QBE European Operations

Property Risk Solutions

Technical guide

Ammonia Refrigeration

Ammonia is a common refrigerant frequently used within large industrial processes. It has no ozone depletion or greenhouse warming potential unlike many other common refrigerants. As a result of its physical properties, ammonia refrigeration systems are typically up to 15% more energy efficient than if alternative fluids were used. In many ways it is the perfect refrigeration fluid, unfortunately it is also toxic and can form explosive atmospheres when mixed with air.

What are the hazards?

Ammonia is absorbed by moisture to form an alkali solution. This process takes place within the mucous membranes of the body and on the skin, at high concentrations the damage is permanent and can result in death.

The short-term exposure limit for ammonia is 35 ppm. 500 ppm is considered to be the level where there is an imminent danger of death. At concentrations between 16 and 25% in air ammonia forms an explosive atmosphere. If an ignition source is present at the same time the result will be an explosion which will cause significant damage to the local area.

What are the control measures?

1. Design and location of the refrigeration plant

The most likely source of a leak is around the main refrigeration plant and it should be located in a detached building. If this is not possible, it should be located in a room which is separated from the main structure by fire resisting walls that have a 60 minute rating. Any perforations through the connecting walls should be fire stopped and be gas tight. A significant proportion of the ammonia in a refrigeration cycle will be held as liquid in the receiver and it is good practice to locate this externally even if the refrigeration plant itself is within the building.

Small bore pipework and instrument connections are much more likely to leak due to fatigue failure from vibration or corrosion than the main process pipework and should be carefully designed.

A large refrigeration system may incorporate a large number of chillers distributed throughout the facility and associated valve sets that control the ammonia flows. Flanges should be minimised by the use of welded pipe and where there is an increased risk of a leak such as valve sets then ammonia sniffers should be located directly above.

The use of a secondary glycol circuit to carry the cooling capacity to chillers distributed throughout the facility reduces the numbers of potential leak points and hence the risk. If ammonia is piped through the building, the pipes and the chillers must be located such that the risk of impact damage from forklifts etc. is minimised.

2. Ventilation and emergency isolation

It is a legal requirement within the UK and European Union to identify zones where a flammable atmosphere is foreseeable and to ensure electrical equipment within the zones is appropriately rated. An alternative to this approach for ammonia refrigeration plant is described within EN 378. The risk of a flammable atmosphere forming and subsequent explosion is mitigated by

- Continuous ventilation of the plant room either by louvres on two opposite walls or using extraction fans.
- Installation of ammonia gas detection within the plant room with two stages of alarm set at 500 and up to 30,000 ppm.
- The first stage of the ammonia alarm initiates emergency ventilation capable of at least 15 air changes per hour within the room.
- The second stage of the ammonia alarm isolates all power to electrical equipment within the plant room that is not rated for use in an explosive atmosphere. The emergency ventilation fans should be fed from a separate circuit and be suitable for use in an explosive atmosphere.

3. Maintenance

An incident can only occur if the ammonia leaks from the system. An effective maintenance system is critical to reducing the risk of a loss of containment. Leak tests should be routinely undertaken by competent staff. A planned preventative maintenance system should ensure that the pressure systems and relief devices are tested according to statutory requirements. Techniques such as vibration analysis should be considered for the early identification of faults on the compressors.

The lagging should be carefully replaced after maintenance. External corrosion is accelerated when lagging is in poor condition and traps moisture against the pipe.

4. Emergency procedures

When a significant ammonia leak occurs, the system must be shut down and the leak isolated. An emergency procedure should be developed which describes

- The evacuation procedure for employees.
- The isolation valves on the system that should be closed after a leak. These should be clearly labelled and visible. For large systems, it is good practice to automate this step with activation possible remotely.
- The safe system of work to be used for entry into contaminated areas. Personnel should not enter buildings where there the atmosphere may be explosive. Canister masks and self-contained breathing apparatus offer protection up to limits certified by the particular manufacturers. Any personnel that may respond to an ammonia leak should be formally trained to understand the limits of what can safely be achieved with the equipment provided.
- The means of ventilating areas contaminated with ammonia and the actions to minimise spoilage of stored goods such as removal from the area and disposal of packaging. These actions will be specific to the site and the materials stored.

Summary

Ammonia has many advantages as a refrigerant, but failure to appreciate or manage the risks can lead to loss of life and property. The risks can be minimised by good design, effective maintenance and the implementation of robust emergency procedures.

Please contact QBE Risk Solutions if you require further guidance after reading this Technical Guide.

QBE Insurance Group Plantation Place 30 Fenchurch Street London EC3M 3BD
tel +44 (0)20 7105 4000 www.QBEeurope.com

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