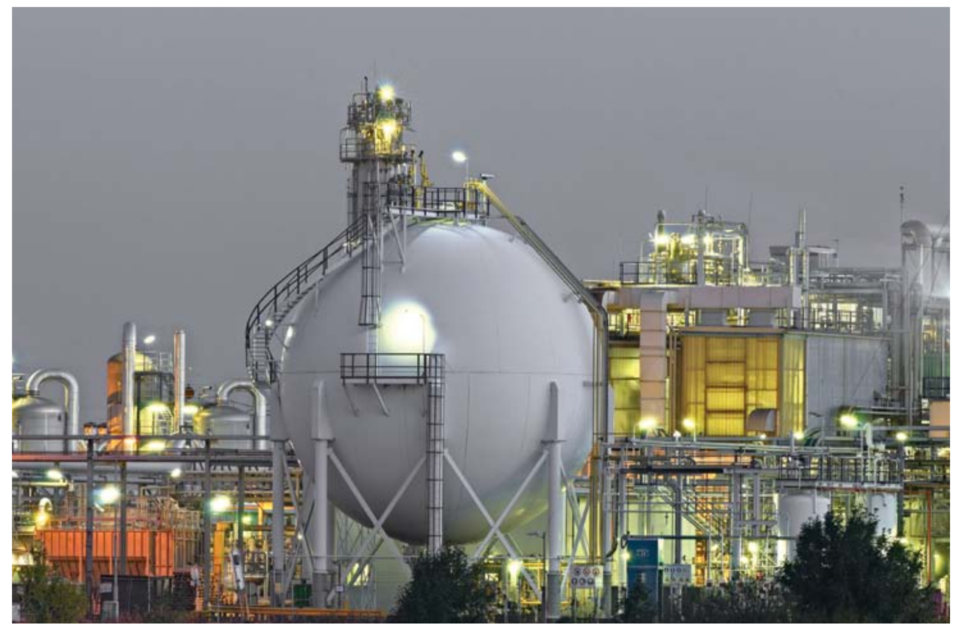
Combating Emissions in a Chlor-Alkali Plant

Regardless of the industry, when it comes to manufacturing, plant owners have a universal goal of functioning safely, efficiently and affordably. Yet, there is a challenge with which they must contend that also spans most industries and that is fugitive emissions. Plant owners in the chemical industry who are focused on lowering the cost of ownership must find ways to extend their equipment life and lower maintenance costs by sourcing corrosion-resistant metals, packing and linings that will prevent the release of fugitive emissions, ultimately keeping their employees and the environment safe.

By Phillip Schultz, Application Specialist, Crane ChemPharma & Energy – A business of Crane Co.



While it is helpful from an equipment provider's standpoint to understand that fugitive emissions exist and that we must minimize or eliminate them, it's more important to understand the exact causes within the plant, which requires sufficient knowledge of the processes that take place there. A Chlor-Alkali plant, for example, has four major phases: brine preparation, chlorine processing, caustic soda and hydrogen production, along with two major downstream processes, hydrochloric acid and sodium hypochlorite synthesis. Each of these sub-processes is characterized by their own set of challenges and pain points that have the potential to contribute to fugitive emissions (see table 1).

Brine preparation is one of the first areas within the plant's flow chart and it is during this phase that raw salt is used to create an aqueous sodium chloride solution (i.e. brine). This brine solution is then treated, filtered, and sent through an ion exchange process to remove any impurities. The purified brine is sent to the electrolyzer and depleted brine returns to the brine handling area for reuse. Here, downstream leakage, particulate abrasion, internal corrosion, jamming of the valve and scaling are common problems that must be resolved in order to ensure longer equipment lifetimes and prevent the escape of fugitive emissions.

Following brine preparation is the Chlorine Processing phase, during which the chlorine gas that is generated in the electrolyzer is cooled, dried, compressed and sent to either the Hydrochloric Acid or Bleach areas, or is liquefied and sent to storage for sale or for downstream processes. This part of the Chlor-Alkali production process is plagued with external emissions, downstream leakage, liner permeation, maintenance difficulty, temperature cycling, and storage transfer hose leakage.

Next, Caustic Soda, or sodium hydroxide (NaOH), is generated in the electrolyzer. A portion of this stream is recycled to the electorlyzer to maintain the pH while the rest is further concentrated and sent to storage or the bleach plant. Similar to the other phases of the plant, problems that exist during the Caustic Soda process include external leakage, scaling, and downstream leakage, but also high temperature corrosion.

