Information paper

Considerations to ensure safe handling of ammonia refrigeration systems

The safe handling of ammonia as a refrigerant is described in documentation such as VDMA standard sheet no. 24020-1, BGR 500, EN 378-4 and DSEAR.

1. Causes of malfunctions

Safety-relevant system components in an ammonia refrigeration system must undergo regular inspection to ensure that requirements stipulated in legislation are met, particularly those in the German Federal Immission Control Act (BlmSchG). Recurring inspections as per Section 15 must be performed either by a 'qualified person' as per Section 2 (7) of the German Operations Safety Regulation (BetrSichV) or by an approved inspection agency. Irrespective of the refrigerant used, the owner needs to determine the inspection intervals for the entire system and system components based on a safety assessment. However, as with any technical equipment, incidents cannot be ruled out. It can be generally said that the most common causes are operational errors rather than material defects. You will find below a few distinguishing aspects that basically apply to all refrigerants, but special attention is drawn to them due to the specific characteristics of ammonia.

2. Action to take in the event of malfunctions

- Try to determine the size of the leak.
- If you can probably enter the room wearing a gas mask,
    - turn on the emergency ventilation before entering the room and
    - shut off the ammonia liquid supply.
- If you have the slightest suspicion that there is an injured person in the ammonia area, raise the alarm. Bring people to safety first, then stop the leak. Close all doors to the room where the gas is escaping.
- Press the emergency stop button. This switches off valves, motors and other equipment to prevent greater amounts of ammonia from leaking out.
- If there is a gas warning system, the machine room ventilation is switched on when the alarm threshold is reached. It must also be possible to switch on the ventilation by hand. A gas warning system is compulsory with ammonia fill levels of 50 kilograms or more.

- If there is no gas warning system present, the fan is turned on manually. A decision needs to be made whether it is permitted to switch on the fan or not if there is a large ammonia leakage (unpleasant odour in the surrounding area).
- Close shut-off valves by sections wherever possible, particularly on the liquid side, so that the amount of ammonia leaking out is minimised. Where possible, evacuate the system section affected and transfer refrigerant to other parts of the system. In doing so, ensure that no liquid refrigerant is shut inside due to the systems sections being shut off.
- If a puddle of ammonia has formed due to ammonia leaking into a spill tray or onto the floor, you can almost completely prevent heat transfer to the liquid and consequent vapour formation by covering the liquid with sheeting (made of PE, for example) or synthetic medium expansion foam (fire service). This gives you enough time for disposal measures.

3. Action to be taken

- Liquid ammonia can cause frostbite and acid burns to the skin and eyes.
- The injured person must wear a safety mask until further notice to prevent them from inhaling vapours from clothing impregnated with ammonia.
- You must shower a person injured by ammonia in water for five to fifteen minutes.
- Carefully remove clothing while they are under the shower.
- If ammonia-impregnated clothing is removed without irrigation, injury may worsen as frozen skin may be peeled off.
- The shower water should be warm if possible to prevent temperature shock.
- An emergency shower is best. Failing that, a hosepipe can also be used.

4. Effects on the surrounding area

- Leaking ammonia can be carried into the neighbouring area by the wind.
- Ammonia is lighter than air and rises quickly. It will reach non-hazardous concentrations when mixed with air.
- Even though the concentration is non-hazardous, the smell of ammonia can be unpleasant.
- People who live in the surrounding area may be excessively alarmed by the word ‘toxic’.
- It is advisable to stay at home and close all doors and windows. The area does not need to be evacuated.
- Major incidences of ammonia in the sewer system – if ammonia vapours are dissipated by water, for example – must be immediately reported to the agency responsible for the local sewage system.

However, hazardous incidents rarely occur thanks to regulation-compliant manufacture, regular inspections of system parts and the extensive expertise of everyone involved. For example, there was no incident involving ammonia in 2014 according to the German Central Reporting and Evaluation Office for Major Accidents and Incidents (ZEMA).

5.1 Oil removal

Refrigeration machines contain two types of oils. First of all, there are refrigeration machine oils in which ammonia is soluble. These oils also happen to be hygroscopic and have been primarily used in compact refrigeration units for some time. Then, there are also conventional refrigeration machine oils in which ammonia is not soluble as per DIN 51503, Group KAA, to which the following instructions apply in particular.

