



High quality equipment is vital in ensuring that the transport of chlorine in bulk is carried out safely

# Big tank of trouble

**CHLORINE** Of all the common products handled in bulk, chlorine is probably the most safety-critical. *David Clugg\** of Midland Manufacturing explains what the risks are and how technology is helping keep this toxic gas in the tank

Chlorine is fundamental to many modern processes, particularly in water purification and as a component in polymers. It is used in more than half of all industrial chemical processes, including 90 per cent of pharmaceuticals and 96 per cent of crop protection products. It is also used in the manufacturing of plastics, paper, medical devices, automobiles, textiles and household cleaning products.

Chlorine is also one of the most hazardous products to be moved in bulk. It is highly toxic and can spread rapidly when released to the air. Chlorine releases therefore pose an extreme hazard to humans and also to the environment.

Small doses of chlorine gas are detectable with measuring devices in concentrations as low as 0.2 parts per million (ppm), and by smell at 1 ppm. Even in these small doses, chlorine can irritate the eyes, skin, and respiratory system. If inhaled at high concentrations - at or above 40 ppm - chlorine begins to break down in the lungs to form hydrochloric acid that burns lung tissue, causing pulmonary oedema and essentially causing drowning as liquid floods the lungs. At about 1,000 ppm, chlorine gas can be fatal after only a few deep breaths.

Although the risk of exposure depends on how close a person is to the release, chlorine spreads easily when caught in the wind. When this occurs, it has the potential to endanger a large population. The

general public can also become exposed if chlorine liquid is released into a water supply, and the water is touched or drunk. Exposure can also occur if it comes in contact with food.

In addition, chlorine is harmful to the environment. It is especially dangerous to organisms living in water and in soil. Once released, chlorine begins to immediately react with other chemicals. When combined with organic material in water, it forms chlorinated organic chemicals, which have the potential to be extremely toxic to plants and animals.

## Hazards of the supply chain

While it is a naturally occurring element, large-scale production of chlorine takes place all over the world because of its high demand. While the majority of chlorine is used directly at the production site, transporting it to additional usage locations is common, amounting to many millions of tonne-kilometres per year.

Chlorine is most commonly transported in tank trucks, rail tank cars or specially designed pressurised tank containers. Generally made and lined with different types of steel, these containers have been designed to carry a few pounds up to several tons of chlorine at any given time. Tank cars use a pressure plate, with the fittings, valve system and a cylindrical protective housing at the top.

This means that all loading and unloading of the commodity is done through the protective housing at the top of the tank.

Chlorine releases that occur during transport (including loading and unloading) can happen either in an accident, by mechanical failure or by operator error. Any unintentional release that does not involve an accident is termed a "non-accident release" (NARs). NARs may be leaks, splashes and other releases from improperly secured or malfunctioning valves, fittings and tank shells, or releases from pressure relief devices.

Most NARs happen during the loading and unloading process, usually as a result of an incorrect connection between the hose and the tank valve. In addition, the hose that connects to the valve for loading and unloading can leak or even break. Given the extreme hazard of chlorine exposure, personnel undertaking such tasks need to wear protective equipment.

Once chlorine has been loaded into a tank and begins its journey, there usually is no one watching to ensure the valves are performing correctly and a leak is not occurring. For this reason, it is imperative that the valve system can be trusted to operate properly and hold the chlorine inside the tank.

There is always the potential for a derailment or a truck rollover. When this occurs, since all the fittings

and valves are located on the top of the tank car, the angle valves and pressure relief valve run the risk of being sheared off, leading to an inevitable release.

### Better standards in transport

Recently, the chemical and transport industries have made significant improvements to help minimise the risk of transporting chlorine, including better rail car equipment and tighter regulations. For example, a major change in US regulation will require extra protection when transporting any toxic inhalation hazard (TIH) commodity.

These new regulations, laid down by the Association of American Railroads (AAR), call for an increase in top protection on the tank car. To address these regulations, industry professionals have two options. The first is to install more physical protection, like a jacket or shield, to cover the loading equipment. This helps ensure the entire area cannot be sheared off or damaged in the event of an accident.

The second option is to install an upgraded valve system that has been designed with the primary seals at or below the surface of the pressure plate. These new valve systems not only reduce the risk of product loss to the atmosphere in the event the fittings are damaged during an accident, but also have been designed with additional sealing to reduce the number of NARs.

Midland Manufacturing of Skokie, Illinois,

recently worked with a number of shippers, rail car builders, leasing companies and regulatory agencies to develop its new Enhanced Fittings Package, which has been designed with the primary seals at or below the surface of the pressure plate. The Package includes Midland's A-14378-ML-VL pressure relief valve, 9100-CS pressure plate, A-180-ML-TG check valve and A-718-S-HC angle valve.

When Midland first introduced the Enhanced Fittings Package in 2009, it was installed on 25 rail cars and tested over a two-year period. Since then, these cars have performed more than 220 trips and travelled in excess of 250,000 miles, including loading and unloading. To date, no leaks or failures have occurred. This is due, in part, because Midland has manufactured the Enhanced Fittings Package with corrosion-resistant materials – including Hastelloy® C, Stellite 21, Monel® and Inconel® X750 – that have been proven to better withstand all of the operating environments typically found in the transport of chlorine.

One of the most significant benefits of Midland's Enhanced Fittings Package is that it offers triple sealing protection. It has been designed with three points of sealing – the check valve, the angle valve at its seat and the plug on the angle valve. So essentially, there have to be three failures in the system for a leak to occur. This is a dramatic improvement over other valve systems that feature only one point of sealing.

Unlike on previous valve systems where the angle

valve was used as the primary seal point, Midland's Enhanced Fittings Package has been designed with check valve as the primary seal. This allows the angle valve to experience less wear and tear over time because it no longer has vapours constantly in contact with it. Additionally, Midland has added an additional layer of protection on the check valve, with a seal chamber located between the seat and the commodity.

In addition, the Enhanced Fittings Package features improved characteristics for loading and unloading tank cars; has been designed to be used with larger diameter protective housings; and can use current load-rack configurations or change to vertical loading and unloading. The package has also been designed with easy maintenance in mind. The pressure relief valve and angle valves can be removed for testing and maintenance without cleaning the car. There is also no need to remove the pressure plate and inspect the check valve because all the internal components can be removed through the pressure plate.

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