Technical Paper

Pumping dangerous chemicals

By Xavier Rasotto

The explosion at Barton Solvents, Wichita, KS, U.S.A. in 2007 destroyed the factory tank farm, injured 11 residents and forced the evacuation of the town's 6,000 residents. The U.S Chemical Safety and Hazard Investigation Board determined that non- conductive flammable liquids capable of forming ignitable vapor-air mixtures inside tanks should be pumped at reduced pumping velocities to minimize the potential for a static ignition. In this article, Xavier Rasotto looks at the history and role of pumps in chemical safety, covering key considerations when selecting a pump to handle acids, solvents and caustics, and describes the advantages of a pump which could have prevented the Barton explosion.

The use of dangerous chemicals dates back to first century A.D. when the origin and properties of "vitriol" were found in the works of Greek physician Dioscorides and the Roman naturalist Pliny the Elder. Vitriol later became known as sulfuric acid, a highly corrosive mineral acid that is used in automotive applications, mineral processing, fertilizer manufacturing, oil refining and wastewater processing. It is also used in the production of dyes, alcohols, plastics, rubber, ether, glue, film, explosives, drugs, paints, food containers, wood preservatives, soap and detergents, pharmaceutical products, petroleum products, and pulp and paper. Learning how to safely handle such chemicals has been a challenging part of our scientific process for thousands of years.

Sulfuric acid is but one example of the many dangerous chemicals that play a prominent role in manufacturing processes around the world. A highly hazardous chemical is any chemical that is a substance that is both toxic and reactive, and whose potential for human injury is high if released. The safe containment, handling and transfer of these types of chemicals is critical.

Role of Pumps in Chemical Safety

Any time a toxic, corrosive or explosive chemical is transferred from one container to another, it poses a very notable threat to the health of workers and the environment. Pipes, valves, seals and connectors are all considered critical transfer components, but pumps are the most critical component. Pumps are used to transfer bulk chemicals from large containers and dispense them into portable containers for shipping to manufacturing or other end-user locations. Pumps also transfer chemicals for blending and dosing applications, among others.

When selecting which pump is ideally suited for handling dangerous chemicals such as acids, solvents and caustics, it is important to consider which pump technology will provide the leak-free operation that is required; which technology has the chemical compatibility for all wetted parts; which pump provides constant flow rates with no slippage; and which technology provides the most reliable operation in harsh conditions or atmospheres.

Comparing Pump Technologies

There are many factors that should go into determining the pump best suited for an operator's dangerous chemical-handling requirements:

Leak-free operation

The most important factor in chemical transfer is containment. End-users have to trust that a pump will not only successfully transfer any challenging chemical in its

The Almatec E-Series solid-body air-operated double-diaphragm (AODD) pumps represent one of the safest, most durable and effective option for transferring hazardous chemicals.

process, but that it will fully contain it, as well. Pumps with mechanical seals are more prone to failure and product leakage than pumps that do not have mechanical seals or packing.

Run dry
In dangerous chemical applications, friction is undesirable and, in certain cases, can be hazardous. When a pump runs dry, that means it continues to run after the chemical has completely passed through it. Where there is no fluid present, internal moving parts will not be lubricated, which can lead to catastrophic failures. This includes the pump's bearings, which will burn up, leading to impeller seizure and bringing the process to a halt.

Self-priming
The location in a hazardous chemical application can often be dictated by the safety and convenience to the operator. This means that large barrels of toxic chemicals are often placed at ground level in protective cabinets and the pumps are situated either on top or on the side of these containers. Strong suction is required in these instances in order to ensure proper flow and transfer rates, which requires a pump that is self-priming.

Materials of construction
Each of the components along the chemical supply chain must be constructed with materials that are compatible with the chemical being handled. For pump equipment, this includes all components on the wetted end, but it is also helpful for the "dry" side of the pump to also have the ability to handle the chemical in the event of an internal seal breakdown or diaphragm rupture.

Shear-sensitivity
When a product is damaged in the pumping process, it is known as "shearing." Substances that require a minimum of agitation are "shear-sensitive." Pumping technologies that have a propensity for shearing are pumps that have meshing teeth or pumps that introduce the fluid to multiple moving parts, such as gear, centrifugal, vane or progressive cavity pumps. The ideal pumping solution will provide the gentle handling necessary to eliminate the chance of altering a fluid's chemical properties.

Almatec's E-Series Plastic AODD pumps are machined from solid plastic blocks of polyehthylene (PE) or polytefrafluoroethylene (PTFE), allowing the pumps to handle the harshest environments.]

Deadheading
Many chemical applications require a very specific and accurate flow rate to maintain the consistency and quality of the product being handled or manufactured. This can involve valves on the discharge side of the pump that must close quickly, which shuts down flow and causes a jolt to the pump. This process is known as "deadheading." Technologies such as gear and rotary vane pumps need an integral relief valve and a system relief valve to re-circulate fluid back to the source, which means extra piping and, more importantly, the introduction of more heat into the process with the potential for unwanted temperature increases occurring with the liquid. In some cases, this can be critical, especially when handling explosive liquids.

