Refrigeration Controls

by

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Water Contamination and Removal in Ammonia Refrigeration Systems

Water Contamination is very Commonly observed due to Solubility of Ammonia in Water

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Refrigerant Grade Anhydrous Ammonia Specifications-ANSI/IIAR 2

Purity Requirements

- Ammonia Content 99.95%Min.
- Non-Basic Gas in Vapor Phase 25PPM Max.
- Non-Basic Gas in Liquid Phase 10 PPM Max.
- Water 500 PPM Max.
- Oil (as soluble in petroleum ether) 5 PPM Max.
- Salt (calculated as NaCl) None
- Pyridine, Hydrogen Sulfide, Naphthalene None

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AMMONIA-WATER RELATIONSHIP

- Ammonia and water have a great affinity for each other.
- For example, at atmospheric pressure and a temperature of 30°C., a saturated solution of ammonia and water will contain approximately 30 percent ammonia by weight. As the temperature of the solution is lowered, the ability to absorb ammonia increases.
- At 0° C. the wt. percentage increases to 46.5 percent;
- At -33°C. the percentage increases to 100 percent ammonia by wt.

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AMMONIA-WATER RELATIONSHIP
SOLUBILITY OF AMMONIA WITH WATER

% Dilution	Saturated Suction Temperature at		
	-0.3 Kg/ cm^2 g	0 Kg/ cm^2 g	2.0 Kg/ cm^2 g
0	-40.2°C	-33.3°C	-8.9°C
10	-38.6°C	-31.6°C	-7°C
20	-36.4°C	-28.9°C	-3.9°C
30	-32.2°C	-24.4°C	2.3°C

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Water Contamination and Removal in Ammonia Refrigeration Systems

Two Sources of Water contamination

1. The contamination sources in the construction and initial start up phase

2. The contamination sources after the system has been put into normal operation.

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Water Contamination and Removal in Ammonia Refrigeration Systems

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Contamination During construction and at initial start up

- Water remaining in new vessels, which are not properly drained after Hydro pressure test.
- During construction, water may enter through open piping or weld joints, which are only tacked in place when either are exposed to the elements.
- Condensation, which may occur in the piping during construction.
- Condensation, which may occur when air has been used as the medium for the final system pressure testing.
- Water, which remains in the system as a result of inadequate evacuation procedures on start up.
- The use of non-anhydrous ammonia when charging the system.

Water Contamination and Removal in Ammonia Refrigeration Systems

Contamination after the system has been put into normal operation

- Rupture of tubes on the low-pressure side of the system, especially in Shell & Tube Heat Exchangers such as chillers or oil coolers
- Improper procedures, when draining oil or refrigerant from vessels or pipes in vacuum range into water filled containers.
- In systems, which are operating below atmospheric pressure or which are making pump down so the pressure goes into a vacuum range: Leaks in valve stem packing, flexible hoses, screwed and flanged piping joints, threaded and cutting ring connections, pump and compressor seals, and leaks in the coils of evaporator units.

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Water Contamination and Removal in Ammonia Refrigeration Systems

Contamination after the system has been put into normal operation

- Improper procedures when evacuating the system or parts of the system, while service and maintenance work is carried out.
- Complex chemical reactions in the system between the ammonia, oxygen, water, oils and sludge's can create more "free" water in the system.
- Lack of adequate or no purging

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Water Contamination and Removal in Ammonia Refrigeration Systems

Contamination after the system has been put into normal operation

- Lack of adequate or no purging

Example

Air Purger in a plant removes 5 Ltr of air per min

The ambient temperature is 35°C, with 75% RH

Hence water contain is 25 g/kg

5 Ltr x 1/1000 ltr X 25.5 g X 60 min = 7.65 grams of Water per hour

That is 45.9 Ltr per year considering 6000 hrs per year plant operation

In 10 years we will have 459 Ltrs of water in our plant

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EFFECTS OF WATER CONTAMINATION

- Water contamination lowers system efficiency
- Increases the electrical costs
- In addition, water also causes corrosion in the refrigerant cycle and
- accelerates the aging process in oil.
- Increased wear and more frequent oil changes generate lower plant availability and increase service costs.

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AREAS OF HIGHEST WATER CONTENT

- Recirculation Sysetms :Pump receiver (LPR)

- Flooded systems: evaporator and surge drum.
- DX systems suction accumulator.

- Two-stage systems vessels and evaporators of the low stage portion of the system.

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AREAS OF HIGHEST WATER CONTENT

Reasons :

- Large difference in Vapour Pressure between water and ammonia.
- For example, at 2°C, the vapor pressure of ammonia is 3.6 Kg/cm^2 as compared to 0.007 Kg/cm^2 for water.
- Since the liquid with the higher vapor pressure will evaporate in greater proportion than the liquid with the lower vapor pressure, a residue is left containing more and more of the lower vapor pressure liquid if infiltration is not corrected.

