Association of AMMONIA REFRIGERATION

Automation for Plant Safety

by
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Definition of Automation

The use of sensors, actuators, and other equipment to achieve a safe level of performance from a system or subsystem without the aid of human interaction. –

ASHRAE Standard 15-2013

Why Automation ?

Observation

- Practically impossible to load unload, start stop compressor manually depending on load variation.
- Operator frequently throttle valves installed at liquid Header (going to cold room) from plant room to avoid liquid stroke to compressor.
- Manually Difficult, every hour to measure and log each room temperature.
- Manually Difficult to close / open each cold room liquid header isolation valve when room temperature is achieved and to reduce load on compressor.
- Measuring and recording energy

Why Automation ?

Human errors and inefficiency

a. Operating plant at designed conditions

b. Safety

c. Energy efficiency

d. Parameters recording

Why Automation ?


अनंत दूध कंपनीत स्फोट

नऊ कामगार जखमी; शीतगृहाच्या भिंती कोसळल्या

सकाळ 23/04/2012 SAKAL

Association of AMMONIA REFRIGERATION

Why Automation ?


THE TIMES OF INDIA
Nagpur

Safety norms at cold storage breached at every level

Shishir Arya, TNN Feb 4, 2012, 04.22AM IST

NAGPUR: Safety seems to have been the last thing on the mind of the owners of Pravesh Cold Storage in Kalamana. The tottering building which had to undergo repairs a fortnight before the fall was overloaded till the last sack of grains brought it down.

A column in the sides had bent to such an extent that only a week ago the whole structure tilted. With this makeshift repairs were made to support the structure, said sources in the business.

This was also confirmed by a close associate of the cold storage's promoter Pramod Khandelwal, who but blamed the contractor for it. He claimed that the whole structure came up on a refilled lake but the architect did not take suitable measures keeping the strata in mind. The first floor is said to have been buried a few feet below the ground.

According to sources, rampant loading of the warehouse continued, even as certain basic features of building a cold storage were ignored. They expressed surprise over the speed at which the whole building was constructed saying that loading began even as construction continued in one of the floors. It was built like a residential apartment overlooking the thumb rule for making a cold storage, they added.

The six storied building had ceilings made of concrete slab in each floor. Multi-storied cold storages are common but none have concrete slabs. This is because the slabs have the possibility of caving in due to excess weight.

"The floors of the upper storey are rather made of wood planks with strong beams supporting them. So in such case of a fall, only a few planks give in, while the beams hold rest of the load. However, the rubble at the Pravesh Cold Storage shows huge slabs of concrete, which broke bringing the entire structure down," said a fellow businessman.

Strangely, even as other cold storages are used for keeping commodities like fruits and chilli, this one was largely stacked with foodgrains which are much heavier than the former. It is estimated that at least 3,000 sacks of grains would have been there.

Though not prohibited, stacking grains in a cold storage is not common. If at all grains have to be stored, then the lowest storey is used but here almost every floor of the building had sacks of grains. The cold storage is learnt to have been originally built to store fruits. Sources in the grain trade said many of the businessmen used his facility because of cheaper rent.

The city has over 11 cold storages mainly concentrated in same area with owners having formed an association too. However, Khandelwal was not a member and he rather remained aloof from others.

Paras Chandra Goal the association's secretary, who confirmed that Khandelwal was not a member, added that none of the cold storages in the city store grains. These are mainly used for storing much lighter items like chilli. A sack of chilli weights only 40 kgs while grains is 100 kgs, which makes a major difference when it come to load-bearing capacity of a building.

Khandelwal also appears to be having utter disregard of the norms as the cold storage was also not registered under the factory's act which the department confirms to be a wilful default from his side.

Why Automation ?

Which Parameters ? Why ?