Ease of maintenance
Maintenance is a key consideration when selecting the right pump technology, no matter the application. However, for pumps in dangerous or hazardous applications, maintenance can be a critical factor due to the elevated safety levels involved when performing any type of maintenance. In addition, any significant downtime due to a pump failure translates into expensive repairs and lost revenue.

AODD Pumps

Air-operated double-diaphragm (AODD) pumps represent the safest and most efficient pumping options available when an end-user needs to handle the most dangerous chemicals in their application. AODD pumps are reciprocating, positive-displacement type pumps that only have a few wetted parts and are driven by an air distribution system rather than an electric motor. This allows the pump to run dry and deadhead without damage.

These pumps have no mechanical seal, which eliminates a crucial leak point; provide the superior suction necessary in dangerous chemicals-handling; and are among the safest and most shear-sensitive pumps because the fluid is simply drawn into a chamber and then pushed out with no contact to moving parts within a linear path.

Competitive technologies such as lobe and gear pumps have disadvantages that make them less reliable in handling dangerous chemicals. Lobe pumps, for example, are not true positive displacement pumps, which makes them prone to slipping, which adversely affects flow rates and production volumes. With gear pumps, the meshing gears will begin to wear as soon as the pump is turned on. As gears wear, volumetric consistency is compromised, leading to reduced or inconsistent flow rates and increased energy consumption.

When compared to centrifugal and gear pumps, whose turbulence can damage the particulates present in cer-

Almatec E-Series solid-body AODD pumps are constructed with a containment ring that provides an enhanced sealing advantage, resulting in a leak-free performance.

tain chemical processes, AODD pumps provide a gentle pumping action. There is no friction, which eliminates the "shearing" that can damage or alter the chemical properties. AODD pumps also offer a variety of compatible materials of construction depending on the chemical being used. By removing the need for mechanical seals, AODD pumps also provide virtually leak-free product containment.

The Almatec AODD pump

Almatec, based in Kamp-Lintfort, Germany, manufacture AODD pumps. Their pumps are capable of providing operators with consistent performance with a minimum of maintenance requirements. The reason for this is that Almatec's AODD pumps are machined from a solid plastic block, which increases its strength and life cycle while eliminating many maintenance concerns.

The E-Series' CNC-machined solid block of polyehthylene (PE) or polytefrafluoroethylene (PTFE) allows the pump to deal with the harshest environments. By contrast, competitive pump manufacturers use a plastic injection molding process or lower quality materials. When there is a temperature variation, components can deform and create a potential leak path, no matter how tight the bolts are. However, with Almatec's solid-block design, there are no crevices where a potential leak path can be created. It is more robust and the integrity of the material is much stronger due to the high static mass.

Material Compatibility

The E-Series features housing constructed of PE, PTFE, PE conductive and PTFE conductive; EPDM, PTFE/EPDM and NBR diaphragms; EPDM, PTFE, NBR and stainless-steel ball valves; and PTFE cylinder valves.

Conductive plastics give the operator peace of mind in explosion-proof zones pumping flammable media or if the pumps are used in an aggressive atmosphere. This provides a level of safety that other AODD technologies cannot. Although AODD pumps are intrinsically safe, the materials of construction for such applications require conductive materials to properly ground the pump and dissipate electrostatic charges. Almatec's PE conductive and PTFE conductive E-Series Pumps meet the requirements for the ATEX 94/9/EG directive.

In the case of Barton Solvents referenced earlier, Almatec's plastic pneumatic diaphragm pumps would have been a safer pumping solution since they have the ability to avoid electrostatic discharges, making them a good choice for use in potentially explosive environments.

Conclusion

The chemical industry is poised for significant growth as it rebounds from the economic downturn of 2008. According to Cefic Chemdata International, sales were up 26.9% in 2010 compared to 2009, and the industry is projected to continue on this sales trajectory. At the same time, technology is forcing the creation of new chemical formulations and thus an ever-increasing list of hazardous compounds, which pose a steady diet of new challenges for the manufacturer.

Dangerous chemicals will continue to play a significant role in the manufacturing of everyday products, but tightening regulations and intense pressures to protect the environment and humans have made the handling of these chemicals more challenging than ever. End-users need a pump solution that will safely contain and transfer these dangerous chemicals. The solid-body plastic AODD pump line, like this one from Almatec, represent an effective option for end-users, protecting the health and productivity of both workers and the environment.

About the Author:

Xavier Rasotto is the Chemical Market Manager, EMEA with Almatec and Pump Solutions Group (PSG). You can find more information on Almatec at www.almatec.de