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COLD CHAIN

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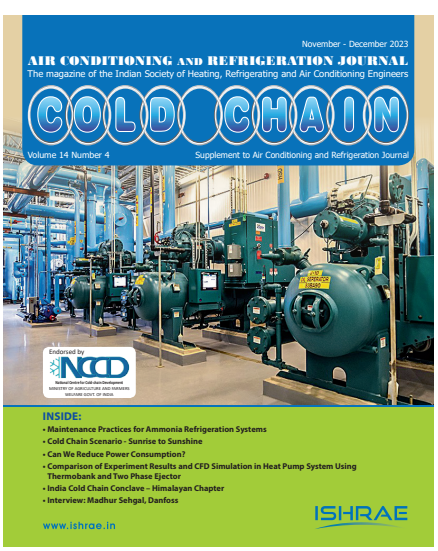

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Maintenance Practices for Closed Circuit Field-Erected Ammonia Refrigeration Systems

By Ramesh Paranjpey, Distinguished 50-Year Member and Fellow, ASHRAE

Introduction

Maintaining a plant well is more about attitude than the actual work involved. Increased productivity coupled with energy conservation is the prime objective for capital equipment. If this is not taken care of, performance is almost certain to suffer at some point of time due to plant failure or breakdown or inefficient operation.

It is not advantageous for anyone if a plant becomes a repair liability before its due time or otherwise fails to operate in other than a satisfactory manner under its design conditions.

The reliability of a plant depends upon whether or not any particular component possesses the capability to discharge its required function and duty as agreed for an extended period under environmental and operating conditions peculiar to its application without rapid deterioration or failure.

Failure means termination of the ability of an item to perform its required function, i.e., either malfunction or complete breakdown.

The owner of a plant should take care of the plant as he takes care of his own health and he should take pride that his plant has been maintained in the best condition.

This is essential as his entire business depends on uninterrupted working of the refrigeration plant at optimum efficiency so as to get maximum output at minimum energy and maintenance cost.

I have come across many plants where least attention is paid to the refrigeration plant and if one visits the plant, it seems to be in horrible condition.

The owner continues to use such plant without paying any regular attention and only looks at it when the plant develops some fault, but then it is too late as the downtime involved in repairing and making the plant operational once again is very long and the losses incurred due to production loss could be enormous.

Instead, if the owner maintains the plants properly and timely, he can become a successful entrepreneur.

Figure 1: Badly installed and maintained refrigeration plant

Figure 2: Rusted receiver and other pressure vessels

Figure 3: Rusted pipelines and equipment

About the Author

Ramesh Paranjpey is a mechanical engineer with an M. Tech. in refrigeration from IIT Bombay, having over 35 years' experience. He has worked in very senior positions with Kirloskar Pneumatic in Pune, Carrier Transicold in Bangalore and Singapore, and Voltas-Air International in Pune. Presently he works as a technical advisor and consultant, based out of Pune. He is a distinguished 50-Year Member and Fellow, ASHRAE; Past President, ASHRAE W.I. Chapter; and Past President, ISHRAE Pune Chapter.

Figure 4: Well-designed and maintained refrigeration plant

While maintaining a plant, the installation should be well-planned keeping in mind the ease of operation and future maintenance requirements for the equipment as it becomes older.

Well-designed Machine Room

Machinery Room Contents

Preferably, the ammonia refrigeration machinery room houses only ammonia refrigeration equipment and direct ancillary equipment such as condenser water pumps and no other unrelated items.

Machinery Room Layout

Sufficient space shall be provided to allow access to equipment for maintenance purposes. Adequate clearance for personnel is recommended between the equipment. Minimum two exits must be provided from the machinery room. Exit doors shall swing outward and an unobstructed path to the exit is to be clearly marked.

Floors

Machinery room floors should be slip-resistant and should be sloped towards floor drains. All floor drains, slopes and drain locations should be coordinated with equipment layouts.

Access Platforms

Elevated equipment and branch hand valves located more than seven feet above the floor level should be provided with access platforms. Ladders and movable cranes in the machine room to lift heavy equipment may be necessary.