Level : Safety & Efficiency

Temperature : Product storage life

Carbon Dioxide CO_2 : Product storage life

Relative Humidity : Weight Loss

Pressure : Efficiency

Various Controls for Refrigeration

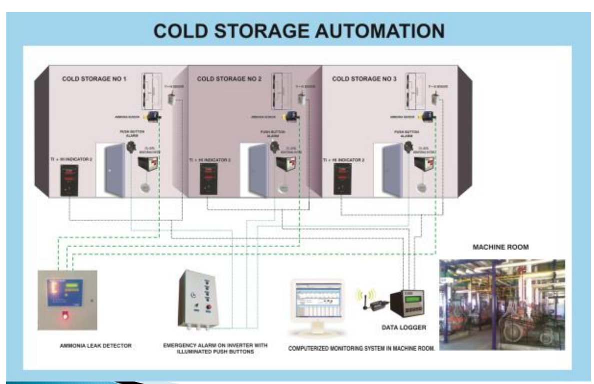
- Liquid Level Controllers, Level Transmitters & Float Switches
- Solenoid Valves, Gas Operated Solenoid Valves Single and Two Stage
- Safety Controls Safety valves, Dual Manifold for Safety Valves, Dead Man's Valve
- Automatic Air Purger, Ammonia Purifier
- In Line components Non Return valves, Strainers,
- Controls Valves Flow Regulating Valves, Over Flow Valves, Pressure & Temperature Regulating Valves, Crank case Pressure Regulators

Various Controls for Refrigeration

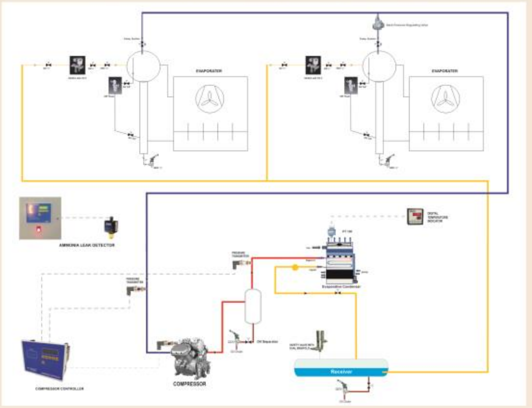
- Compressor Capacity Controllers, PLCs for Piston and Screw Compressors
- Data Loggers, Temperature, Pressure, Humidity and Gas Indicators / Indicating controllers
- Alarm Annunciators, Defrost Controllers, Ice thickness Controllers
- Ammonia Leak Detectors
- Sensors & Transmitter for temperature, pressure, humidity, CO2, ethylene, Oxygen etc.
- Web-base Monitoring & Control Systems
- Mobile Applications to Monitor plant

Standards for Plant Design and Safety

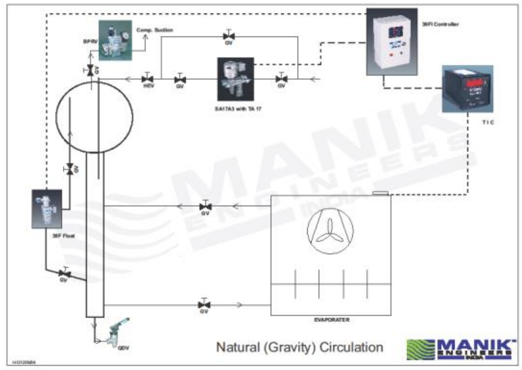
1. ASHRAE Standard 15 -2013
2. IIAR Standard 2A-2008
3. ISO 5149-1993
4. IIAR Standard 3-2012
5. EN/BS 378
6. AAR Standard 1