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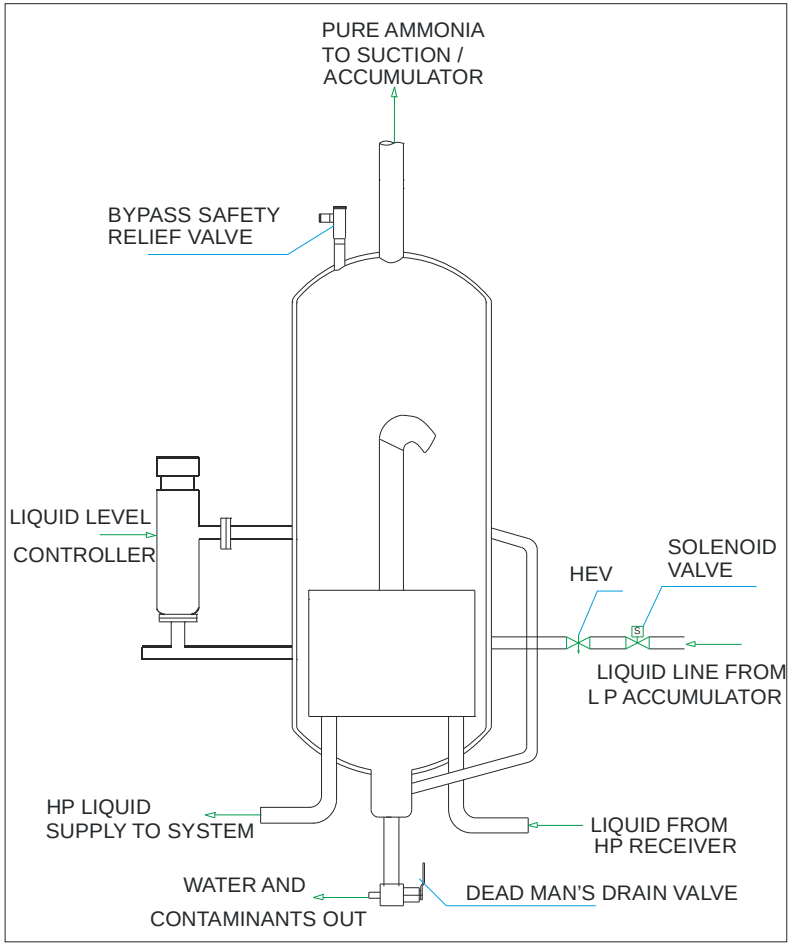
Ammonia Regenerator



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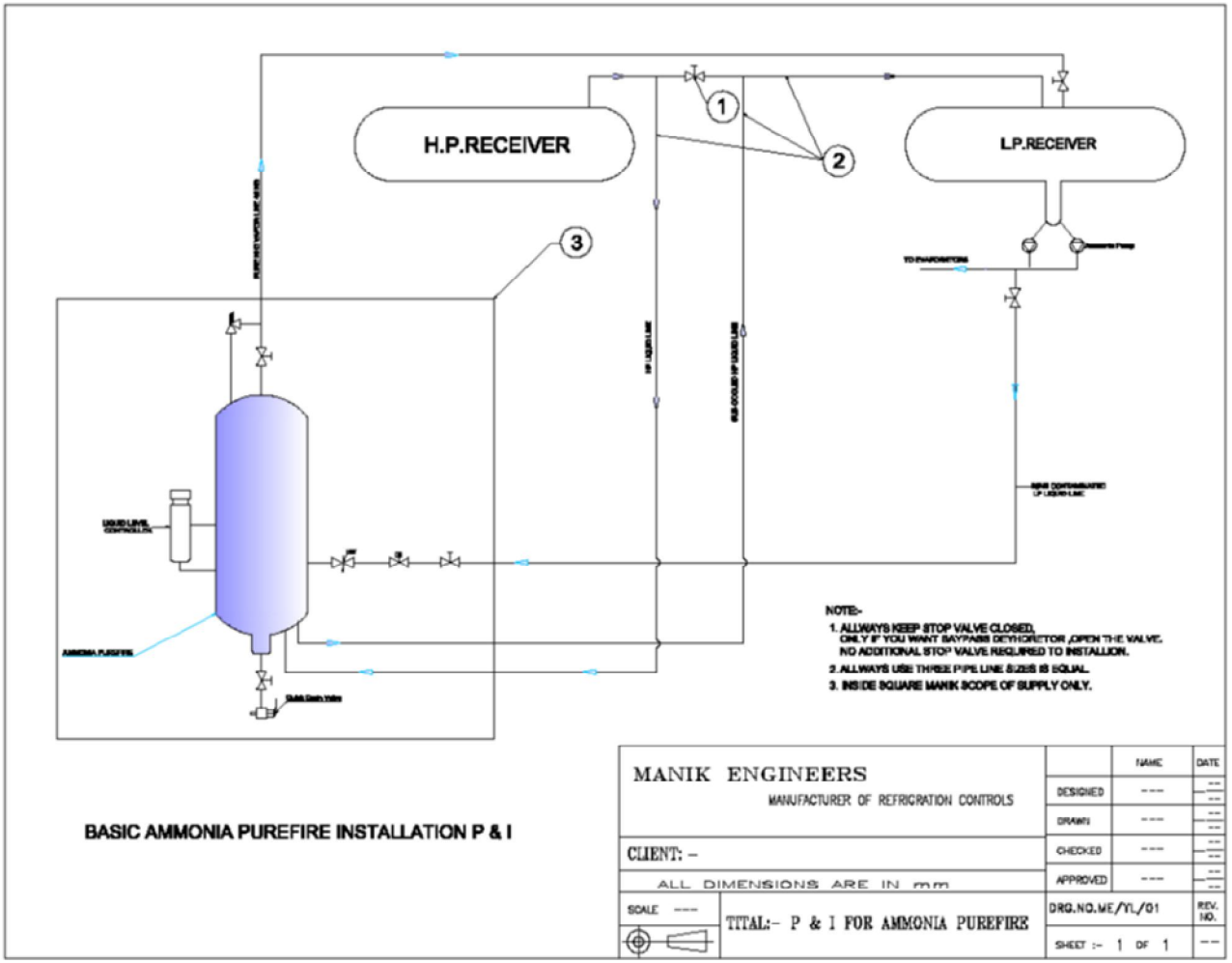

Ammonia Regenerator

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Thank You

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