Emergency Eyewash and Shower Facilities

Because of the potential for eye and skin exposure to ammonia, accessible eyewash and body shower facilities shall be provided. Because of the importance of quick flushing of the eyes in the event of a spray or splash of liquid ammonia, eyewash facilities should be located in the area of the machinery room.

Maintenance Guidelines for Machine Room

- Sweep and mop engine room floor daily.
- Wipe compressors and other equipment daily.
- Perform machine room clean up inspection for safety, operational cleanliness to help extend asset life.
- Things to adjust or eliminate may include:
  1. Oil on the floor.
  2. Brooms, mops, shovels, operator's cloths, jackets, belts, electrical cables, hoses, etc. hanging on valves, compressors, or panels.
  3. Boxes, garbage cans, empty cylinders stored next to compressors or other equipment in machine rooms should be removed.
  4. Ensure clearance in front of all electrical panels.
  5. Open or unlock electrical panels.
  6. Hoses and electrical cables hanging or lying on floor.
  7. Water on the floor from condensation from pipes, valves or equipment.
  8. Burned out light bulbs to be replaced.

For proper maintenance, associated materials and equipment should be available and technicians should be appropriately trained and equipped so that they are able to maintain temperature-controlled systems in an operable, safe and efficient condition. The basic equipment needed for proper maintenance includes the following:

- Refrigeration equipment service manuals for each item
- Digital thermometer
- Cleaning equipment (non-solvent based)
- Insulated envelope repair equipment
- Multi-meter for electrical testing
- Electronic leak detectors as also hand-held leak detector and sponge and soapy water
- Manifold gauges-set and refrigeration tools
- Spare cylinders containing enough refrigerant as well as nitrogen in case pressure testing is required
- Spare part kits for compressors, evaporative condensers, pumps, air coolers, etc.
- Spare mercury in glass thermometer and pressure gauge
- Refrigerant recovery equipment
- Vacuum pump
- Weighing scales
- Torch to enter dark areas
- Thermography camera (can be rented in case insulation leak is suspected)
- All personal safety equipment such as goggles, non-slippery shoes with hard toe, hard hat, protective dress, gloves, etc.
- Ventilation fans in the plant room should be provided

based on 2cfm/ft^2, and should run continuously. Two such fans should be provided, and in case of accidental leaks both the fans should be activated so that the ammonia vapors are dispensed more effectively.

- One bottle of boric acid and eye cup and one bottle of vinegar
- A 100 feet length of ½" diameter rope to tie a person entering high refrigerant concentration area
- Sulphur dioxide or hydrochloric acids to detect ammonia leaks
- Emergency alarm or hooter to be provided in the plant room
- Emergency eye wash basin and body shower facility readily accessible in the machine room must be provided
- Fire protection systems as proposed and approved by local regulations shall be provided in addition to providing sprinklers over any major ammonia storage vessel like high-pressure receivers to prevent excessive temperature rise taking place in case of fire.
- All ammonia vessels, equipment, piping should be labeled with flow direction arrows. Piping should be color coded – discharge red, liquid yellow and suction green and water blue color.
- Piping and instrumentation diagram must be explained to all operating staff and should be displayed on the wall in sufficiently big size, which can be easily read without removal.
- Machinery room lighting should be adequate so that all instructions are clearly readable. One light should be on standby automatic battery supply in case of electricity failure.
- Necessary operating tools of right size, ratchet spanner for cylinder opening, vacuum pump, hoses, and other required maintenance tools should be available in plant room.
- Operators should be properly trained to handle ammonia installations and should be familiar with functioning, operating safety and maintenance aspects of equipment installed.

The cooling system can continue to run for many years if proper maintenance is observed.