AMMONIA GRAVITY FIELD SYSTEM

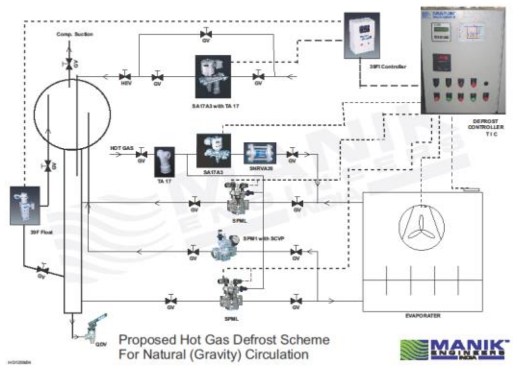


TYPICAL INSTALLATION FLOODED AIR COIL UNIT



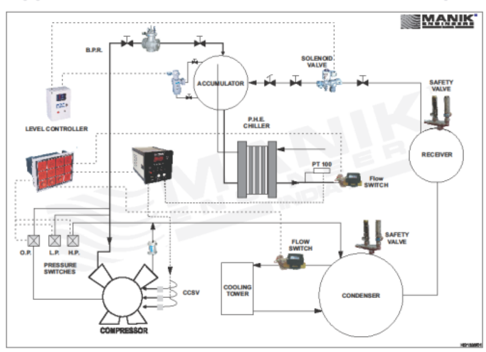
TYPICAL INSTALLATION FLOODED AIR COIL UNIT

Flooded System with Hot Gas Defrost



Flooded System with Hot Gas Defrost

Typical Controls for Flooded PHE System



Advantages of Level Controller + Solenoid Valve Liquid Control System

- Liquid Level Controllers along with Solenoid Valve maintains evaporator flooded
- Prevents Liquid Stroke to the compressor
- Appropriate flooding of evaporator
- Better heat transfer efficiency of the evaporator
- Less wear & tear of compressor
- Running hours of compressor are reduced
- This all generates energy saving
- Bar graph display continuously display the rising & falling of liquid level inside the float chamber

INSTALLATION GUIDE LINES FOR LEVEL CONTROLLER

- The level marks on the ball float show the Maximum and Minimum Level for the Ammonia refrigerant
- The lowest connecting pipe must have an inclination towards the liquid separator to avoid an oil seal forming which would hamper the ball float's movement.
- The shut-off valve/solenoid valve must be mounted as close as possible to the ball float
  - to minimize trapped liquid volume
  - to avoid risk of water hammering
- The amplifier can be fitted at any distance from the ball float housing, no effect of wiring length on performance
- The amplifier housing must be fitted vertically

TYPICAL INSTALLATION FLOODED AIR COIL UNIT PROBLEM ?

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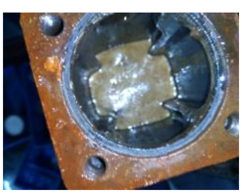
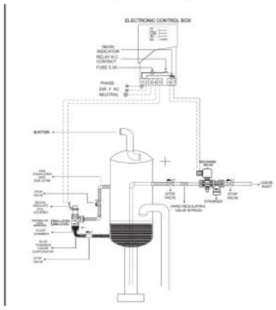


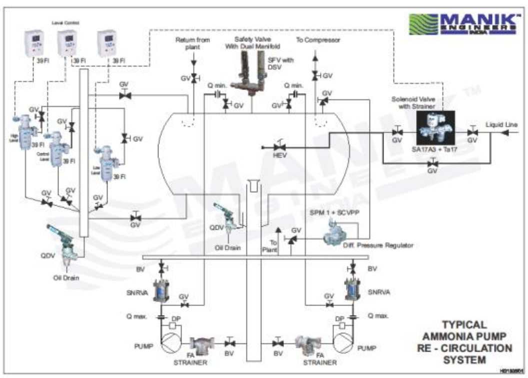
TYPICAL INSTALLATION FLOODED AIR COIL UNIT PROBLEM ?

