would swing it over to the other side of the splitter box to feed the other tank.

The need that created this system was real — but the arrangement led to numerous operational inefficiencies.

While the tank walls and floor were sound, the welding rod material used for the tank’s seams wasn’t resistant to some components in the brine solution and would repeatedly corrode. As a result, every few months the plant had to shut down the reactors to re-weld seams.

At least once per shift the cyclone separator had to be flushed to clear out solids’ buildup. Moreover, constantly moving the filling hose — with the attendant sudden addition and removal of salt feeds — caused upsets in the brine-saturation-tank level controllers. This led to abrupt changes to the flow rate of the weak brine used to cool a byproduct gas stream, which in turn altered the temperature of the byproduct gas, prompting the byproduct gas compressors to trip offline.

Alternating the salt slurry between tanks was a problem, too. The salt level in the tanks decreased as the weak brine dissolved it, so the brine leaving the tanks became too weak, reducing reactor efficiency. In addition, operators had to invest a full shift twice a week to clean the salt recovery equipment.

Although the problems seemed endless, extensive discussions among the team of internal engineers, the consulting process engineers and key operations personnel produced a simple solution: combine the
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parallel operations to create one continuous process.

The process includes a new brine saturation tank that feeds both reactor sets and a single new feed neutralization tank fitted with two outlets, and combines the brine-saturation and excess-salt-dissolver operations (Figure 2). The solution also incorporates new specifications for active cathodic corrosion protection of the brine saturation feed tank — it has thicker walls and welds protected with a trowel-applied lining. The salt-slurry cyclone separator, splitter box, and excess-salt dissolver tank all were eliminated.

The changes have provided a number of substantial benefits:
- elimination of corrosion as verified by subsequent checkups over time;
- increased byproduct gas recovery to 93% from 85%;
- improved reactor efficiency due to nearly 100%-strong brine availability;
- decreased operating complexity; and
- reduced maintenance because of the significantly lower quantity of equipment.

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The only thing worse than being late for his daughter’s wedding is never making it.

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This solution illustrates that sometimes it’s necessary to go beyond thinking about fixing the problem to thinking about a more straightforward way to do the process.

SIMPLIFIED CONTROL
Unnecessary complexity also can afflict control systems. For example, when working up a design for additional processing capacity for a reactor effluent gas stream, the consulting process engineers noticed opportunities to simplify the existing control system.

Typically, the system for recovering byproduct from the reactor was viewed as having two separate procedures, reaction and compression, and was designed with separate control valves for each. As byproduct from the reactor made its way to the compressors that processed the end product, it first was cycled through an intermediate recovery unit where a dedicated valve controlled the pressure of the reactor. Downstream of that valve, another control valve on the compressor’s discharge recycle line regulated compressor suction pressure. In this configuration, the pressure was controlled on both sides of the control valve (Figure 3).

Viewing the two processes as one continuous system led to a straightforward solution — eliminating the upstream valve and controlling pressure only with one properly sized valve in the compressor’s discharge recycle line (Figure 4). This also allowed for a slightly smaller compressor that optimally handles a higher suction pressure and better controls the volume flow of the compressor feed stream. The change supported a continuous flow at a rate that met the increased capacity requirement.

COMMON CONCERNS
Process simplification means change — and that can raise objections. People resist because they’re invested in the existing process, worry about the reliability of the new configuration, or even fear job losses.

Engineers experienced in simplification don’t dwell on criticizing the existing process, but instead focus on the benefits of the improvements and, when possible, how to implement them in a phased way if that better suits the situation.

A question that often arises during streamlining efforts is: “What if the line breaks down, then what?” When the solution stems from a holistic team-based
approach, the ability to see the sound technical basis of simplification surfaces more readily. The notion that separate processes creating daily operational problems and frequent maintenance are more reliable than a single continuous process becomes moot, especially when engineers have experience with streamlining and can cite successful implementations.

