Ammonia Refrigeration Plant Piping practices

By

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P – H DIAGRAM ALLOWS YOU TO "SEE THE INVISIBLE"

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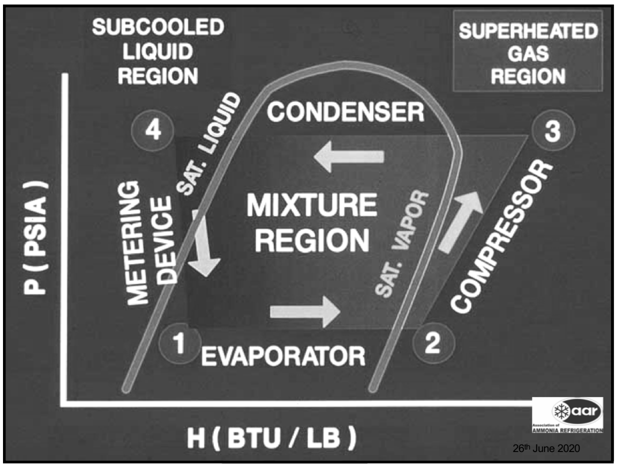

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1. Ammonia systems are generally field erected, where location of major equipment is scattered, hence correct piping -interconnecting these items assumes great importance.
2. For oil return, systems using Ammonia and other immiscible refrigerants reply on gravity rather than velocity
3. Generous sizing therefore saves operating cost for such systems

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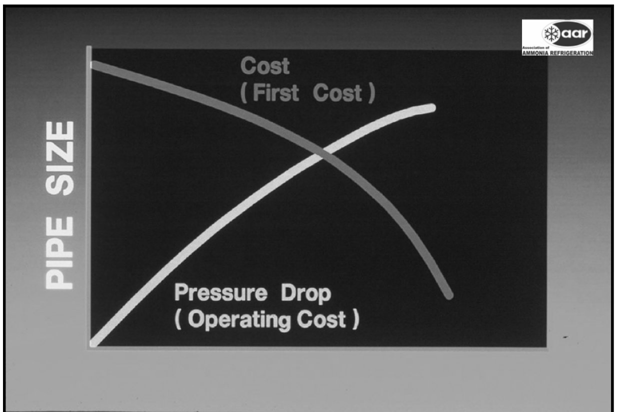

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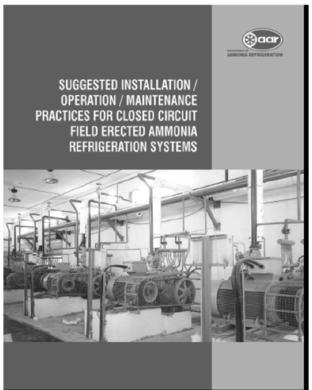

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CAN YOU IDENTIFY ?

GENERAL GUIDE LINES

1. Keep Piping arrangement as simple as possible
2. Minimize number of joints
3. Prevent back flow of refrigerant in off cycle
4. Provide adequate and proper insulation to avoid condensation and rusting of pipes
5. Provide adequate supports
6. Provide for expansion/contraction and vibrations in the piping by providing loops
7. Provide safety, drain, purge and instrument connections where ever possible

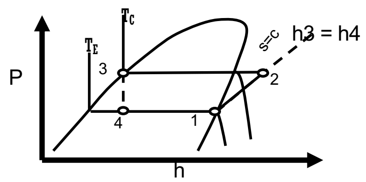
Refrigerant Piping Sizing Priorities In Descending Order

1. Suction Line sizing is most important
2. Ammonia Pump inlet Line from L.P. vessel
3. Wet Return Line to and from LP vessel
4. High pressure liquid line
5. Condenser to Receiver Liquid line
6. High Pressure Discharge line

SELECTING PIPE SIZES FROM BASICS

VAPOUR COMPRESSION CYCLE

P-H DIAGRAM



MASS FLOW & PIPE SIZE CALCULATIONS

Basic Data-Assumed Arbitrarily

1. Capacity-100 kW(28.43 TR)
2. Condensing Temperature: $+40^0C$
3. Evaporating Temperature: $+5^0C$
4. No superheat or sub-cooling: 0^0C

Calculation for Pipe Diameter Selection:

1. From Ammonia Table properties: vapour enthalpy at compressor suction h_1= 1467.385 kJ/kg
2. Liquid Enthalpy at h_3=h_4=390.64 kJ/kg
3. Refrigerating Effect: h_1-h_3=1467.385-390.64=1076.745 kJ/kg
4. For 100 kW mass flow : 100/1076.745= 0.09287 kg/s
5. Specific volume of gas at point 1: 0.24321 m^3/kg
6. Volume flow rate required at compressor suction: 0.09287x0.24321=0.022586m^3/s=81.31m^3/hr.
7. Assuming suction line velocity as 12m/s, the pipe cross sectional area would be 0.001882m^2 or 1882 mm^2
8. Diameter of pipe would be:√1882 =43.38mm
9. Select nearest size available as 50 NB

Recommended Velocities For Line Sizing

	From 25mm	To 300 mm
Compressor Suction Line	15m/s	18m/s
Wet Return To L.P. Vessel	12m/s	15m/s
Ammonia Pump Suction Line	0.3m/s	0.5m/s
Ammonia Pump Discharge Line	1.0 m/s	1.0m/s
Condenser to Receiver Line	0.3m/s	0.5m/s
Liquid Feed from main receiver	1m/s	1.5m/s
Compressor Discharge Line	18m/s	20m/s

AS diameter increases, ratio of cross section area to circumference increase and one can have higher velocity

PIPE SIZING –ASHRAE TABLE 2.10

Table 2 Suction, Discharge Line, and Liquid Capacities in Kilowatts for Ammonia (Single- or High-Stage Applications)