Flooded PHE System

TYPICAL INSTALLATION FLOODED SYSTEM FLAKE ICE MACHINE

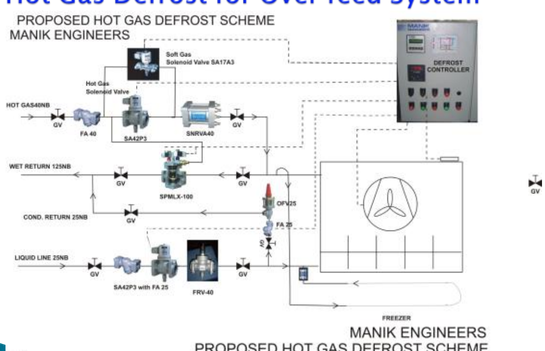


TYPICAL OVER FEED SYSTEM VESSEL

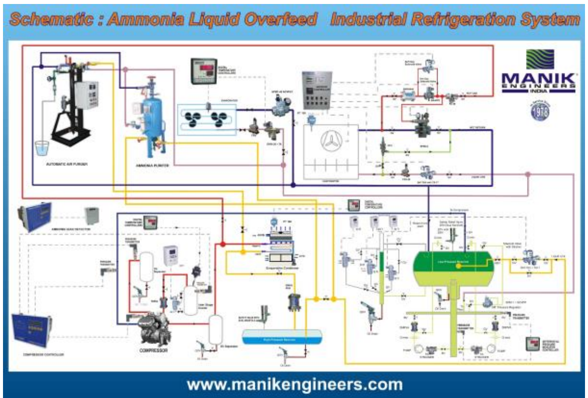


PUMP OVERFEED SYSTEM VESSEL

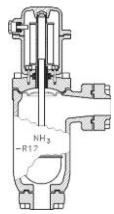
Hot Gas Defrost for Over feed System

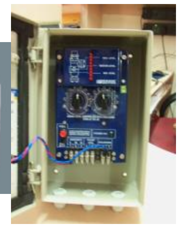


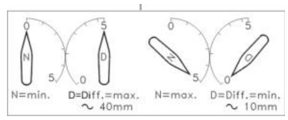
Hot Gas Defrost for Over feed System



Liquid Level Controller







Float Switch

FUNCTION:-

1 Internal float assembly
2 Switch box
3 M4x8pinol tail stock screw
4 Top cover
5 4 pcs.M12x35 stainless steel bolt
6 FKS 39 housing
7 Pressure tube
8 Top cover gasket
9 'O'- ring for pressure tube
10 DIN plug for electrical connection
11 Aluminum gasket
12 Locking ring for internal float
13 Stainless steel bolts
14 Flanges
15 Flanges gaskets

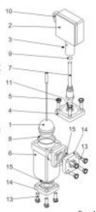
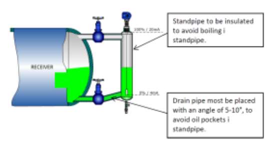


fig. 1

- An electro -mechanical float switch
- Adjustable liquid level differential switch point
- The complete switch box can easily be replaced without any interference with the refrigeration system.

LIQUID LEVEL TRANSMITTERS



Solenoid Valves

Type Solenoid Valves
- Direct Acting
- Pilot Operating
  Piston Type
  Diaphragm Type

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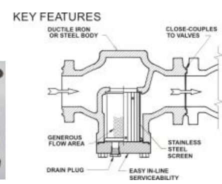
STRAINERS



- Strainer are with interchangeable filter insert
- Suitable for all common nonflammable refrigerants, including R 717
- Pleated filter net of stainless steel with a very large net surface ensures long intervals between cleaning and low-pressure loss.
- Retains contaminants, e.g. slag, and weld beads and swart.
- Pressure drop insignificant.
- Filter insert Stainless steel weave, mesh size

STRAINERS

Selection of Strainer

1. **Line Size by flow Rate**
2. **Mesh Size**

Flow Rate

The kv value is the flow of water in m3/h at a pressure drop in the strainer of 1 bar, p=1000kg/m3.

What is mesh ?

Mesh is the number of threads per inch.
µ[microns] is the distance between two threads (1µ = 1/1000 mm)

LIQUID LINES:

Before pumps: 500µ [38 mesh]
After pumps : 150µ [100 mesh) / 250µ [72 mesh]
Protection of automatic regulation equipment
Generally: 150µ [100 mesh) / 250µ [72 mesh]
Sensitive equipment, e.g.
Suction regulators with low temperature : 250µ[72 mesh]

Suction Lines

Before screw compressor 250µ [72 mesh]
Before piston compressor:150µ [100 mesh]

SAFETY VALVES AND DUAL MANIFOLD

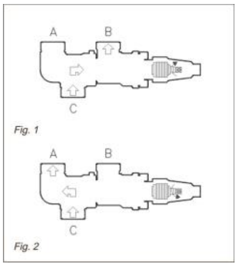
SAFETY VALVES AND DUAL MANIFOLD

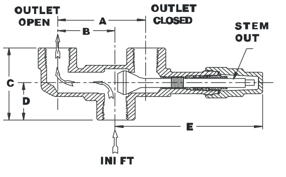
- Single Safety Valve
- Dual Manifold for Safety Valve
- Various Sizes of Safety valves

Single Safety Valve or Dual Manifold ?