Converting the brine feed process to a straightforward one required fewer pieces of equipment, increased the efficiency of the brine saturation process, and eliminated controller upsets and byproduct compressor trips. The higher byproduct recovery rate boosted the profit on its sale.

Similarly, eliminating the controller in the reactor process allowed for a smaller more-efficient compressor to regulate the feed stream volume in such a way that controlling pressure separately at both ends of the process wasn’t necessary; the simplification cut cost while raising production.

The aim of process simplification is to improve efficiency and achieve operating savings, not to eliminate jobs. Indeed, streamlining may enable redeploying staff to higher-value activities.

EMBRACE THE OPPORTUNITY

Succeeding at process simplification doesn’t demand “reinventing the wheel.” Rather, it requires focusing on how streamlining can improve a process. The KISS strategy can identify straightforward changes for enhancing the efficiency and profitability of a chemical process. Not every system will derive a huge gain from process simplification — but most can realize some benefits from adapting proven solutions.

Remember, as a process gets increasingly streamlined and simplified, so, too, do training and maintenance. As a result, further opportunities for improvement become easier to recognize.

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Think Straight About Orifice Plates

Insufficient flow conditioning often undermines measurement accuracy

By Andrew Sloley, Contributing Editor

**PLANTS FREQUENTLY** rely on differential pressure created by an obstruction in a line to measure flow. Accuracy depends upon two factors: the correctness of the differential pressure measurement obtained via taps upstream and downstream, and the calculation for turning that measurement into a flow rate.

The obstruction placed in the line most often is an orifice plate — a flat plate with a machined orifice. (For more on orifice plates, see: “Remember the Old Reliable Orifice Plate,” www.ChemicalProcessing.com/articles/2006/132/; for other differential-pressure flow metering options, see: “Look Beyond Orifice Plates,” www.ChemicalProcessing.com/articles/2008/253/.) Orifice plates are cheap and reliable. Moreover, orifice plates manufactured to specific dimensions and tolerances generate known pressure drops for a given flow rate. The International Standards Organization (ISO) has summarized the dimensional criteria; all reputable orifice-plate manufacturers meet these standards.

ISO standards also cover installation requirements. Proper installation plays a crucial role in achieving accurate orifice-plate measurements. The major criteria include a stable flow pattern, a fluid-filled pipe and an unobstructed flow path (no blockages). If these criteria are met, flow meter calculations can be based on the physical dimensions of the system; no in-place measurement or calibration is required.

Let’s look in detail at the first requirement, a stable flow pattern. An oft-repeated rule of thumb states that a length of straight-run pipe equal to 10–15 piping diameters creates a sufficiently stable flow pattern. How does this compare to the ISO standards?

The ISO standards include multiple upstream
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piping configurations — from fully open full-bore valves upstream and downstream to multiple right-angle turns to tee-branch connections. They also detail for multiple values of $\sqrt{\text{value}}$ — the orifice diameter/pipe diameter, in consistent units — the length of straight-run piping required (Table 1). In general, the lower the $\sqrt{\text{value}}$, the shorter the pipe run necessary. During piping design, the final $\sqrt{\text{value}}$ ratio is unknown. So, many engineering standards attempt to reduce overall cost by specifying a maximum $\sqrt{\text{value}}$ of 0.55 to 0.63.

The best cases are fully open full-bore valves with a straight run upstream of them, and a single right-angle bend upstream. The required piping runs for a 0.55 $\sqrt{\text{value}}$ are 13 diameters for the full-bore valves and 16 diameters for the single right-angle bend. Every other configuration is worse — in some cases, much worse. Higher $\sqrt{\text{value}}$ values increase upstream requirements.

For two 90° bends in series, an orifice with a 0.55 $\sqrt{\text{value}}$ requires 44 diameters of upstream piping to meet ISO standards. Even with properly installed straightening vanes, this layout needs 22 diameters. A $\sqrt{\text{value}}$ of 0.84 raises the requirement to 40+ diameters for all types of installations.