Steel Nominal Line Size, mm	Suction Lines (Δt = 0.02 K/m) Saturated Suction Temperature, °C: –40, Δp = 76.9	–30, Δp = 116.3	–20, Δp = 168.8	–5, Δp = 276.6	+5, Δp = 370.5	Discharge Lines Δt = 0.02 K/m, Δp = 684.0 Pa/m, Saturated Suction Temp., °C: –40	–20	+5	Steel Nominal Line Size, mm	Liquid Lines: Velocity = 0.5 m/s	Δp = 450.0
10	0.8	1.2	1.9	3.5	4.9	8.0	8.3	8.5	10	3.9	63.8
15	1.4	2.3	3.6	6.5	9.1	14.9	15.3	15.7	15	63.2	118.4
20	3.0	4.9	7.7	13.7	19.3	31.4	32.3	33.2	20	110.9	250.2
25	5.8	9.4	14.6	25.9	36.4	59.4	61.0	62.6	25	179.4	473.4
32	12.1	19.6	30.2	53.7	75.4	122.7	126.0	129.4	32	311.0	978.0
40	18.2	29.5	45.5	80.6	113.3	184.4	189.4	194.5	40	423.4	1469.4
50	35.4	57.2	88.1	155.7	218.6	355.2	364.9	374.7	50	697.8	2840.5
65	56.7	91.6	140.6	248.6	348.9	565.9	581.4	597.0	65	994.8	4524.8
80	101.0	162.4	249.0	439.8	616.9	1001.9	1029.3	1056.9	80	1536.3	8008.8
100	206.9	332.6	509.2	897.8	1258.6	2042.2	2098.2	2154.3	—	—	—
125	375.2	601.8	902.6	1622.0	2271.4	3682.1	3783.0	3884.2	—	—	—
150	608.7	975.6	1491.4	2625.4	3672.5	5954.2	6117.4	6281.0	—	—	—
200	1252.3	2003.3	3056.0	5382.5	7530.4	12 195.3	12 529.7	12 864.8	—	—	—
250	2271.0	3625.9	5539.9	9733.7	13619.6	22 028.2	22 632.2	23 237.5	—	—	—
300	3640.5	5813.5	8873.4	15568.9	21787.1	35 239.7	36 206.0	37 174.3	—	—	—

SUCTION LINE SELECTION MEDIUM & HIGH TEMPERATURE

Steel Nominal Line Size, mm	Saturated Suction Temperature, °C: –20, Δt = 0.005 K/m, Δp = 42.2 Pa/m	–20, Δt = 0.01 K/m, Δp = 84.4 Pa/m	–5, Δt = 0.005 K/m, Δp = 69.2 Pa/m	–5, Δt = 0.01 K/m, Δp = 138.3 Pa/m	+5, Δt = 0.005 K/m, Δp = 92.6 Pa/m	+5, Δt = 0.01 K/m, Δp = 185.3 Pa/m
10	0.91	1.33	1.66	2.41	2.37	3.42
15	1.72	2.50	3.11	4.50	4.42	6.37
20	3.66	5.31	6.61	9.53	9.38	13.46
25	6.98	10.10	12.58	18.09	17.79	25.48
32	14.58	21.04	26.17	37.56	36.94	52.86
40	21.99	31.73	39.40	56.39	55.53	79.38
50	42.72	61.51	76.29	109.28	107.61	153.66
65	68.42	98.23	122.06	174.30	171.62	245.00
80	121.52	174.28	216.15	308.91	304.12	433.79
100	249.45	356.87	442.76	631.24	621.94	885.81
125	452.08	646.25	800.19	1139.74	1124.47	1598.31
150	733.59	1046.77	1296.07	1846.63	1819.59	2590.21
200	1506.11	2149.60	2662.02	3784.58	3735.65	5303.12
250	2731.90	3895.57	4818.22	6851.91	6759.98	9589.56
300	4378.87	6237.23	7714.93	10973.55	10 810.65	15 360.20

Note: Capacities are in kilowatts of refrigeration resulting in a line friction loss per unit equivalent pipe length (Δp in Pa/m), with corresponding change in saturation temperature per unit length (Δt in K/m).

SUCTION LINE SELECTION –LOW TEMPERATURE

Table 1 Suction Line Capacities in Kilowatts for Ammonia with Pressure Drops of 0.005 and 0.01 K/m Equivalent

Steel Nominal Line Size, mm	Saturated Suction Temperature, °C: –50, Δt = 0.005 K/m, Δp = 12.1 Pa/m	–50, Δt = 0.01 K/m, Δp = 24.2 Pa/m	–40, Δt = 0.005 K/m, Δp = 19.2 Pa/m	–40, Δt = 0.01 K/m, Δp = 38.4 Pa/m	–30, Δt = 0.005 K/m, Δp = 29.1 Pa/m	–30, Δt = 0.01 K/m, Δp = 58.2 Pa/m
10	0.19	0.29	0.35	0.51	0.58	0.85
15	0.37	0.55	0.65	0.97	1.09	1.60
20	0.80	1.18	1.41	2.08	2.34	3.41
25	1.55	2.28	2.72	3.97	4.48	6.51
32	3.27	4.80	5.71	8.32	9.36	13.58
40	4.97	7.27	8.64	12.57	14.15	20.49
50	9.74	14.22	16.89	24.50	27.57	39.82
65	15.67	22.83	27.13	39.27	44.17	63.77
80	28.08	40.81	48.36	69.99	78.68	113.30
100	57.95	84.10	99.50	143.84	161.77	232.26
125	105.71	153.05	181.16	261.22	293.12	420.83
150	172.28	248.91	294.74	424.51	476.47	683.18
200	356.67	514.55	609.20	874.62	981.85	1402.03
250	649.99	937.58	1107.64	1589.51	1782.31	2545.46
300	1045.27	1504.96	1777.96	2550.49	2859.98	4081.54

LIQUID LINE SELECTION-PUMP CIRCULATION SYSTEMS

Table 3 Liquid Ammonia Line Capacities in Kilowatts

Nominal Size, mm	Pumped Liquid Overfeed Ratio 3:1	4:1	5:1	High-Pressure Liquid at 21 kPa[a]	Hot-Gas Defrost[a]	Equalizer High Side[b]	Thermosiphon Lubricant Cooling Lines Gravity Flow[c] Supply	Return	Vent
40	513	387	308	1544	106	791	59	35	60
50	1175	879	703	3573	176	1055	138	88	106
65	1875	1407	1125	5683	324	1759	249	155	187
80	2700	2026	1620	10 150	570	3517	385	255	323
100	4800	3600	2880	—	1154	7034	663	413	586
125	—	—	—	—	2089	—	1041	649	1062
150	—	—	—	—	3411	—	1504	938	1869
200	—	—	—	—	—	—	2600	1622	3400

Source: Wile (1977).
Rating for hot-gas branch lines under 30 m with minimum inlet pressure of 724 kPa (gage), defrost pressure of 483 kPa (gage), and –29°C evaporators designed for a 5.6 K temperature differential

[b]Line sizes based on experience using total system evaporator kilowatts.
[c]From Frick Co. (1995). Values for line sizes above 100 mm are extrapolated.

WET RETUN LINE SIZING

Temperature-0C	Liquid volume m3/kg	Liqui d volume with 5:1 ratio- m3/kg	Vapour volue- m3/kg	Ratio
-40	0.00145	0.0072	1.55	215
-20	0.00194	0.0097	1.504	155

ASHRAE Recommends wet return line size, one size higher than normal suction line selection. From above table it is obvious that the volume occupied by liquid even with 5:1 circulation rate, is very small in comparison with volume occupied by vapours, and hence selection of one size higher is more than adequate.