Maintenance of Refrigeration Equipment

The maintenance of equipment falls under various categories as illustrated below:

Inherent Maintenance

This responsibility lies with

- Original equipment manufacturer
- Application engineer-proper machine room design
- System designer
- System installer

Preventive Maintenance

This depends on

- Scheduled maintenance
- Condition monitored or observed
- Replacement or repair prior to failure

Corrective Maintenance

This is related to

- Breakdown leading to repair or replacement of part

Opportunity Maintenance

As and when this depends on breakdown or shutdown of the plant.

One can do some preventive maintenance during this time even though it is not scheduled.

Daily Maintenance Checks

The daily maintenance checks include the following practices:

- All compressors used should be checked for oil leakage and proper oil level.
- The refrigerant levels in the receiver or L. P. vessels, interstage coolers should be checked as well.
- The evaporators and drain pans in the cold room should be checked for ice formation.
- The proper water or brine or cold room temperature and R.H. needs to be checked on a daily basis and maintenance of uniform temperature throughout the cold room should be ensured.

Monthly Check-Ups

The daily maintenance should be done throughout the month.

The efficiency of the system should be checked by carrying out the following practices:

- Make sure that the fins of condenser coils are clean.
- The evaporator and fins of the cooler should be kept clean as well.
- Make sure that the room is cooling perfectly when fully loaded.
- Ensure that the levels of refrigerants are maintained properly.
- The control valves are functioning efficiently.
- The function of defrosting should work properly, because defrosting is imperative to the efficiency of the negative temperature cold rooms.
- The evaporators should be clean and functioning efficiently to make sure that the temperature is maintained.

- The casing of the evaporator should be cleaned, along with the blower fans.
- The temperature indicators should be calibrated.
- Perform a system functional test to make sure that there is no malfunctioning.
- At least every month, check conditions of the belt, drive guards; abnormal vibrations, abnormal temperatures, smells, and leakage suspect points. The compressor inspection on the basis of hour runs, foundation bolts, shaft and floats should also be checked.

Quarterly Maintenance Practices

Perform all monthly maintenance practices. They should not be ignored. If ignored, it can lead to increase in energy consumption and inefficient cooling.

The overall functionality of the system should be tested to make sure that there are no leakages or damage to the cold room panels, doors, etc.

Annual Maintenance Practices

The daily, monthly and quarterly maintenance checks should be carried out without any exception. By carrying out all the maintenance steps mentioned above, the efficient functioning of the room can be ensured.

The heat exchangers should be washed chemically. This will help in removing any impurities, which may become a hindrance in the efficient functioning of the room.

The reciprocating compressors should be opened one by one and clearances should be checked to ensure that they are within acceptable limits. If not, replace the defective part.

Record Keeping

It is essential to maintain good records of all parameters to ensure that equipment is operating at peak efficiency. If major decisions around the area are contemplated, consider engaging a specialist in energy-auditing service, which will highlight where real energy savings can be made.

With ever-increasing energy costs, carbon footprint of the storage, energy consumption and exploring options for energy saving are the need of the hour.

Keep service records safely as it is important to be able to demonstrate due diligence in the management of the store, especially if there is a need to demonstrate legal compliance or if there is a contractual problem affecting the quality of the crop.

Maintenance

Preventive Maintenance Practices

- For ammonia leak detectors, calibrate each sensor with certified calibration gas, making sure that the cell reacts to ammonia and trips the alarm.
- Record readings as detailed earlier and maintain log book in the plant room.
- Maintain history of parts used with dates and reason for replacement.
- Keep valve stems clean and oiled and valves not requiring adjustment capped.
- Any pipe or shell vessel showing rust should be cleaned and painted. Repair insulation as required.
- Maintain correct belt tension on all drives, check coupling in case of direct drive.
- Use correct lubricants and compressor oil as per manufacturer's recommendations.
- Defrost before excessive accumulation and do not remove frost by hammering.
- Maintain correct water quality and check water treatment plant if installed.
- Bleed off continuously from the evaporative condenser tank at least equal to evaporation rate to maintain concentration same as make up water. It should be kept in mind that only water evaporates and sediments settle down in tank as they do not evaporate.
- Maintain compressor oil level.
- Safety guards must be in place after any service and before operating
- Color coding of pipes, flow direction arrows and valve position indication (either open or close) is desirable.
- Never close valves on pressure, liquid lines, valves before safety devices.
- Keep all equipment clean and machinery room clean, putting oily rags in fire proof containers.
- Arrange visits to the local fire department and conduct emergency drills.

