



Ammonia Refrigeration Plant Rooms

Important factors to be considered in the initial design

By K. Viswanathan

An ammonia refrigeration plant room generally consists of most of the major equipment for a refrigerated facility. It is therefore important to evaluate various requirements during the initial stages of design in order to ensure the safe operation of the refrigeration plant.

Design requirements can be broadly classified as :

- Site considerations and machinery room layout
- Leak detection
- Ventilation
- Pressure relief and emergency venting
- Identification of piping and system components

- Electrical requirements
- Safety

Site Considerations Layout

It is necessary to evaluate the space requirements based on equipment to be installed during the initial stages of building and facility design.

Machinery rooms should preferably be located at ground level in a separate building or sharing the area with another utility system) or in a part of the main building with at least two or three exposed walls and exposed roof.

It is not desirable for plant rooms to be located in basements, floors above ground level and near heavily

occupied areas like handling area, loading areas or offices.

Ensure that access is provided to the plant room for emergency vehicles.

Construction

The plant room structure should be designed for static and vibration loads of equipment, vessels and piping. Plan for any elevated structures, hoists, etc. that might be required.

Foundations for equipment must be planned depending on location and operating loads. Access platforms must be taken into consideration for elevated structures.

Floors should be slip resistant.

The plant room must have a minimum of two exits with outward opening doors, fitted with panic type hardware. A clear path to the exits must be provided and also duly marked.

Fire Protection

Appropriate fire protection system as required by local

About the Author

K. Viswanathan is a mechanical engineer with over 15 years experience in the HVAC & R industry and is presently working in the refrigeration division of a large contracting organisation in the Middle East

regulations must be installed. Providing sprinklers over ammonia vessels is advisable.

Equipment Layout

All equipment should be located in such a way as to allow access for maintenance purposes. Check for clear space requirements specified by equipment manufacturers and also ensure clear access to important isolating and control valves.

Boilers, furnaces and any equipment with open flames, etc., should not be located in an ammonia system plant room.

Provide isolation valves at important branches and for the various installed equipment. If future expansion is planned then provide isolating valves at all branches which will have to be tied into the existing system.

Note: Valves for equipment installed on elevated structures must have clear access for operation.

Drainage

Provide a separate drainage system that can be used in the event of an ammonia spill in the plant room as such spills may cause disruption of existing drain facilities and / or other utilities.

Leak Detection

A plant room with ammonia vapor concentration above 400 ppm causes major throat irritation to operating personnel and continuous exposure to these levels of ammonia could be dangerous. Concentration above 1600 ppm causes convulsive coughing and could be fatal to workers if exposed for even 30 minutes or less.

Concentration of ammonia above 16% by volume in air is highly explosive and is flammable by spark ignition at these concentrations.

A typical ammonia plant room with a good ventilation system will still contain about 5-6 ppm of ammonia. It is therefore necessary to have an effective leak detection and ammonia ventilation system in the plant room.



Figure 1: An ammonia-leak detector.

Ammonia leak detectors should be used in the plant room as well as in enclosed utility areas (such as service corridors or enclosed maintenance walkways) with long ammonia piping runs.

A number of leak detectors are available which

can either be installed in specific locations or single system with multi-zone capabilities (which can sense ammonia leaks at different locations within the plant room). The cost of a good leak detection system is negligible in comparison to the cost of the refrigeration plant.

Leak detectors should be wired to trigger alarms (as well as the emergency ventilation system) to alert the operator in case of minor leaks or the entire facility in case of an emergency or major leak.

Programmable leak detection systems are also available which can be used to sense the amount of leakage and the location and thus programmed to trigger either operator alarms, ventilation systems or even shut down the complete ammonia plant.

Ventilation

It is important to design and install a proper ammonia ventilation system in the plant room.

Ventilation systems in plant rooms are typically used

- for room temperature control and
- ammonia evacuation in case of a leak.

“ANSI/ASHRAE 15 and ANSI/IIAR-2 state that as long as the ventilation requirements laid down by these codes are satisfied, the machinery room is classified as a ‘Non-Hazardous Location’ by the National Electric Code (NEC). If such ventilation is not provided all electrical equipment must comply to Class I Div 2 requirements.” (The latter requires special electrical gear which would make the system expensive.)

Various codes provide guidelines and recommendations to design ventilation systems based on the ammonia plant, refrigerant charge, room volume and floor area.

Some codes and guidelines recommend a minimum of 12 air changes per hour based on room volume.