1. Wet Return sizing--One Size larger than calculated Suction Line or velocity reduced by √1/(circulation rate). It means ½ the velocity selected for dry suction
2. Gas Line Velocity is higher than Liquid line velocities since Density of liquid is higher hence more friction and thus more pressure drop in liquid lines hence velocity in liquid lines is low
3. Smaller Diameters have low velocity, larger diameters have higher velocity

COMPRESSOR PIPING SUGGESTIONS

Compressor Discharge Piping with header

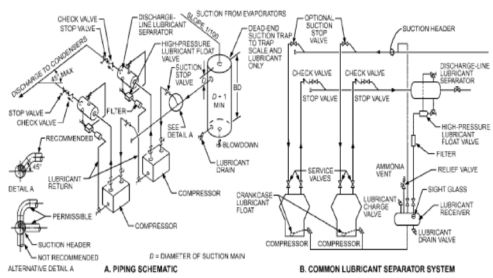
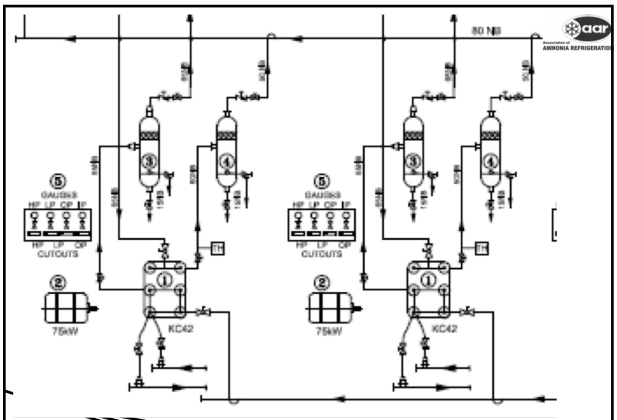


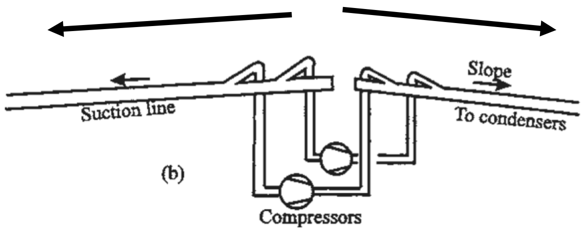
Fig. 1 Schematic of Reciprocating Compressors Operating in Parallel



IMPORTANT POINTS TO NOTE:

1. The NRV should be after oil separator and not between compressor and oil separator
2. Depending on NRV design, keep NRV in horizontal line
3. Provide stop valve after NRV before joining header
4. Provide independent oil separator for each compressor
5. Oil separator oil drain should be above oil return level of compressor
6. Connect individual discharge and suction pipe to the header from top with a loop like gent's umbrella handle or at 45 Degree inclination towards flow direction
7. Compressor suction and discharge pipes well aligned to compressor connections to avoid vibrations. Do not apply force to pull pipe and then do bolting in flanges of the compressor

COMPRESSOR SUCTION/DISCHARGE PIPING



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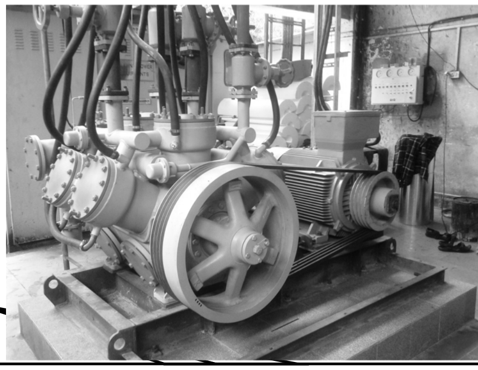
COMPRESSOR-MOTOR COMMON FRAME



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VIBRATION FREE OPERATION

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EVAPORATIVE CONDENSER PIPING

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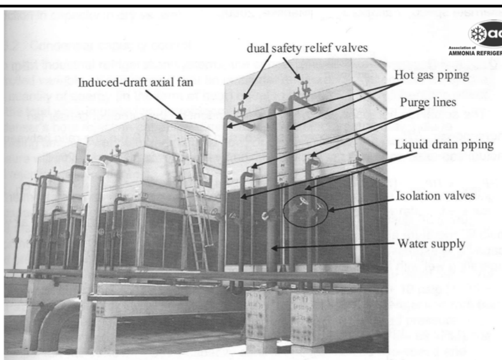

Figure 2-29: Field installation of an induced-draft evaporative condenser.

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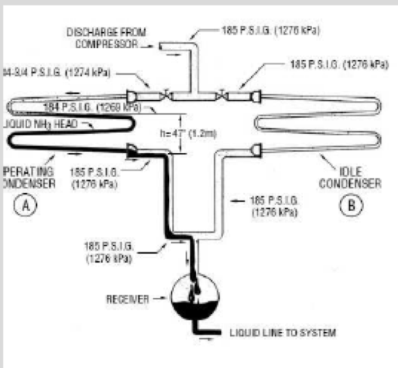
Evap. Cond.-Incorrect Piping Arrangement



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Correct Piping with Gas Equalizer pipe

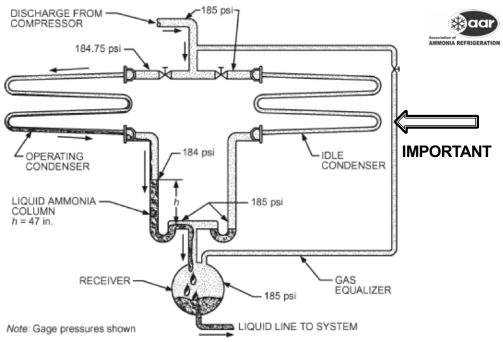

Fig. 31 Two Evaporative Condensers with Trapped Piping to Receiver

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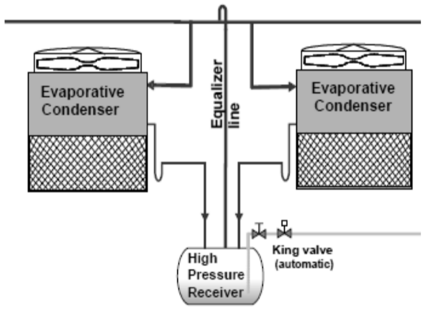

Evaporative Condenser Piping with Top inlet Receiver

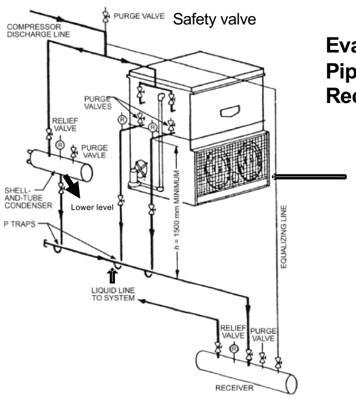

Fig. 33 Piping for Shell-and-Tube and Evaporative Condensers with Top Inlet Receiver