Major Preventive Maintenance

Reciprocating Compressors

- Check abnormal noise and vibrations.
- Perform oil analysis.
- Inspect refrigerant lines.
- Grease motor bearings.
- Keep terminal boxes free from moisture and dirt.
- Check and calibrate pressure and temperature sensors.
- Inspect oil lines.
- Lubricate valve stems.
- Check tightness of foundation bolts for compressor and motor.
- Check 'V' belt tightness.
- Replace oil filters if necessary.

Screw Compressors

- Visually check seal oil.

- Check oil levels in oil separators.
- Adjust loading or unloading solenoid valve if necessary.
- Check oil pressure regulator.
- Perform vibration check and analysis if necessary.
- Perform oil analysis.
- Calibrate pressure and temperature sensors.
- Replace oil filters if necessary.
- Grease motor bearings.
- Clean oil pump suction strainer.
- Check operation of oil heaters if installed.
- Check tightness of motor anchor and compressor package foundation bolts.
- Check compressor motor alignment if necessary.
- Replace or calibrate safety valves at a frequency as per good engineering practices.

Pressure Vessels

- While the system is operational, external appearance of the surface of vessels or heat exchangers, insulation conditions shall be visually inspected weekly by staff for any abnormal observations. Liquid level gauges to be inspected and oil built up drained if necessary.
- Oil addition or drained oil quantities to be recorded.
- Quality of oil for impurities, contamination and deterioration should be checked periodically, which helps in a long way in troubleshooting and preventive maintenance analysis.
- Cooling coils and defrost water drains should be examined weekly for excessive frost build up and defrosted as necessary. System should be purged for non-condensable if necessary.
- Accumulation of water on the low side to be checked and water removed as required.
- Finned heat exchangers should be inspected monthly for possible dirt or contamination on tubes and fins and cleaned as appropriate. Defrost elements should be tested electrically for correct operation.
- Every six months the fan impeller should be checked for corrosion and cracks. Correct direction of airflow and rotation should be confirmed after every disconnection from power supply.

Cooling Tower or Evaporative Condenser Maintenance

- Weekly, clean pan strainers and ensure adequate bleed off and proper operation of bleed off valve. The bleed should be equal to 0.03 gpm per ton of refrigeration. This will vary depending on the quality of makeup water.
- Check water distribution system, drift eliminators, float valve adjustment, fan belt tension, dirt and debris, etc.
- Clean all debris from the cooling tower every day.
- The strainer on the pump suction line should be removed and cleaned every week or as often as necessary to keep it clean.
- Before working on the unit, switch off and lock out the motor and pump.
- The basin should be flushed out weekly or as often as necessary to prevent an accumulation of dirt and debris.
- The makeup valve must be checked every day to ensure the valve is functioning and set properly.
- The pump and pump motor should be lubricated monthly.
- The water distribution system should be checked weekly for proper operation. Always check the water distribution system with the pump on and the fans off.

Plate Heat Exchangers

- Back wash the PHE during defrosting or freezing for 30 minutes every day.
- Cold store's PHE back washing to be done once a week.
- Clean the plate heat exchangers every quarterly by opening to clear fouling,
- After opening, clean the plates with a soft brush and running water. Take care of gaskets to avoid any damage.
- Clean with high pressure and then chemical cleaning using sulfamic acid maximum 4% concentration at max 60°C temperature. Do not use hydrochloric acid with stainless steel plates.
- Replace the damaged gaskets.

Shell and Tube Condensers

- Quarterly clean the tubes of condenser by scrubbing.
- Renew the gaskets.
- Inspect for tube leakages and rectify.