- Single Pressure Relief Valve for Vessel of internal gross volume more than 3 cu. ft or less than 10 cu. Ft
- Dual Manifold for all pressure vessels with internal gross volume more than 10 cu. Ft.

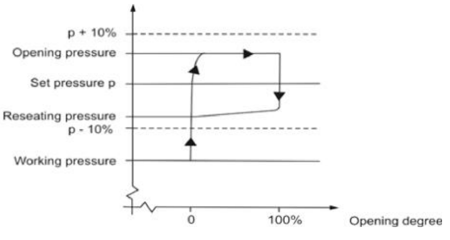
THREE WAY VALVE / DUAL MANIFOLD





MANIK ENGINEERS INDIA

SAFETY VALVE RELIEF SETTING



SIZING OF SAFETY VALVE

The minimum required rated discharge capacity for a vessel shall be:

C = F x D x L

C = Discharge capacity of the relief device
D = Outside diameter of the vessel
L = Outside length of the vessel

Refrigerant	Value of F
R-717	0.5 [0.041]
R-22, R-134a,R-401A, R-407c	1.6 [0.131]
R-404a, R-410a, R-502, R-507a	2.5 [0.203]

See Table 2/ASHRAE 15.
When combustible materials are used within 20 ft (6.1m) of a pressure vessel, multiply the value of F by 2.5.

SIZING OF SAFETY VALVE

Ammonia Pressure Vessel	IP	SI
General	C = 0.5DL	C = 0.04DL
If combustible materials are used within 20 ft (6.1 m)	C = 1.25DL	C = 0.1DL
For plate heat exchanger or double-pipe condenser	C = 0.5(A/2)	C = 0.04(A/2)

where
C = required discharge capacity , lb(air)/min [kg/s]
D = OD of vessel, ft [m]
L = length of vessel, ft [m]
A = Overall external surface, ft2 [m2]

SIZING EXAMPLE

1. Select a relief valve for an ammonia vessel 6 feet diameter by 16 feet long.

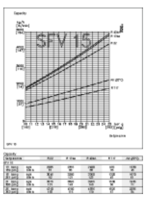
C = f D L = 0.5 x 6 x 16 = 48 lb-air/min

2. Select the desired pressure setting of 225 psig.

3. Refer to the capacity table / Use Discharge Capacity Graph Provided by Manufacturer.

4. select model.

SIZING OF SAFETY VALVE



PRESSURE-RELIEF VALVE CAPACITY RATINGS

Cat. No.	Air Capacity	Standard Pressure Settings (psig)									
		150	175	200	225	250	275	300	325	350	400
SH5600R	lb/min.	10.6	6.12	13.9	15.6	17.2	18.9	20.5	22.1	23.8	27.1
SH5602R	scfm	141	166	185	207	229	251	273	294	317	360
SH5600A	lb/min.	31.3	36.1	40.9	45.7	50.5	55.3	60.1	64.9	69.7	74.5
	scfm	417	480	544	608	672	736	799	863	927	992
SH5601	lb/min.	35.8	41.3	46.8	52.2	57.7	63.2	68.6	74.1	79.6	
SH5602	scfm	476	549	622	695	768	841	913	986	1059	

SAFETY VALVES AND DUAL MANIFOLD

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SAFETY VALVES AND DUAL MANIFOLD

Stop valve Below
Safety Valve
Not Recommended

SAFETY VALVES AND DUAL MANIFOLD

SAFETY VALVES AND DUAL MANIFOLD

AMMONIA LEAK DETECTOR & ALARM

- Detects Leakage of Ammonia from 30 PPM
- Multi Level Alarm
- Single and Multi Channel Detection Unit
- 16 X 2 Line LCD display shows continuous ammonia level
- Inbuilt Hooter, And Relay to Operate Ventilation System
- Easy to Install
- Three Core Cable connection for Sensor
- Area Covered by one sensor is @ 2000 Sq. ft.