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Piping for Parallel running of two evaporative condensers

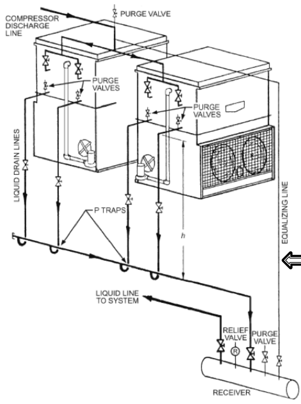

Fig. 35 Piping for Parallel Condensers with Top Inlet Receiver

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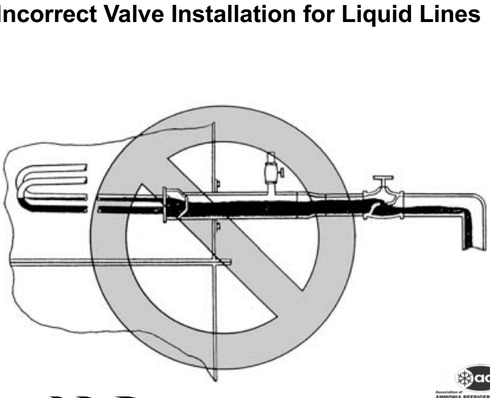
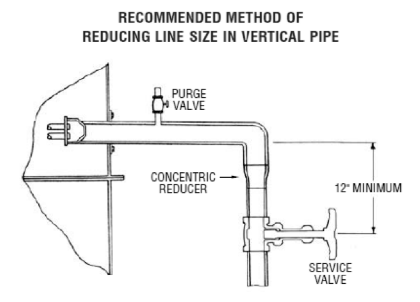
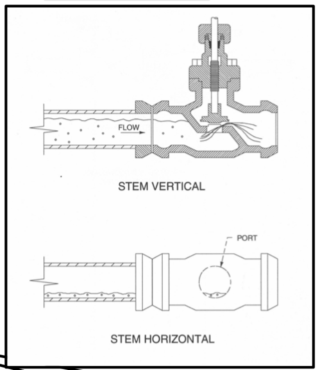
Incorrect Valve Installation for Liquid Lines





Liquid hold-up valve position if vertical stem-Hence Always install with horizontal stem



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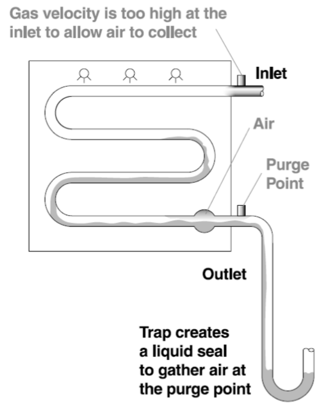
Evaporative Condenser Purge Piping



Purge point location for an evaporative condenser.

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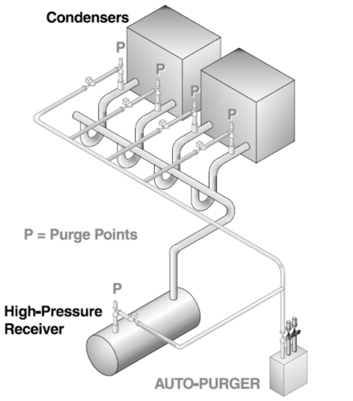
Multiple Condenser Purge Piping



Multipoint purging.

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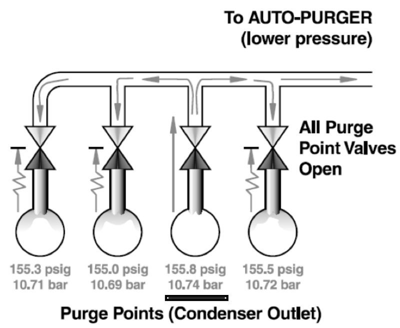
Multiple Condensers –Purge one at a time



When multiple purge points are open simultaneously, air is purged from only the point with the highest pressure.

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RECEIVER PIPING

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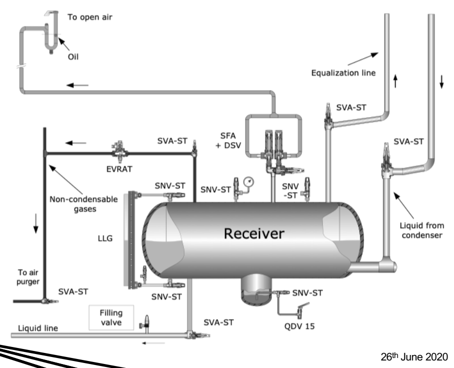
Receiver system - Piping



Condenser system

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RECEIVER SPRAY HEADER

Water Sprinkler on Ammonia Receiver

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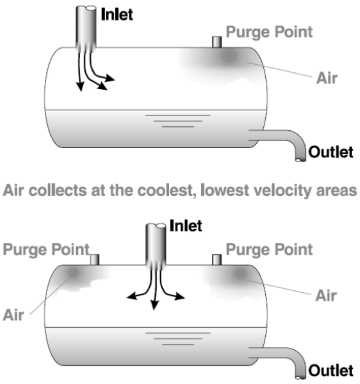
Receiver Purge Points



Purge point locations for horizontal receivers.

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L.P.VESSEL PIPING

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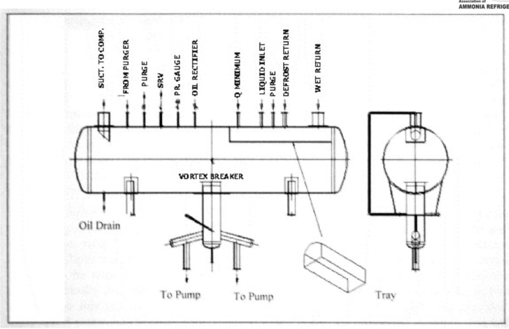

Low Pressure vessel details

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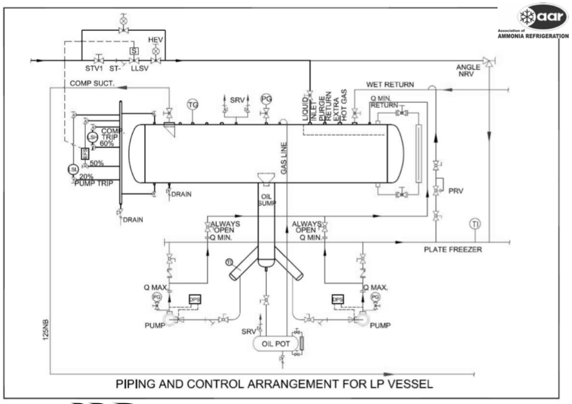

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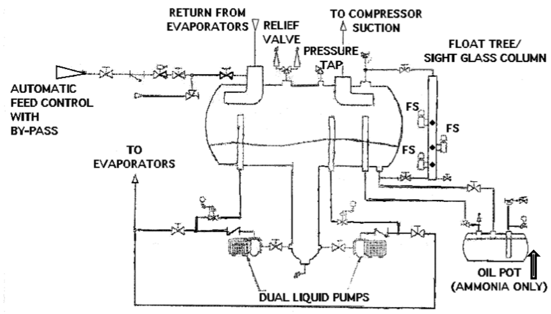
Ammonia Pump circulation Arrangement



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Automatic Liquid Flow Regulating Valve

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WHY FLOW REGULATING VALVE & NOT HAND EXPANSION VALVE?