ANSI / ASHRAE-15:

$$\text{cfm} = 100 \times \sqrt{\text{pounds of ammonia (system charge)}}$$

Other Codes :

Minimum continuous ventilation rate of approx. 1.5 cfm/sq.ft. and a maximum (in case of an ammonia leak) of 10 cfm/sq.ft. (subject to a minimum of 20,000 cfm)

This would be the most stringent of the requirements in most cases and can be used as a guideline but it is important to consider local regulations while designing a ventilation system.

Use of up-blast high velocity discharge exhaust fans is preferred for the effective dispersion of ammonia.

Some regulations state that fans comply to Class I, Div. I electrical requirements, which implies the use of explosion proof motors.

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In plant rooms where air intake dampers or louvers are required, it is recommended that you use motorized intake louvers with 'open on failure' actuators instead of manual dampers.

Provision should be made for ventilation systems to be controlled remotely and preferably powered by a separate power source.

Pressure Relief and Emergency Venting

All ammonia vessels including HP receivers, separators, oil coolers, oil separators, surge drums, priority vessels, discharge headers, etc., must be installed with pressure relief valves having the appropriate rating. Installed pressure relief valves must be operated and also tested at regular intervals as specified by the manufacturer and local regulations.

Outlets of all pressure relief valves must be piped to the outside, to vent ammonia preferably to a water absorption system or into the atmosphere (if allowed by local regulations and provided there is no danger to the public or other premises).

In case of a fire or similar emergency, an ammonia refrigeration system located inside a building must have a system to safely discharge ammonia manually by relieving of vapour pressure. Emergency discharge lines should be independent of all other lines and connected directly on top of all pressure vessels. In locations where release of ammonia to the atmosphere may be hazardous to public or other premises the vent piping should discharge to a water absorption system.

Pipe sizing for pressure relief and emergency vents is extremely important and needs to be designed adequately.

Identification and Markings for All Ammonia Refrigeration Piping and Equipment

The ammonia refrigeration piping network as well as all system components should be clearly identified by help of tags or name plates appropriately sized. All piping and components are generally tagged to indicate the refrigerant, physical stage of the refrigerant, relative pressure level of the refrigerant and the direction of flow.

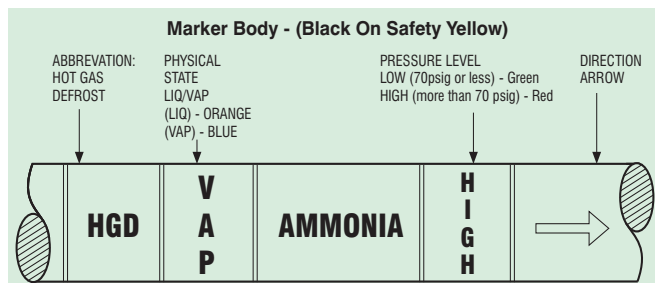


Figure 2: Typical pipe marker - for hot gas defrost line.

All system components such as compressors, condensers, receivers, pressure vessels, thermo-siphon vessels, inter-coolers, oil pots should be clearly identified and marked.

IIAR (International Institute of Ammonia Refrigeration) Handbook provides standard guidelines for such identification of piping and components. Figure 2 shows one example as approved by IIAR.

Electrical

Estimate electrical load requirements for present as well as future expansion if planned, as well as for cable trenches, routing and location of cable trays, location of MCC and control panels, etc.

Plan for location of the MCC and control panels required for the system in such a way that they are easily accessible and provide all major equipment with "Emergency Stop" switches. All indicating instruments should be clearly visible and appropriately marked.

The ammonia plant should be provided with an emergency-shut-down system with a proper sequencing of the shut-down. An emergency shut down could be triggered manually or by the leak detection system or fire alarm system or probably by any of the other safety systems that exist within the facility. Plant emergency shut down system should be provided both at local as well as remote locations for a safe emergency shut down of the plant.

Safety

Ensure that the plant rooms and also those enclosed service areas having long ammonia pipe runs have at least the minimum safety equipment for operating personnel.

- First aid kit
- Fire extinguishers
- Gas masks and breathing apparatus kits
- Emergency eye wash and shower facilities (See Figure 3).

Safety of any ammonia system is of paramount importance.

Considering the various advantages in designing and operating a safe and efficient ammonia plant room, the increase or additional cost, if any, would be negligible.



Figure 3: A shower and eye-wash facility for use in a plant room during accidental gas leaks.