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Topic

How to Make Sure Your Ammonia Refrigeration Systems are Safe

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How to Make Sure Your Ammonia Refrigeration Systems are Safe

Ammonia has been for many years the refrigerant of choice for businesses with a need for process cooling, temperature controlled storage and distribution, food and drink manufacturing and many other applications. The benefits of using ammonia include high energy efficiency and zero global warming potential. All over the world f-gases are being phased out, and using ammonia as a refrigerant has become a natural progression as it is just as effective while offering an eco-friendly, low cost and long-term option. Ammonia is produced by biological processes, doesn't add to the greenhouse effect and is naturally decomposed. In addition, its price is stable as it is link to the agricultural industry for fertilising utilisation.

However, there are some challenges to using ammonia, as it can be risks if not handled correctly. It may be a natural refrigerant, but ammonia is highly toxic and flammable – so extra care must be taken. There is also a risk of over pressurisation in these refrigeration systems and risks of leakage, which means strict safety inspections need to be carried out and regulations strictly followed.

Legislation relating to ammonia refrigeration systems

There are various UK and EU laws and regulations which apply to plants with ammonia refrigeration systems. The main publications which have legally binding responsibilities for the owners of the systems are:

The Pressure System Safety Regulations 2000 (PSSR)
Provision and Use of Work Equipment Regulations 1998 (PUWER)
EN378:2016 Refrigerating systems and heat pumps – Safety and environment requirements (Part 1-4)
EN12693:2008 Refrigeration systems and heat pumps – Safety and environmental requirements –Positive displacement refrigerant compressors.

PSSR Regulations – The Pressure System Safety Regulations 2000

The purpose of the PSSR regulations is to protect against dangers created by the release of significant stored energy caused by pressure envelope failure. The release of stored energy during failure can cause blast/projectile damage. The regulation requires the Written Scheme of Examination and inspections to be carried out that include the following:

- Safe operating limits to be established
- All protective devices and their settings
- Every pressure vessel and pipeline where a defect many give rise to danger from stored energy
- Specify the frequency of the examination
- Specify any measures necessary to prepare for a safe examination
- The type of examination and intervals of the examination
- A statement to say the system is safe to operate to a specified date

The PSSR Regulations require a competent person to inspect refrigeration systems and if they are of the opinion that the system gives rise to imminent danger, must report immediately to the owner and the UK Health and Safety Executive.

PUWER Regulations – Provision and Use of Work Equipment Regulations 1998

The PUWER regulations require every employer to take adequate measures to reduce the likelihood of unintended or premature release from equipment of gases and liquid that can cause a hazard. There is a further requirement to reduce the likelihood of releases of gases and liquid that may result in an unintended explosion. Every employer must ensure that the equipment exposed to conditions causing deterioration, which is liable to result in danger, shall be inspected at suitable intervals. The purpose of and inspection is to identify whether the equipment is operated, adjusted and maintained safely and that any deterioration can be detected and remedied before it

results in unacceptable risks. The results of the inspection shall be documented.

EN378:2016 Part 1 Annex E defines the safety group for ammonia as B2L, meaning lower flammability and higher toxicity and therefore ammonia systems fall under the requirement of PUWER regulations.

Consequently, the complete ammonia system which includes piping, vessels and components must be inspected and the results are to be recorded by competent persons to reduce the likelihood of an ammonia release that can cause a hazard from the toxic and flammable effect of ammonia.

Preventing over pressurisation

When appropriate over pressure protection devices are in place, maintained and tested, the pressure system should not exceed 10% above the maximum allowable pressure. When a relief valve vents to atmosphere, it is not considered over pressurisation, but a function of the design.

EN378:2016 Part 2 and EN126932:2008 standards provide the requirement and testing of the over pressure protection devices installed in refrigeration systems. EN378 gives clear guidance on the requirement to inspect and test protection devices. This includes:

- Compressor high pressure cut-out switch to be tested annually
- Low pressure switch that can freeze fluids to be tested annually
- External relief valves that vent to atmosphere name plate shall be checked for settings and leakage annually and tested or replaced every five years
- Overflow valve name plate settings shall be checked annually

Measuring pressure envelope ageing

The term ageing is not about how old the plant is; it is about its condition and how it is changing over time. Ageing is the effect whereby a plant suffers some form of material deterioration or damage with an increased likelihood of failure over the lifetime.

In the UK, the Health and Safety Executive (HSE) encourages risk based inspections to be carried out for pressure envelopes and has published guidelines, "Best practice for risk based inspections as part of plant integrity management". The risk based inspection methodology uses information and experience already gained in inspections and pressure envelope failures, requiring more frequent inspection in high risk areas whilst still ensuring the complete system is safe to operate.

Based on the HSE publication "Managing Ageing Plant" which is applicable in the UK, a systematic inspection approach for refrigeration systems pressure envelope ageing has been developed.

The main aging mechanisms that relate to typical mechanical systems include:

- External corrosion and erosion
- Internal corrosion and erosion
- Stress corrosion cracking
- Cyclic stresses
- Mechanical damage
- Failure of supports and anchorages
- Flange leakage and flange bolt failure
- Gland seals on valves, pumps and compressors
- The mechanical Integrity Inspection Report

To bring together all of these best practices and safety guidelines, we recommend regular inspections, by a competent person. The comprehensive inspection will cover all the different UK and EU legislation to ensure the operator of an ammonia system is compliant and the plant is safe. The inspector should produce a full report divided into a number of sections:

Actions required

- Part 1 – Written Scheme of Examination
- System description
- Pressure vessels and general components
- Equipment to be inspected
- Part 2 – Inspection to the Written Scheme
- Protective devices
- Pressure vessels
- Pipe inspections
- References and person issuing the report

When a written scheme of examination is prepared, the system allowable pressure for each part of the system must be established, and the vessels and components like condensers, evaporators, and heat exchangers, including their protection devices should be listed. The written scheme should also list the values that must be locked open, and detail how hot gas defrost lines hydraulic shock is prevented.

When preparing the written scheme of examination, the structure for the inspection to the written scheme of examination should also be developed allowing the inspector to fill the information into the report efficiently to ensure all areas are covered.

When a protection cut-out device is tested or inspected, the result of the inspection should be in the report that gives the actual cut-out point. Where a relief valve is checked for setting and date, the serial/batch number and date on the relief valve should be recorded.

Pressure vessels with their supports shall be checked as individual pieces of equipment. The report should state their condition at each inspection. The report should also include or direct to other reports where repairs to the vessels have previously been carried out. The report should also be a log of the changes in condition of the vessels over time.

The insulated and non-insulated piping system with their supports and flanges should split into sections as different pipe lines may be ageing at different rates.

The report should state their condition at each inspection and for non-insulated pipe the condition of the vapour barrier for insulated pipe.

Where pipe or vessel cores or sections of insulation require removing, the report should identify (using photographs and site layout drawings) the location of the inspection points; these points should also be marked on site. Where corrosion has been identified on pipe or vessels, the report should show pictures of the corrosion areas and the location on the site layout drawing. It is very important to record any repairs to vessels and piping as any future corrosion identified in the area may require further examination as the metal may now have structural weakness.

Want to find out more about ammonia refrigeration systems and safety? Get in touch with the Star Refrigeration team who have pioneered the latest low charge ammonia chillers.

Also see: https://www.youtube.com/watch?v=LNMf_aRKC5E

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