Flow regulating valve once set for particular ratio-say 5:1 will always ensure this proportion is maintained irrespective of load.

The hand expansion valve , works in opposite direction, in the sense, when load is less , the suction pressure drops whereas liquid line pressure is same, hence pressure drop across the hand expansion valve increases and flow increases, whereas in reality we require less flow because of low load,

The FRV maintains constant flow, once adjusted, irrespective of fluctuations in suction pressure on account of load fluctuations

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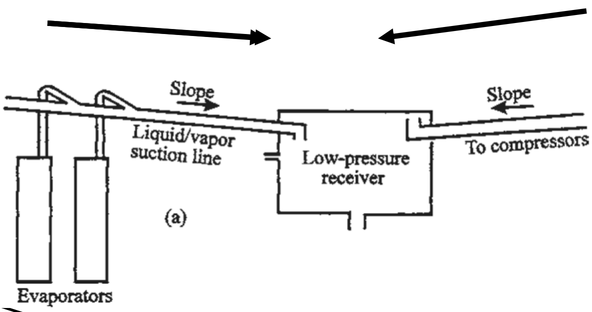
L.P. VESSEL PIPING ARRANGEMENT



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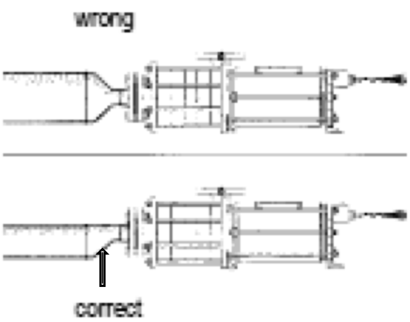
REDUCER AT AMMONIA PUMP INLET



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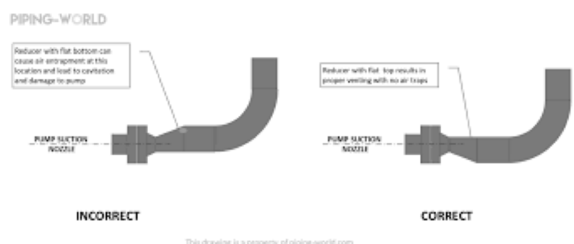

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AIR COOLER PIPING

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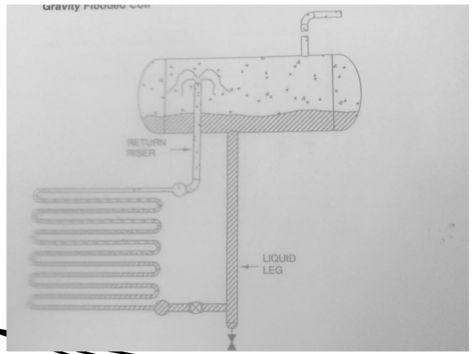
Coil Full of Liquid-Accumulator level above top of coil



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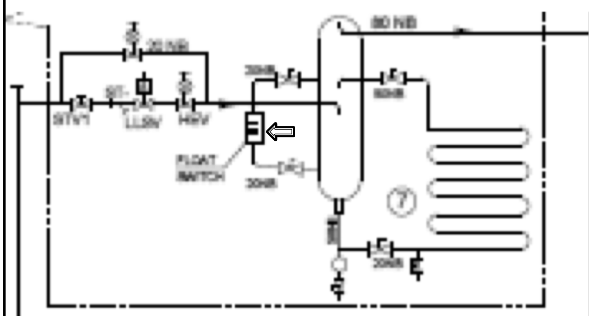
GRAVITY FEED AIR COOLER WITH ACCUMULATOR PIPING



FLOAT LEVEL TO ENSURE TOP ROW IS FULLY IMMERSED IN LIQUID AMMONIA

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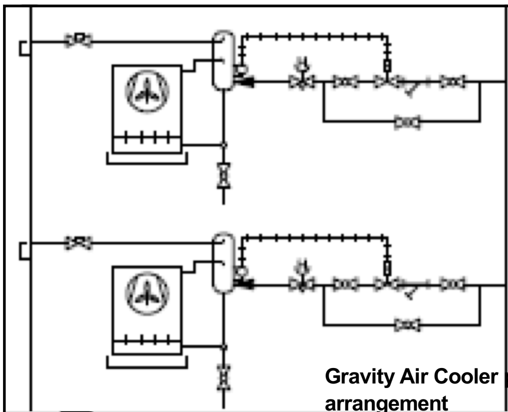

Gravity Air Cooler piping arrangement

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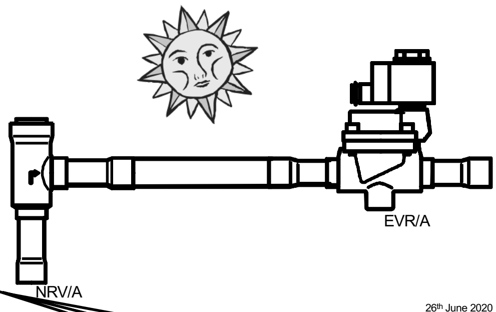
AVOID LOCKED REFRIGERANT



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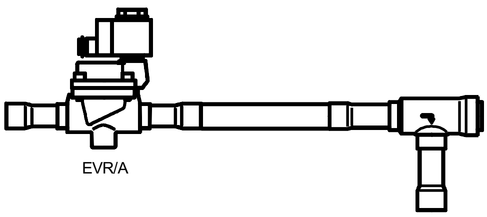
HOW TO PLACE SOLENOID AND CHECK VALVE



Ceiling Hung Evaporator

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Air Cooler piping outside the building on terrace