What this all means is that if your plant needs maximum accuracy, use lots of pipe run upstream of orifice plates. In some cases, 90 diameters are necessary. Additionally, if you’re having flow meter problems, check the installation. I’ve observed many orifice meters inside process units that don’t meet ISO standards. The 10–15-diameters rule only applies to a “best case” — i.e., everything else is done correctly and a low-$\sqrt{\text{value}}$ orifice plate is installed. Most industrial installations require 20+ diameters. Using straightening vanes can help, but doesn’t completely solve the problem. The toughest installations are downstream of flow branches and where multiple elbows in series are at right angles to each other. To paraphrase a quote from pump installation guidelines, the only thing worse than one elbow upstream of a flow orifice is two elbows.

While a plant may start with low-$\sqrt{\text{value}}$ orifice plates, as hydraulics become tighter it may put in new plates with lower pressure drops (and higher $\sqrt{\text{value}}$ values). Installing a short run of larger diameter pipe doesn’t solve the problem (Figure 1). The upstream expansion creates a flow pattern with unknown effect on the orifice meter.

If the piping configuration doesn’t meet ISO standards, accuracy will suffer. For monitoring unit trends, reduced accuracy may be an acceptable tradeoff for a cheaper meter installation. For high and reliable accuracy, always follow the ISO requirements.

ANDREW SLOLEY, Contributing Editor
ASloley@putman.net

<table>
<thead>
<tr>
<th>UPSTREAM CONFIGURATION</th>
<th>$\sqrt{\text{VALUE}}$</th>
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<tbody>
<tr>
<td></td>
<td>&lt;0.32</td>
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<tr>
<td>Fully open, full-bore valve</td>
<td>12</td>
</tr>
<tr>
<td>Two right-angle bends in same plane, Two or three bends at right angles with straightening vanes</td>
<td>15</td>
</tr>
<tr>
<td>Two or three bends at right angles, Flow branch</td>
<td>35</td>
</tr>
<tr>
<td>Fully open globe valve</td>
<td>18</td>
</tr>
<tr>
<td>Single right-angle bend</td>
<td>10</td>
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Table 1. Required number of pipe diameters in upstream straight run generally decreases with $\sqrt{\text{value}}$.
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Consider CPVC for Chlor-Alkali Applications

Chlorinated polyvinyl chloride offers many advantages over other materials

By Lubrizol

INDUSTRIAL-GRaDE CHLOR-AlKALI production has been underway for more than 120 years, and in many ways, the principles by which these plants operate haven’t changed significantly. What has changed is the range of material choices available for chlor-alkali systems. Today, chlor-alkali plants operating across the globe require pipes, tanks, headers, manifolds, storage towers and more be fabricated with resilient materials that can stand up to harsh conditions. Materials used to transport acids, bases, brine or other chemicals must exhibit superior corrosion-resistance properties and function continuously at high temperatures, among other requirements. The more resilient the material, the longer the service life of chemical processing equipment, and in turn, the lower the costs required to maintain it.

Choosing the right materials also can mean reduced risk of monetary loss related to system downtime and reduced risk of injury or damage related to chemical leaks. As a result, it’s important to know the precise needs of chlor-alkali applications, the properties of the most compelling materials on the market for these applications, and how you can ensure you’re constructing systems that offer the most service life for your investment. The benefits offered by chlorinated polyvinyl chloride (CPVC), a material that, when formulated by technology leaders, offers the sort of properties a chlor-alkali facility needs.