Ammonia Pumps

- Check for abnormal vibration or noise.
- Check pump oil level wherever applicable.
- Test and rotate standby pump.
- Check the operation of pump differential switch.
- Drain oil from pump low point.
- Examine pump exterior and adjacent lines for damage or corrosion.
- Verify minimum flow orifices and regulators are open and properly adjusted.
- Rotate working and standby pump once in six months to ensure equal number of hours running of each pump.

Water Pumps

- Check daily the water pumps for any abnormal sound.

- Check for water leakages through glands. Tighten or renew the gland packing.
- Weekly measure the current (RYB) and report any abnormalities.
- Check water pump discharge pressure and clean water strainers.

Ammonia H.P. Receiver

- Check the functioning of the pressure gauge every shift.
- Check and rectify leakages through the valves.
- Always cap the vent lines.
- Check ammonia level and ensure that it is adequate say 50% minimum when the plant is not operating and 20% minimum when the plant is operating and 80% maximum when the entire charge is pumped down in the receiver.

Intercoolers

- Check whether the float switches are in operation.
- Do not tamper with the setting of expansion valve.
- Drain oil from intercooler weekly.

L P Vessel

- Check whether the float switches are in operation. Drain oil from LP vessels weekly.

Evaporators

- Perform visual check of coil and fins and fans.
- Inspect evaporator outdoor piping and valve stations.
- Drain oil from evaporator wherever applicable.
- Periodically review defrost schedules to determine if the length of time between defrost can be increased to save energy.
- Check air temperature differential across coil.
- Check and clean coils and pans for excessive dirt.
- Check evaporator supports, motor mounts, fans and guards.

Validation of Safety Interlocks

It should be performed every week, in presence of concerned officer or manager.

H P cut off

While running the compressor, close the compressor discharge valve and check the compressor is tripping at 16-17 bara, and record.

L P Cut Off

While running the compressor, close the suction valve, check the compressor trips at -0.3 bar, and record.

Intermediate Cut Off

While the compressor is running, close the intermediate discharge valve, check the compressor is tripped above 4 bars.

O P Cut Off

Start the compressor with lower oil level than required, the compressor should trip within a minute.

Interlock with Cooling Tower Fan and Pump – Start Up

Start the compressor after starting the pump and cooling tower fan. The compressor should not start first.

Interlock with Cooling Tower Fan and Pump – while Running

While running the compressor manually, stop the supply to the pump by switching off the MCB. The compressor should trip.

General

- Check regulating devices.
- Correct function and set points.
- Avoid water in the system. Maximum 1-2% in ammonia is acceptable (per 2% by volume water the suction pressure rises by approximately 0.5°C).
- Avoid non-condensable gasses in the system (condenser and receiver). Prefer an automatic air purger to manual purging.
- Regular oil draining from the system.
- Keep a log book (operation conditions, maintenance, malfunctioning, operating hours for compressors, oil- and refrigerant account, etc.).
- Provide automatic monitoring of operating conditions.
- Implement maintenance schedules.
- Keep documentation and item lists updated (year, maintenance intervals, last repaired, etc.)
- Drain oil from the system on a regular basis and have the oil analyzed.

Log Book Recording

Table 1: Format of log book for entire plant covering at a minimum

Date	
Ambient temperature, °C	
Time of starting of plant	
Total running hours of plant	
Total production if process plant like blast freezers, IQF, plate freezers, etc.	
Compressor discharge pressure, kg/cm^2	
Compressor discharge temperature, °C	
Compressor suction pressure, kg/cm^2	
Compressor suction temperature, °C	
Compressor oil level	
Oil temperature in case screw compressor, °C	
Compressor Amps (current/power consumption)	

Cooling water temperature – condenser inlet	
Cooling water temperature – condenser outlet	
(Tank temperature, °C, in case evaporative condenser)	
Makeup water temperature, °C in case evaporative condenser	
Ammonia temperature in LP vessel, °C	
Ammonia temperature at air cooler or equipment inlet, °C	
Room temperature in case cold room, blast Freezers, °C	
Defrost frequency and defrosting time	
Brine inlet/outlet or chilled water inlet/outlet temperatures for process plants, °C	
Quantity of oil removed/charged, cc	
Any abnormal observation – noise, smell, oil patches, etc.	