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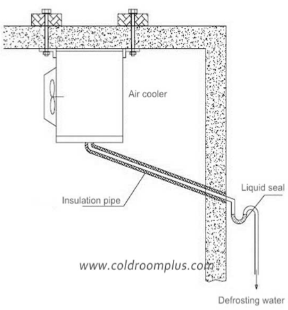
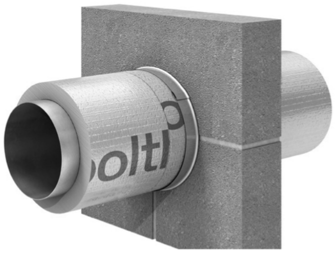
AIR COOLER DRAIN PIPING WITH LIQUID SEAL





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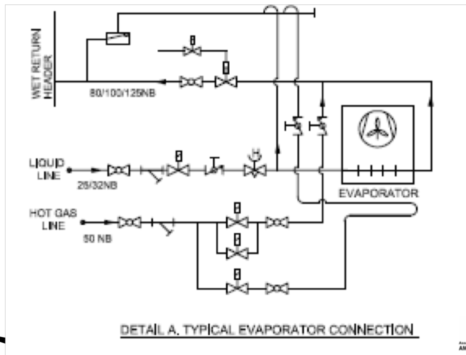
EVAPORATOR PIPING WITH HOT GAS DEFROST



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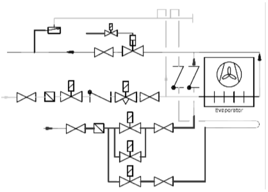
Separate hot gas defrost line for defrost pans



Having a separate valve station for the defrost pan:

- Reduces the energy consumption since a smaller solenoid valve is necessary to heat the pan during the length of the defrost sequence
- Main hot gas solenoid valve will only be active for 10 minutes reducing the amount of heat added to the refrigerated space.

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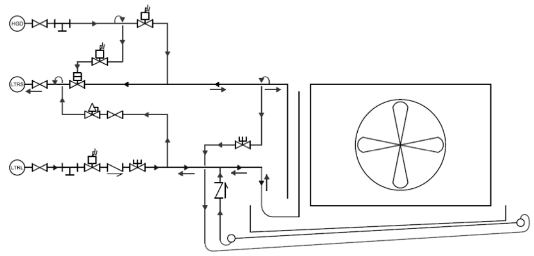
RECIRCULATED BOTTOM FEED
2-PIPE HOT GAS DEFROST
VERTICAL HEADERS
1-PASS PAN LOOP



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Hydraulic Shock/water Hammer-Why?

1. **Damaging Hydraulic Shocks are often Condensation induced**
2. **Occur in low temperature applications during onset or termination of defrost**
3. **Normally occur in two phase suction line-wet return line-due to liquid slugs**
4. **During initiation of defrost hot gas rushes in low side and relieved at termination**
5. **When gas flow is large it scoops up liquid from wet return line**
6. **Wet return header closed without exit gas gets compressed even more**
7. **When pressure rises the gas gets condensed and draws liquid in to the suction behind it and the liquid hits the close end cap**
8. **The slugs then develop pressures of even up to 52 bar and damage seamless pipes even up to 400 mm diameter.**

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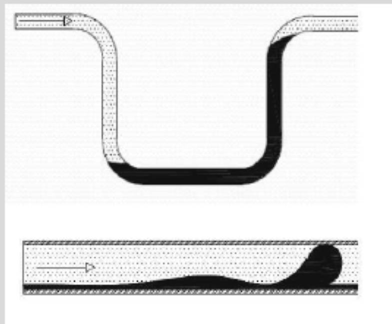
Liquid Hammer-Liquid Trap



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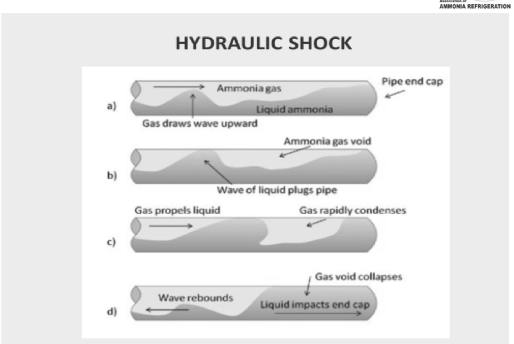

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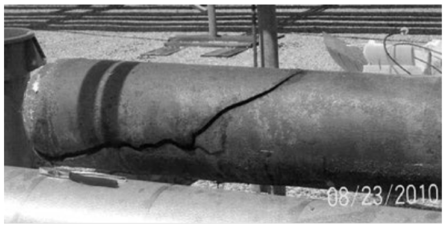


PIPING PRACTICES TO DECREASE HYDRAULIC SHOCKS

1. Hot gas piping-No traps, if traps unavoidable then provide liquid drains
2. The evaporator must be fully drained before admitting hot gas, giving any liquid slugs free flow through evaporator to suction piping
3. Especially important for evaporators with vertical suction header and bottom feed
4. Evaporator shut off valves with stem horizontal
5. Wet suction should contain no traps
6. Evaporator outlet connection from top of wet return header
7. Wet suction and branches-No dead end or closed valves
8. Do not overcharge or undercharge LP vessel
9. Draining a vessel puts gas in liquid line
10. Overfilling puts liquid in gas lines
11. Use soft gas defrost with smaller solenoid in parallel to equalize pressures for larger plants both in liquid and hot gas defrost lines to evaporator

GOOD PIPING PRACTICES

1. Piping to slope in direction of flow except for L.P. vessel
2. Provide loops – for thermal contraction & expansion
3. Oil separator to be mounted above crankcase level for oil to flow to compressor crankcase
4. For all high points provide-vent valves-for purging
5. Liquid line valves- install preferably in vertical lines
6. Use eccentric reducers instead concentric wherever possible
7. Use always back seating type valves
8. In horizontal liquid line mount globe valves with stems horizontal to eliminate liquid accumulation upstream as also for reducing pressure drop.

GOOD PIPING PRACTICES

9. Valves to be installed to close against flow or pressure
10. Use Long stem valves- for insulated pipe lines
11. Suction branches should be taken from top of header
12. Liquid branches to be taken from bottom of header
13. Hot gas branches to be taken from top of header
14. Always seal caps for valves not in use- like drain, purge, charging valves
15. Safety valve discharge outlet pipe –15 ft. Above ground
16. Drain/vent caps to be provided with small drilled hole
17. No shut off valve before safety valve & if provided in locked open position with handle removed
18. Operational Valves should be approachable from from/fixed platform and not ladder
19. Water tank /spray in plant room-ammonia