WHAT DOES A CHLOR-AlKALI FACILITY NEED?
Because of the nature of chlor-alkali applications, materials that might usually last 25 years in other demanding industrial applications may last five to eight years at best in a chlor-alkali system — often, eight to 10 years of service life is considered good. That being said, some materials work better than others, and thus it’s prudent to focus on a few key differentiators when making choices.
Corrosion resistance. The foremost requirement of any chlor-alkali processing system is corrosion resistance. Frequently the substances being transmitted through pipes and tanks in a chlor-alkali facility are corrosive to some extent, and very few materials can stand up well to these chemicals over an extended period of time. Examples include:

- Sulfuric acid
- Sodium hydroxide (caustic soda)
- Concentrated sodium chloride (brine)
- Cell liquor (brine, sodium hydroxide)
- Sodium hypochlorite
- Hydrochloric acid
- Demineralized/deionized water
- Wet Chlorine Gas.

Any material chosen for piping, chemical-resistance layers in tanks, or other structures within a processing system may need to resist corrosion from a variety of strong and weak acids and bases, salts, aliphatic compounds, oxidants and more. Materials used in wastewater treatment applications are often useful in chlor-alkali applications; these materials must also persevere when in contact with many of these substances over a prolonged period of time.

While some degree of corrosion over the course of a pipe or tank’s service life is inevitable, ideally you want uniform corrosion across surfaces. Localized corrosion, where penetration into vessel walls occurs more prevalently in specific areas, can lead to concentrated erosion and shortened service life of system components. Over time, issues with localized corrosion have become associated with carbon steel components, whereas stress corrosion cracking, another risk posed to pipes and other structures in a corrosive environment, is often seen when stainless steel is chosen. It can be difficult to detect these types of subtle corrosion, but by knowing the inherent strengths and weaknesses of the materials you choose, you have a better chance of avoiding certain issues altogether.

High Temperature Resistance. Another key requirement of any material used in chlor-alkali systems is reliable long-term operation when exposed to high temperatures. It’s frequently the case that chlor-alkali systems are transporting and storing fluids and gases that are consistently around 220°F, and thus system component materials must be able to not only stand up to corrosion, but do so at continuously elevated temperatures.

Non-Leaching Properties. Because the success of an oxidation/reduction process within an electrolysis cell is dependent on certain inputs being present, it’s important to ensure the purity and concentration of the various compounds. For this reason, the leaching of elements — such as calcium, magnesium, silicon, nickel, lead or tin — out of piping or other system components as a result of chemical reactions can cause significant problems both with processing and system service life. For instance, in the most commonly used type of electrolysis chamber, a membrane cell, a charge-sensitive membrane that only allows ions with a certain charge to pass through is crucial to the electrolysis process, but can be compromised if anything but low levels of leached minerals infiltrate the cell.
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OTHER POSSIBLE NEEDS
In addition to the three key properties mentioned above, it’s also possible that a system, depending on its design, could require system components to demonstrate other specific properties. Examples of desirable material traits might include:
• A high hydrostatic pressure rating at elevated temperatures.
• Simple fabrication of system components.
• Easy weldability for repairs and additions.
• The inclusion of flanges for secure transitions among other pipe materials.
• Creep-resistance properties.

In general, know the intricacies of your system and processing when doing any sort of material selection, such as which transported substances might be particularly aggressive, how those substances might interact with different system component materials (which a supplier can often help to explain), what rate of corrosion is acceptable to maintain the desired lifespan of your structures, and so forth. By taking steps to educate yourself, you stand the best chance of choosing a material that will work best for your specific application.

THE CASE FOR CPVC: AN IDEAL MATERIAL FOR CHLOR-ALKALI SYSTEMS
While a number of materials demonstrate desirable properties in some of the performance categories we’ve mentioned, such as carbon or stainless steel, one material increasingly being specified for its universal appeal in chlor-alkali applications is chlorinated polyvinyl chloride (CPVC). One of the simplest ways to tell whether a material can stand up to the demands of an application is to look at the history of its longevity, and CPVC has been chosen as a chemical barrier material for the transport of hot, caustic chemicals or brine for more than 30 years. Corzan Industrial Systems material, for instance, is frequently chosen for not only piping within chlor-alkali and wastewater treatment facilities, but as a chemical resistance layer in dual-laminate fiberglass piping and tanks, as well. The best industrial-grade CPVC products offer:
• Superior chemical resistance across a broad spectrum of substances.
• Outstanding mechanical properties.
• Excellent combustion properties.
• Low thermal conductivity compared to metallic materials.
• Low thermal expansion compared to other non-metallic materials.
• Non-leaching properties.
• High-pressure performance.
• Global availability.