AMMONIA LEAK DETECTOR & ALARM

Limits of Toxicity of Ammonia

Minimum Detectable Concentration	10 ppmv
TWA Value	30 ppmv
Serious Irritation Level	250 ppmv
Limit to Tolerable Breathing	500 ppmv

AMMONIA LEAK DETECTOR & ALARM

Ammonia Leak Detector Setting		
Alarm	Setting PPM	
	Manned Area	Unmanned Area
First	50	30
Second	150	70
Third	250	100

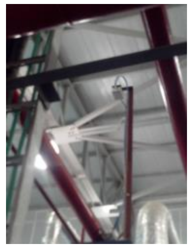
AMMONIA LEAK DETECTOR & ALARM

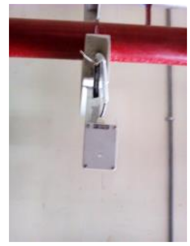
Location of Ammonia Sensors

- The Gas Detectors must be installed at High Level
- At least 1 detector at ceiling level on a grid of 10m to 20m intervals
- Above or to both sides of compressors
- Above Pressure vessels like H P / LP receivers
- Emergency power supply, e.g. battery or UPS for the detection system

AMMONIA LEAK DETECTOR & ALARM

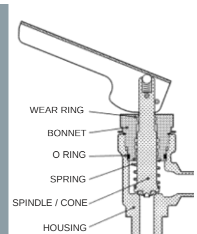
AMMONIA LEAK DETECTOR & ALARM

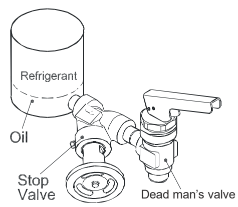




AMMONIA LEAK DETECTOR & ALARM: PROBLEM

DEAD MAN'S VALVE





DEAD MAN'S VALVE

AIR PURGERS

AMMONIA PURIFIERS

Two Elements which affect performance of refrigeration plant

Water

Non-condensables gases

Common Non-condensables
Air
Nitrogen
Hydrogen
Hydrocarbons

Example

Anhydrous Ammonia Gas will change phase from gas to liquid if heat is removed at temperature 35°C and pressure 13.5 kg/cm^2

At same pressure any Nitrogen present would have be cooled to -164°C to liquefy.

Hence any nitrogen present in always remain in gaseous state

VARIOUS WAYS IN WHICH NON-CONDENSABLES ENTER THE SYSTEM:

1. The refrigerant, when delivered, may contain non-condensable gases upto 15%.
2. Inadequate evacuation before commissioning the refrigeration plant
3. For service and maintenance certain parts of the refrigeration plant are frequently opened, causing air to penetrate into the system.
4. Oil changing and recharging with refrigerant have the same effect.

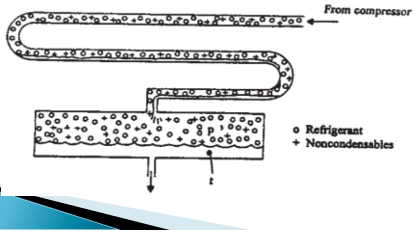
VARIOUS WAYS IN WHICH NON-CONDENSABLES ENTER THE SYSTEM:

5. Leakage: Systems operating with suction pressure below atmospheric pressure (i.e., working temperatures below -33°C for ammonia system) can have small leaks (from system piping, valves, vessels valve stem packing, bonnet gaskets, compressor shaft seals, non-welded connections, and control transducers etc.) allowing air to penetrate into the system.
6. Decomposition of the refrigerant or the lubricating oil can occur due to catalytic action of the various metals in the installation and due to high discharge temperatures. Ammonia for instance decomposes into Nitrogen and Hydrogen.

Air and other non-condensables

$$P_{actual} = P_{refrigerant} + P_{noncond}$$

When to Purge ?
If $P > P_t$
Where,
P is actual Pressure in receiver
P_t is saturation pressure corresponding to temperature t



The presence of non-condensable gases

- Increases electrical power demand
- Decreases Refrigeration system capacity
- Decreases system efficiency
- Excess head pressure puts more strain on bearing and drive motors. Belt life is shortened and gasket seals are ruptured.

The presence of non-condensable gases

- Increased pressure leads to increased temperature, which shortens the life of compressor valves and promotes the breakdown of lubricating oil.
- Increases condenser scaling which increases maintenance cost and reduces life of condenser
- Increase in discharge temperature leads to "Ammonia explosions" and it breaks down into Nitrogen and Hydrogen. Which means further addition to non-condensable gases.