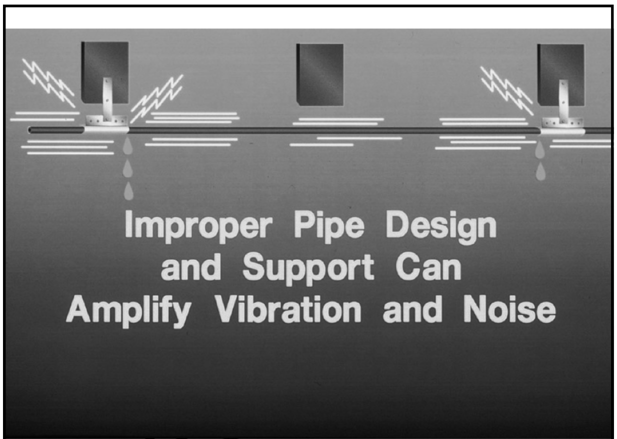
GOOD PIPING PRACTICES

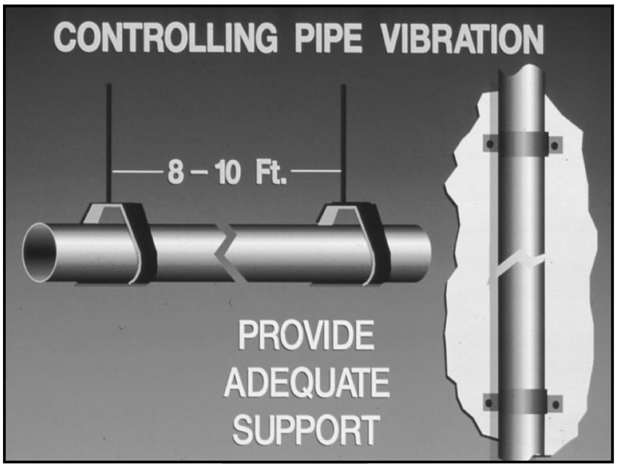
20. Provide Rust preventive treatment of piping before insulation
21. Alignment: Do not force pipes into alignment; this builds in an undesirable stress. Make all joints free of any alignment stress. Built-in stress in connections to equipment can cause stress in the equipment itself and can cause vibrations and other undesirable consequences.

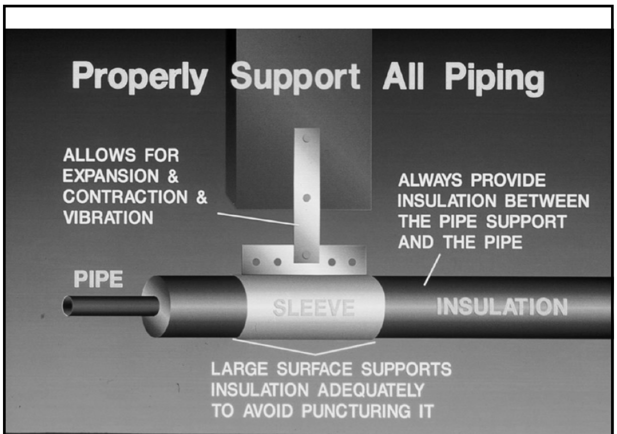
No Flange joints-all welded joints

PIPE SUPPORT SPACING

Pipe Diameter-inch	Maximum Span-ft	Minimum rod Diameter-Inch
Up to 1	7	3/8
1 ¼	9	3/8
2	10	3/8
2 ½	11	½
3	12	½
4	14	5/8
5	16	5/8
6	17	¾
8	19	7/8
10	22	7/8
12	23	7/8
14	25	1
16	27	1
18	28	1 ¼
20	30	1 1/4







PIPING MATERIAL & THICKNESS

1. Piping/fittings as per ANSI B31.5-2013
2. Carbon Steel A53 Grade A or B ERW or A106 grade A/B seamless
3. Do not Use Galvanized Piping(Low Grade)
4. 1 ½" and smaller -Sch. 80
5. 2" to 6' Sch. 40
6. 8" to 12" sch 20
7. Sch 80 $\geq$ Sch 40 $\geq$ sch20
8. All Welded Fittings-Avoid Threads/Flanges

ALTERNATE STANDARDS

Sr No	Description	ASTM	ISO	BS	EN
1	For room temperatures	A53	9329-1	3601	10216-1
2	For Elevated Temp (Boilers)	ASTM A106	9329-2	3059 /1,2 , 3602-1	10216-2
3	For low temperatures	SA333 , SA 334	9329-3	3603	10216-4
4	For heat exchangers tubes	A179 ,A178 ,A333 ,A214 & A334	6758 , 6759	3606	10216-2 & 10216-4

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Pipe Material-Low Temperature

- Carbon Steel(Low Temperature):ASTM A333-Grade 1 or 6
- Carbon Steel Pipe, ASTM A53 or A106 may be used below -20^{0}F(-28.9^{0}C) if it meets ASME B31.5-2013 Refrigeration Piping and Heat Transfer component requirements

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Pipe Material-Low Temperature

- **ASME B31.5 allows use of carbon steel pipe material for use between -28.9^{0}C to -101.1^{0}C provided the most severe conditions are multiplied by 2.5 times in determining the thickness**
- **This is due to the fact that in refrigeration systems when the temperature is low pressure is also low so pipe thickness deigned for ambient conditions is much safer to withstand the operating conditions. Pressures and temperatures do not occur simultaneously**

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EXAMPLE CALCULATIONS

- A53-GrA to be used for low temperature below -29^{0}C
- Design pressure -19.8 kg/cm^2
- Design Temperature -Minus 50^{0}C
- Liquid line -10" NB-OD 10.75" Sch. 20-Thickness 0.365"
- T=2.5xPD$_0$/2xSE=(2.5x19.8x14.22x10.75/2x13 600)+ corrosion allowance
- T= 0.278+0.06=0.338"
- Actual Thickness of Sch20 =0.365"- Hence Safe

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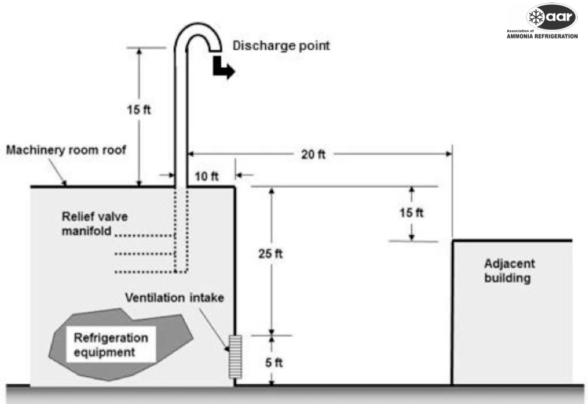
PIPING ACCESSORIES MATERIAL