The final major phase of the Chlor-Alkali production process is Hydrogen production which is characterized by high pressures and the danger of explosion from fugitive emissions of flammable hydrogen. The Hydrogen produced is either burned as fuel or used to make Hydrochloric Acid, the production of which involves the reaction of compressed chlorine gas from the Chlorine Processing phase with Hydrogen from the electrolyzer. Similarly, Sodium Hypochlorite, or bleach, synthesis requires the reaction of purified chlorine with concentrated caustic soda. Again, downstream leakage, internal corrosion and external emissions pose a problem here, as well as high temperatures, high maintenance costs, and storage transfer hose leakage.

Throughout this entire process, two problems that appear frequently are downstream leakage which is caused by corrosion, abrasion, bi-directional sealing, scaling and seat wear, and external emissions, a result of inadequate sealing systems, permeation, thermal cycling, abrasion, corrosion and valve jams. While many different types of equipment are used in each area of the plant (i.e. valves, pipes, hoses, lined accessories, etc.), owners will want to find products that are engineered specifically for the chemical industry to address as many of these problems as possible and diminish the negative effects. One such flexible valve type is the lined butterfly valve.

Downstream Leakage:

The sources of downstream leakage each relate to the condition of the equipment in place, and therefore, affect maintenance costs. For example, the corrosion and erosion of metallic valve components as a result of line media can result in in-line leakage, as well as the inability to maintain shutoff. Or, in environments where the introduction of moisture could prove detrimental (i.e. dry chlorine), corrosion of piping system components could occur. These are critical concerns that can be mitigated by having the right lined product in place, like the Xomox® XLD Lined Butterfly Valve, that features PFA lining as opposed to PTFE. PFA body and disc liners are resistant to attack from virtually any chemical, including all of those present in the Chlor-Alkali process. While all lined valves are susceptible to abrasion, PFA lined butterfly valves have been shown to have a 20% longer life than similar PTFE lined butterfly valves. The wide band resilient seal allows for pressure distribution along the sealing surface, and a tight bi-directional seal to prevent leakage that could lead to the corrosion of piping system components. Furthermore, due to micro porosity in PTFE, PFA is less susceptible to permeation than PTFE. Specifically in the Xomox® XLD, its 3 mm thick PFA liner is more permeation-resistant than similar lined butterfly valves with thinner liners.

External Emissions:

It is obvious why external leakage is a problem that must be controlled, but there is no sole culprit, as external leak paths can be caused by a number of different sources. For instance, inadequate sealing systems in the Chlorine Processing and Hydrochloric Acid processes allow hazardous media to reach the environment through multiple potential leak paths, including the valve stem, flange leaks, and permeation of valve and pipe lining. While abrasion and corrosion of valve components are key contributors to downstream leakage, they can also lead to the creation of these external leak paths. Additionally, as process temperatures fluctuate between high and low extremes during the dry Chlorine processing phase, delayed seal "rebound" can also create an external leak path.

Again, the right lined product can resolve all of these issues. The Xomox® XLD, for example, has a fully lined bottom shaft, as opposed to a bearing design, which means that there is no secondary leak path along the bottom shaft. Belleville disc springs provide a live loaded compression on its secondary seal, maintaining a strong external seal while also making it less susceptible to deformation under thermal cycling than standard springs. Triple Viton o-rings also offer a second, third, and fourth line of defense against fugitive emissions. Certification is vital, as well, as the XLD is fully ISO 15848 certified, and maintained a tight atmospheric seal through a rigorous test of four 180°C thermal cycles and 2,500 mechanical cycles.

Understanding the ins and outs of each process within the plant is the first step to identifying emissions sources and addressing them. This knowledge will aid in the selection of valve equipment that has the right features that are capable of directly resolving the issues.

Table 1 – Specific Process Challenges Across the Major Phases of a Chlor-Alkali Plant

		Brine Preparation	Chlorine Processing	Caustic Soda	Hydrogen Production	Hydrochloric Acid	Bleach Synthesis
Downstream Leakage	**Corrosion**	X	X	X		X	X
	Abrasion	X	X	X		X	
	Bi-Directional Sealing		X		X	X	X
	Scaling	X		X			
	Seat Wear	X	X	X	X	X	X
External Emissions	**Inadequate Sealing Systems**		X		X	X	X
	Thermal Cycling		X-dry			X	X
	Leak Monitoring		X		X	X	X
	Valve Jams	X		X