CPVC is easily welded or joined by inexpensive solvent cement, making fabrication of system structures simple (see Figure 1). Because of its composition, CPVC is extremely resilient to many acids, bases and other caustic materials, and has been shown both in testing and via end-use performance to be an excellent fit for chlor-alkali system use. CPVC piping is also pressure-rated for continuous use at temperatures up to 200°F, and can be used at higher temperatures in non-pressure systems or dual-laminated applications.

This differentiation between CPVC grades is an important point to remember: While CPVC in general is a desirable material for corrosive, high-heat environments like chlor-alkali facilities, not all CPVC piping compounds are equal.
Composition of the compounds can vary based on additives used during formulation, processing of the CPVC can affect mechanical and resistance qualities, and so forth.

Consider again cell classification rating. Defined by the ASTM D1784 and certified by NSF International, each number in a cell classification corresponds with a certain property of a CPVC compound — base resin, impact strength, tensile strength, modulus of elasticity and heat deflection temperature, respectively. The difference in ratings between standard CPVC and the highest-rated CPVC compounds corresponds to a three-fold increase in impact strength and a heat deflection temperature that’s at least 18°F higher in a 24448-rated compound. Practically, this means the 24448-rated compound is easier to cut, less likely to break or fracture.

Other telling certifications that can help differentiate between compounds for chlor-alkali applications include those related to leaching and hydrostatic pressure. Knowing which standards denote materials demonstrating different performance criteria can help you in choosing products most aligned to your needs.

The Chlorine Engineering Corporation (CEC), for example, outlines procedures for testing the leaching potential of different piping and system component materials, providing the basis for recommending specific materials for leaching-sensitive applications. Pipes and fittings made from the latest-generation of CPVC compounds have been accepted for use in ion-exchange membrane super-pure-brine piping based on these criteria.

The Plastic Pipe Institute (PPI) certifies CPVC compounds based on criteria for testing hydrostatic design bases (HDB), or the ability to stand up to the stress of hydrostatic pressure. PPI procedures and the ASTM D2837 standard for testing hydrostatic pressure have been used to show an HDB of 1,000 psi at 180°F for Corzan pipe material. Corzan HP pipe material — designed for high-pressure, high-temperature applications — has an HDB of 1,250 psi at 180°F. Corzan HP fittings are manufactured from the only industrial-grade pressure-rated CPVC fitting material having an HDB of 1,000 psi at 180°F. As a comparison, these fittings last four times longer than fittings molded with other CPVC compounds when pressure tested at 180°F at 551 psi, and also demonstrate improved creep resistance.

For chlor-alkali systems with heightened pressure requirements, it may be necessary to look for piping materials that adhere to the newly recognized ASTM 4120-06 material classification for higher pressure capability as defined by ASTM F-441.

EDUCATE, ASK QUESTIONS, REDUCE COSTS

By understanding your application and knowing what to look for in terms of certifications, approvals and specific property data, you’ll be able to determine which chlor-alkali system material best suits your needs.

Also, consider some of the less-tangible benefits of a certain material choice over another. Choosing materials from manufacturers that are material technology leaders, provide a quality assurance program to guarantee certain levels of product performance, provide testing documentation or services to ensure products meet application demands, or provide other support services — such as field assistance to ensure your system’s properly constructed, can be beneficial when creating long-lasting systems. With the right approach to specification and construction, you’ll likely find yourself saving time, money and risk over the course of many years.

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