Besides the recommended automatic oil return function, there is also a manual oil removal function at the bottom of the separator. This comprises a shut-off valve with a downstream quick-action stop valve. This valve is held open against spring pressure using the quick-action stop lever when removing oil. Observe the following when operating the lever:

- Only operating staff who are familiar with the system may drain oil. At least two specialists are required for this work. Great care must be taken when draining oils. Always wear a protective suit and ensure that your skin does not come into contact with liquid refrigerant.
- The pressure in the oil collection chamber from which the oil is to be removed must be above atmospheric pressure. If normal operating pressure is below atmospheric pressure, the oil must be removed during a defrosting period or when the system is not functioning; otherwise, an oil sluice must be used.
- If no oil comes out when the shut-off valve is fully open and the quick-action stop valve is slightly open, this may be the result of a blockage and the latter must be closed immediately. Under no circumstances may you try to unblock the flow of oil from the outside. Instead, you must extract the ammonia from the tank from which oil needs to be removed. You must then empty the tank of ammonia and detach the shut-off valve, including the quick-action stop valve.
- Draining oil on a regular basis prevents clots of dirt forming, making it unnecessary to clean the valve as described above.
- The operator must not leave the drainage point while the oil is being drained.
- The quick-action lever must not be propped open by placing wood beneath or tying it open with wire, for example, while the oil is being drained.

5.2 Venting

Air in the system will cause a higher condensing pressure and thus increase energy input. Air may be in the system due to:

- Carelessness while feeding in oil and/or refrigerant (air sucked in)
- Leaks on the low-pressure side of cryogenic systems

Protective gloves and gas masks should be used when venting the system by hand. Manual venting is not necessary if an automatic bleeding device is installed.

5.3 Lack of relief devices to prevent fluid expanding

All too often there are systems where the solenoid valve and non-return valve combination have been fitted in the wrong order in fluid pipelines. The solenoid valve needs to be fitted first in the direction of flow followed by the non-return valve. If they are fitted the other way round, liquid will be trapped between the non-return valve and the solenoid valve when the solenoid valve is shut. This liquid heats up while it is stagnant and expands, causing pipelines or connection flanges to rupture. This is particularly the case in pipelines which conduct cold liquids.

5.4 Taking refrigerant pumps out of operation

There have been many incidents caused by liquid refrigerant trapped in refrigerant pumps – when switching from a duty pump to a standby pump, for example. If the duty pump is closed on both sides when switched from operating mode, cold, liquid refrigerant remains in the pump. While stopped, the refrigerant heats up in the pump, leading to leaks due to cracks in the housing or flanges breaking off.

5.5 Opening drainage points

Most heat exchangers have drainage points which feature drainage screws for the different compartments. Before a drainage screw is removed, you must ensure that the refrigerant compartment is not under pressure.

5.6 Measurement sensor threads

Before undoing sensor threads, you must always verify whether the thread has a thermowell or not. If it does not, you will be opening directly into the refrigerant compartment.

5.7 Unfastening flanges

Do not undo all screws at the same time when dismounting flanges. Leave at least two screws in opposite corners and check whether the fitting is still under pressure before removing all screws. Use a gas mask and gloves.

5.8 Subcooled liquid in system parts

If system sections are opened for repairs and pressure is equalised with the atmosphere as a result, you cannot be sure whether any subcooled ammonia is still left in an opened section. Ammonia has a very high heat of evaporation, meaning that heat incidence in pipelines which contain a ‘liquid pocket’, for example, is not sufficient to vaporise the liquid ammonia rapidly, especially if the pipeline is insulated. The situation is different with R-22, R-134a or even R-404A. These refrigerants have a heat of evaporation of less than 20 percent in relation to ammonia and, consequently, less time is required to evaporate any remaining liquid. Specific reference is made to this hazard in BGR 500, Section 2.35.

Characteristics of ammonia

- Ammonia is present in both a liquid and a gaseous state in refrigeration systems.
- Liquid may escape if there is a leak. Sizeable quantities of steam are released as a result of its evaporation.
- Wearing protective masks and gloves during maintenance work minimises the likelihood of health risks.
- Ammonia vapour is lighter than air and rises quickly. However, part of the vapour combines with the air humidity and falls as ammonia solution mist, forming a white cloud.
- Ammonia is flammable. However, it will only burn if there is another flame present; an ammonia flame will always extinguish if there is no other flame. The explosive limits are close together and are high at between 15 and 35 volume percent. The rate of combustion is low.
- The German employers' liability insurance association guideline (BGR 500) does not specify any special explosion protection requirements for electrical equipment with regard to refrigeration machines containing ammonia. Danger can only be expected in a non-ventilated room in a building if the concentration at 105 grams per cubic metre exceeds the lower explosive limit and high-energy ignition sources are at hand.
- Ammonia is absorbed by water. Water sprays are thus used for ammonia leaks to condense vaporous ammonia. One cubic metre of water can bind with around 540 kilograms of ammonia, depending on the temperature. However, under no circumstances should you sprinkle water on liquid ammonia, since this will cause a great deal of gas to form and liquid ammonia to spray out.
- Do not use water in machine rooms.
- Ammonia solution must not be channelled into water bodies or the sewage system.
- Maintenance instructions must be simple and easy to understand. Training on maintenance instructions should be provided on a regular basis.

Published by *eurammon*
Postfach 71 08 64 ◆ 60498 Frankfurt Germany
Phone +49 (0)69 6603 1277 ◆ Fax +49 (0)69 6603 2276
Email: karin.jahn@eurammon.com
http://www.eurammon.com