Gas Detection of Tank Farms and Liquefied Gases

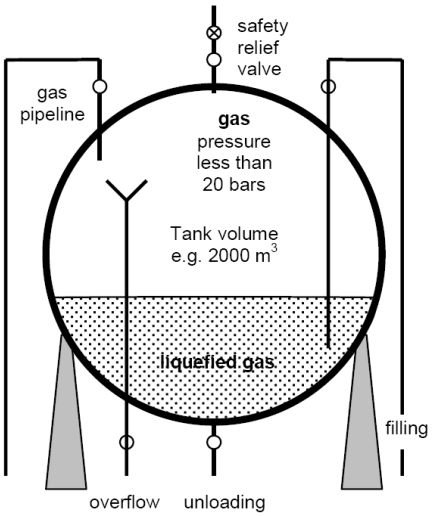
Application Field: Chemical and Petrochemical Industries

A chemical plant is realized by a continuous mass flow from the input storage to the output storage, in case of gases or liquids, the storage area is a tank farm. To increase the mass of gases, they are either compressed or liquefied. Basically there are **three different types** of storage tanks: Pressure Tanks, Cryogenic Tanks, and Atmospheric Tanks.

Pressure Tanks

These are mostly cylindrical or spherical tanks. Spherical tanks are optimal concerning the surface/volume-ratio and ensure homogenous tension load. Because of this, the wall thickness can be half of the cylindrical tanks only. However, the disadvantage is that because of their height they cannot easily be installed underground. Big spherical tanks are used for pressures up to 25 bars (vapor pressure of the liquefied gas) where a lot of gases can be kept in the liquefied state. As liquefied gases need a much lower volume than the gas itself.

Typical gases stored in pressure tanks are ammonia, amines such as methyl amine, dimethyl amine, ethyl amine, and trimethyl amine, C_3/C_4-hydrocarbons such as propane, cyclopropane, propylene, butanes, butylenes, and butadiene, mixtures of propane and butanes called LPG (liquid petrol gas), ethyl chloride, ethylene oxide, chlorine, dimethyl ether, methyl chloride, phosgene, sulfur dioxide, nitrogen dioxide, and vinyl chloride.

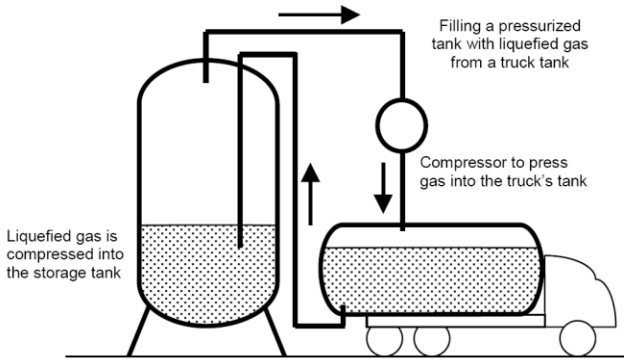


Spherical tank for liquefied gas storage

Pressure tanks are equipped with a fill level indicator with alarm facilities and sensors to measure the interior temperature continuously to switch on a cooling sprinkler system in case of temperature alarm.

The Art of Gas Detection

Safety relief valves control the internal pressure; the gas is released into atmosphere or into a flare-system to be burnt. Both these processes mean costly loss of product, the first one leading to potentially explosive of toxic atmospheres additionally - gas detection is needed.



Tank filling is made by two connecting tubes, one for the gas, one for the liquid. The gas is drawn out from the storage tank and by means of a compressor it is pressed into the truck's tank. The resulting pressure forces the liquefied gas into the storage tank then. This is a more or less dangerous process, especially when making the necessary tube connections. Gas leaks can occur and gas detection is recommended. The most famous gases kept in a pressure tank are ammonia, chlorine and LPG.

Cryogenic Tanks

If liquefied gases have a vapor pressure of more than 25 bar, greater containments would involve an increased dangerous risk. In this case there is another way of obtaining liquefied gases: Cryogenic. When cooling down a gas below its boiling point it will liquefy.