Conclusion

A well maintained plant would lead to reduction of Mean Time Between Failure (MTBF) and would give the owner maximum output at minimum operating and maintaining cost.

WHAT'S HAPPENING

Carrier Transicold Launches Lynx™ Fleet Digital Platform

Carrier Transicold has announced the launch of its Lynx™ Fleet digital platform, now available in India for over-the-road owners, operators and leasing companies providing a new level of visibility, data and actionable insights. Applying advanced internet of things (IoT), machine learning and analytics, Lynx Fleet provides users with a new ability to monitor and manage their refrigerated transport, automate key processes and reduce logistics failures to increase performance and lower total cost of ownership. Carrier Transicold is also part of Carrier Global Corporation, global leader in intelligent climate and energy solutions.

"Our customers have asked for a more connected cold chain to improve their fleet optimization and business operations," said Cynthia Lu, Managing Director, Truck Trailer Asia, Carrier Transicold. "We will continue to strengthen Lynx Fleet to further support our customers in meeting their goals."

Depending on configuration and service plan, customer benefits include temperature monitoring and control, automatic notifications, real-time alerts, refrigeration unit performance monitoring, wireless data transfer, fuel level monitoring, door switch monitoring, and improved refrigeration unit uptime.

"The system's unit analytics provide a unique advantage for Carrier customers", said Pankaj Mehta, Managing Director, Truck Trailer, India & South Asia, Carrier Transicold. "No other telematics solution provides as much insight about Carrier Transicold units, because it was developed and qualified specifically for Carrier Transicold equipment."

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The President of JKPICCA, Majid Wafai, and other entrepreneurs of the valley expressed gratitude to NCCD for bringing a National Level Conference to Kashmir. They commended NCCD for bringing international speakers, financial institutions, and energy specialists to Kashmir and putting the development of CA stores on the international map. The JKPICCA President also requested to make this event an annual occurrence in Kashmir, facilitating access to global changes in the Cold Chain industry for local farmers and growers.

The event's success wasn't just measured in numbers; it was a testament to the collective will and determination to usher in a new era for the cold chain industry in Jammu & Kashmir. The discussions sparked during the event laid the groundwork for innovative solutions and collaborative initiatives, promising a future where sustainability, efficiency, and resilience define the region's cold chain narrative. The success of the event was widely covered by the media all around the valley.

The conclave's success was underpinned by key partners, including the JKPICCA, Directorate of Horticulture, BEE, ISHRAE, and PHD emphasizing the growing recognition of the vital role played by sustainable cold chain development in India.

The following day of the event, the Joint Secretary, accompanied by the Director of Horticulture and the COO-NCCD, toured the India International Kashmir Saffron Trading Centre (IIKSTC) at Pampore to inspect the infrastructure established for the welfare of farmers. During the visit, they reaffirmed the government's dedication to the comprehensive development of the saffron sector. He also visited IGC-Lassipora, a prominent center for cutting-edge Controlled Atmosphere (CA) storage facilities in South Asia, to see the working and usage of modern and advance machinery in CA facilities in Kashmir Valley.

As the echoes of the event reverberate through the valley, the momentum generated promises a transformative journey for Jammu and Kashmir's cold chain industry. The blueprint for sustainable practices, forged through collaboration and shared vision, is set to redefine how the region approaches the storage, transportation, and preservation of its agricultural treasures.

In the wake of this successful event, the cold chain industry in Jammu & Kashmir stands at the cusp of a new era – an era marked by innovation, sustainability, and a commitment to global standards. The lessons learned and connections forged at SKICC are poised to reverberate far beyond the valleys and mountains, shaping the future of cold chain practices not just in the region but as a beacon for the world to follow. The story of Jammu & Kashmir's cold chain is no longer confined to its borders; it is a narrative that transcends, inspiring a global movement towards a greener and more sustainable future.