AIR VS. POWER LOSS

% of Air by weight	0.5	1.0	2.0	4.0
Air Pressure in PSI	0.7	1.3	2.7	5.5
Power %	0.6	1.2	2.5	5

for -15°C Evaporating and 30°C Condensing Ref. IIAR Paper TP-22

Calculation of increased power cost

Plan Condition :
Evaporation Pressure for -40°C,
Condensing Pressure for 38°C, 13.7 kg/cm^2
Refrigeration Capacity 500kW
Power required by compressor 281kW*
If our actual pressure is 0.5 Kg/cm^2 higher i.e. 14.2 kg/cm^2
Then power required would be 285kW
The 4 kW per hour for 6000 hours of operation is 24000kW
If Electricity Cost is Rs. 8/- per kW
The total increase in electricity bill is **Rs. 1,92,000/-**

The Three Types of Purging

1. Direct venting of the air-refrigerant mixture
2. Compression of the mixture, condensing as much as possible of the refrigerant, and venting the vapor mixture that is now rich in noncondensables
3. Condensation of refrigerant using a small evaporator, followed by venting of the air-refrigerant mixture this is now rich in noncondensables

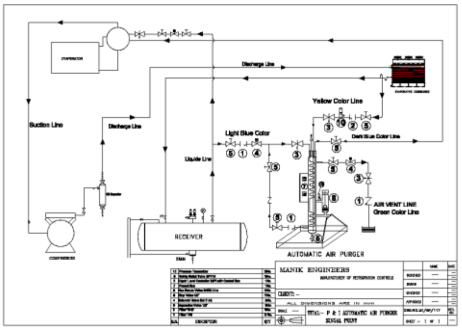
Advantages and Disadvantages of Automatic Air Purger

Advantages	Disadvantages
Safety: Automatic Purgers eliminate the need for refrigeration staff to manually "open the system" on frequent basis	**Capital cost:** The cost is high because of purger unit, piping, solenoid valves and other controls
Effectiveness: A properly installed and operated multipoint purger can continually function to scavenge and remove NCG from System	**Maintenance Cost:** For the purger unit, accompanying solenoid valves and transducers required for purge control
Labour: Eliminates the labour associated with personnel regularly removing NCG by manual operation	

Automatic Purger

- Fully automatic gas purger for refrigeration plants
- Maintains condensing temperature at nearly optimum operating conditions
- Reduces the concentration of non-condensable gases to a negligible Percentage
- No need separate refrigeration system

Automatic Purger



Where to Purge air ?

- Purge point connections must be at places where air will collect.
- Refrigerant gas enters a condenser at high velocity. By the time the gas reaches the far (and cool) end of the condenser, its velocity is practically zero.
- This is where the air accumulates and where the purge point connection should be made.
- Similarly, the purge point connection at the receiver should be made at a point furthest from the liquid inlet.

Purge Points

Evaporative Condenser

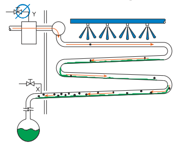


Fig. 1.(left) High velocity of entering refrigerant gas prevents any significant air accumulation upstream from point X. High velocity past point X is impossible because receiver pressure is substantially the same as pressure at point X. **Purge from point X.** Do not try to purge from point Y at the top of the oil separator because no air can accumulate here when the compressor is running.

Purge Connection for Receiver

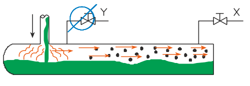


Fig. 5. Purge from Point X farthest away from liquid inlet. "Cloud" of pure gas at inlet will keep air away from point Y.

Water Contamination and Removal in Ammonia Refrigeration Systems

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

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.

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

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.

Water Contamination and Removal in Ammonia Refrigeration Systems

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.

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

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

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.

Areas Of Highest Water Content

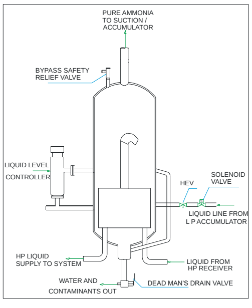
- Recirculation Sysetms :Pump receiver (LPR)
- Flooded systems: evaporator and surge drum.
- DX systems suction accumulator.
- Two-stage systems vessels and evaporators of the low stage portion of the system.