Cryogenic tanks need a complex cooling system; therefore, cryogenic storage is more expensive than the pressurized storage. But it is safer since liquefaction is obtained at atmospheric pressure. The combination of pressurized and cryogenic technique is also common.

Gasoline stations also have cryogenic LNG-tanks. The gas detection is needed in this application for leaks of LNG cannot be smelled. The reason is that odorants normally used cannot be added to liquefied methane. Low temperature cryogenic tanks are effectively insulated and a big part of their volume is insulation only. These tanks contain liquefied gases such as argon (- 186 °C), ethane (- 88 °C), ethylene (- 104 °C), helium (- 268 °C), methane (-161 °C), oxygen (- 183 °C), and nitrogen (- 196°C) at temperatures near their boiling point and atmospheric pressure. Besides oxygen and nitrogen, ethylene is one of the mostly used products world-widely, so often tank farms are ethylene tank farms.

Atmospheric Tanks

Atmospheric tanks are used for substances which, under normal conditions, are liquid. Typical atmospheric tanks are used for flammable liquids (e.g. methanol, toluene, xylene), and hydrocarbon mixtures (e.g. gasolines, kerosene) produced in the refineries. Atmospheric tanks normally have wall thicknesses laid out for filling pressures up to 100 mbar above atmospheric pressure only. Loading and unloading of tanks with a fix roof would cause higher pressure differences and that's why there are relief valves with breathing openings to the outer atmosphere. Atmospheric breathing is done by flame arrestors to avoid flash-back into the tank. Vapors are often fed through flame arrestors to a flare system, sometimes they are re-condensed. As the vapor pressure of liquids is lower than atmospheric pressure, there is an inert blanket of nitrogen (or other inert gases) added so that there is always a small over-pressure against atmosphere, and air access into the tank is avoided. Sometimes tanks with floating roofs swimming directly on the liquid surface are used.

Is the gas detection system needed for bulk storage of toxic and/or flammable substances, liquefied or pressurized? National laws and regulations require high safety standards when the amounts of dangerous goods exceed a given limit. **NFPA says: Continuously monitored low temperature sensors or flammable gas detection systems shall sound an alarm at the plant site and at a constantly attended location if the plant site is not attended continuously. Flammable gas detection systems shall**

activate an audible and a visual alarm at not more than 25 percent of the lower flammable limit of the gas or vapor being monitored. (NFPA 59A, Standard for the Production, Storage, and handling of liquefied Natural Gas(LNG), Chapter 12.4.2 Gas Detection)

There are two targets for gas detection. One is explosion protection, the other is early leak detection. Explosion protection means being alarmed at concentrations of about 20 to 40 % LEL to promptly activate countermeasures at site (informing operators, technicians and fire brigade) and/or switching countermeasures (closing solenoid valves, activating cooling showers, water sprayers). Also loading and unloading might be accomplished by heavy leaks when connecting the appropriate pipes.
Early leak detection is preferably practiced by detecting low concentrations (e.g. 10 % LEL). Although there are temperature and pressure gauge sensors small leaks (hairline cracks) cannot be detected. However, in long-term consideration these leaks mean costly loss of mass and may tend to become a great leak with hazardous consequences. In a tank farm there must be a safety distance between the tanks so that in case of a fire the probability of affecting the other tanks is minimized. Some applications even strip out the cooling water to monitor for dissolved flammable e.g. ethylene.

RC Systems' Recommendation:

Wired Gas Detection System		
Gases	Detectors	Controller
ammonia, amines, sulfur dioxide, chlorine	SenSmart 3100/6100 EC	ST-90 (Up to 4 points) ST-71 (Up to 16 Points) ST-72(Up to 64 Points)
Flammable Gases	SenSmart 3300/6300 IR	
Fence monitoring to avoid flammable gases leak and drift into safe areas	Quasar 900 Open Path	
Wireless Gas Detection System		
Gases	Detectors	Controller
ammonia, amines, sulfur dioxide, chlorine	SenSmart 7100 EC	WNR WaveNet Receiver
Flammable Gases	SenSmart 7400 IR	(Up to 32 Points)

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