- **Fittings**
- **Carbon Steel ASTM A105**
- **Carbon Steel ASTM A234**
- **Carbon Steel(Low Temperature) ASTM A420**
- **Flanges**
- **Carbon Steel ASTM A105**
- **Carbon Steel ASTM A181**
- **Carbon Steel (Low Temperature) ASTM A707**
- **Bolting**
- **Cast Iron Flanges when used with ring gaskets, or when coupled to a raised face flange: ASTM A307 Grade B**
- **Carbon or Stainless steel Flanges down to -55^{0}F –ASTM A193 Grade B7**
- **Low Temperature applications**(-55^{0}F to -150^{0}F): ASTM A320 Grade L7
- Nuts: for above materials: ASTM A194

WELDING PRACTICES

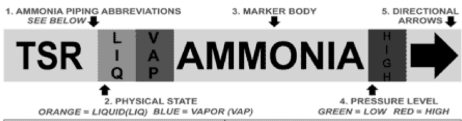
1. Root run with TIG-Tungsten Inert Gas(Argon) for piping
2. Root run with TIG(Argon) or MIG (Metal inert Gas)for vessels
3. Welding by qualified welder certification level 3
4. Welding rods- Argon- High side-AWS-A5.18 ER70S-G, Low side -AWS -A5.28 ER70S-G
5. Electric Welding - AWS -A5.1 E7016, Do not use structural welding rods 6013
6. Remove valve internals & controls, strainers Solenoid coils etc. before welding

SAFETY VALVE PIPING OUT LETS

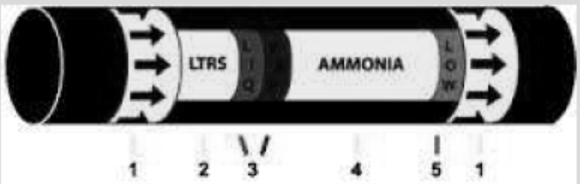


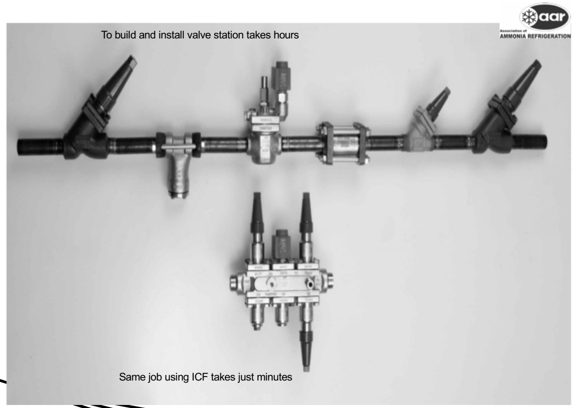
REFRIGERANT PIPING COLOR CODE

SR.NO.	DESCRIPTION	SCOPE	COLOUR CODE
1	HP Hot gas	High Stage Discharge Booster Discharge	Red
2	HP liquid refrigerant	Receiver to Economizer Economizer to Intercooler	Orange
3	LP liquid refrigerant	Intercooler to LP Vessel	Light green
4	LP refrigerant vapor	High Stage Suction Booster Suction	Dark green
5	Liquid/vapor mixture of refrigerant		Purple
6	Oil Circuit	Both Booster & High Stage	Black

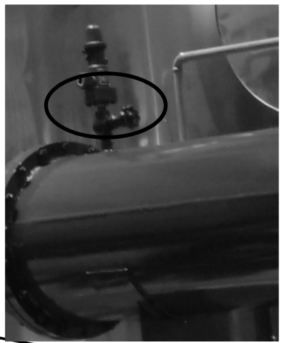


BD=BOOSTER DISCHARGE	LD=LIQUID DRAIN
CD=CONDENSER DRAIN	LIC=LIQUID INJECTION COOLING
DC=DEFROST CONDENSATE	LSS=LOW STAGE SUCTION
EQ=EQUALIZER	LT=LIQUID TRANSFER
ES=ECONOMIZER SUCTION	LTRL=LOW TEMPERATURE RECIRCULATED LIQUID
FG=FOUL GAS	LTRS=LOW TEMPERATURE RECIRCULATED SUCTION
HG=HOT GAS	LTS=LOW TEMPERATURE SUCTION
HGD=HOT GAS DEFROST	MTRL=MEDIUM TEMPERATURE RECIRCULATED LIQUID
HPL=HIGH PRESSURE LIQUID	MTRS=MEDIUM TEMPERATURE RECIRCULATED SUCTION
HSD=HIGH STAGE DISCHARGE	MTS=MEDIUM TEMPERATURE SUCTION
HSS=HIGH STAGE SUCTION	PO=PUMP OUT
HTRL=HIGH TEMPERATURE RECIRCULATED LIQUID	RV=RELIEF VENT
HTRS=HIGH TEMPERATURE RECIRCULATED SUCTION	TSR=THERMOSYPHON RETURN
HTS=HIGH TEMPERATURE SUCTION	TSS=THERMOSYPHON SUPPLY





SHUT OFF VALVE BELOW SAFETY VALVE- INCORRECT PRACTICE



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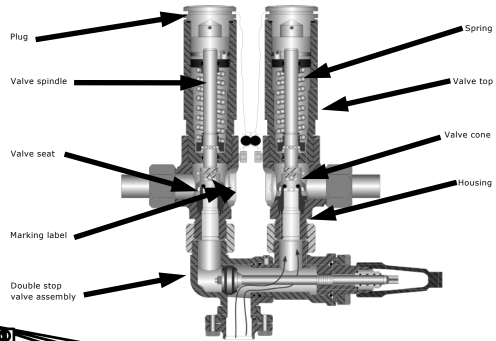
Double Stop Valve - type DSV and Double Safety Valve - type SFV



Technical brochure

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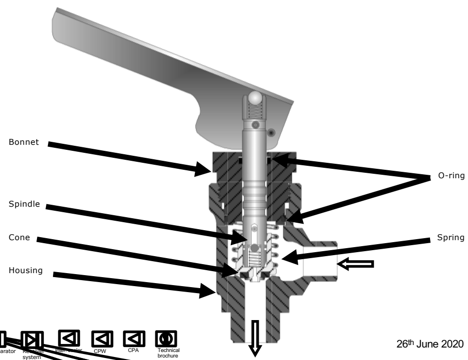
Quick closing oil drain valve – type QDV 15



Pump separator | system | CPW | CPA | Technical brochure

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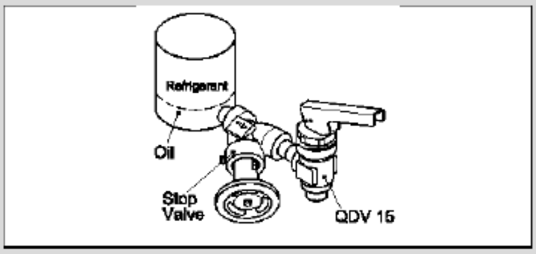
QUICK CLOSING OIL DRAIN VALVE



WELL DESIGNED MACHINE ROOM

THANK YOU
Questions?

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