Areas Of Highest Water Content

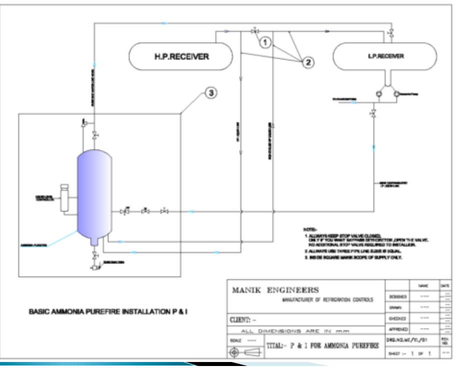
Reasons :

- 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.

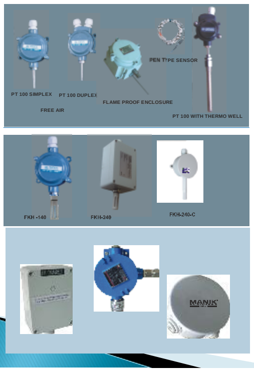
Ammonia Purifier



Ammonia Purifier



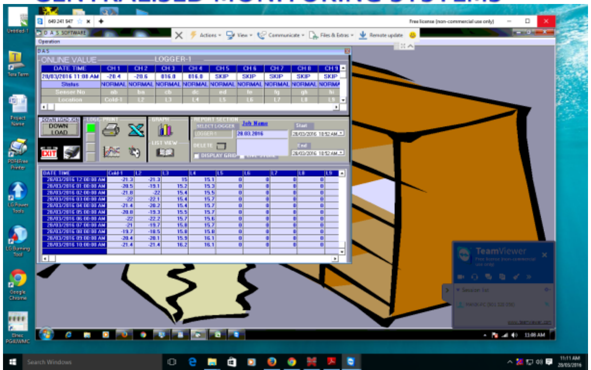
Sensor & Transmitters for Temperature, Humidity, Pressure, Ethaline, CO_2 & O_2



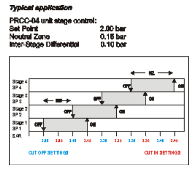
Temperature, Humidity Indicators & Controllers

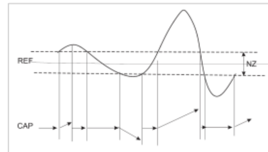


CENTRALISED MONITORING SYSTEMS



COMPRESSOR CONTROLLERS





COMPRESSOR CONTROLLERS

MANIK ENGINEERS INDIA

COLD ROOM ALARM

- The COLD ROOM ALARM kit allows a person trapped in inside the cold room to activate an acoustic-luminous alarm installed outside the room and so call for help.
- The system will work even in the event of a temporary power cut thanks to the buffer battery on the external unit.
- The Cold Room Alarm Unit is available in 3 different models 4, 8 or 16 Input.
- The 4 input unit can be used for 4 cold rooms.

CALIBRATION OF EQUIPMENTS

What is Calibration ?

Calibration is a comparison between measurements – one of known magnitude or correctness made or set with one device and another measurement made in as similar a way as possible with a second device. The device with the known or assigned correctness is called the standard. The second device is the unit under test, test instrument, or any of several other names for the device being calibrated.

What is Traceability ?
The term "measurement traceability" is used to refer to an unbroken chain of comparisons relating an instrument's measurements to a known standard. Calibration to a traceable standard can be used to determine an instrument's bias, precision, and accuracy.

CALIBRATION OF EQUIPMENTS

Why Calibrate ?

CALIBRATION OF EQUIPMENTS

Calibration Frequency

1.	**Temperature Gauges**	**1 Year**
2.	**Pressure gauges**	**6 Months**
3.	**Temperature Indicator**	**1 Year**
4.	**Humidity Indicators**	**1 Year**
5.	**Datalogger**	**1 Year**
6.	**Pressure Cut Outs**	**6 Months**
7.	**Safety Relief Valves**	**1 Year**

Thank You