For Ammonia (R717)

Description

Although this bulletin is concerned mainly with surge drum design, TABLE 1 applies to all vessels that involve the separation of liquid from vapor. Horizontal separators require special consideration. For a vertical desuperheater it is recommended that the ratings in the 30 PSI (+17°F) column be reduced by 20%.

Design Function

The surge drum on a flooded evaporator performs various important functions. They are:

(1)To separate the liquid out of the gas returning from the evaporator, allowing the gas to pass to the compressor through the suction line, and returning the liquid to the evaporator for re-circulation.

(2)To absorb such surges in the evaporator as may occur due to variation of load during operation. The coil circuits will carry an amount of liquid in them in somewhat inverse proportion to the load. With light duty, less gas is formed in each coil circuit, and there is room for more liquid. When the load becomes heavier and duty is greater, more gas is formed and less liquid is carried in the coil circuits. Even room coils have changes in the load, principally due to the addition of warm products to the room.

(3)To absorb the violent liquid surging that occurs when the suction line of a flooded evaporator is opened quickly. The immediate drop in pressure on the liquid lying in the evaporator that accurs when the suction line is opened creates a tremendous amount of vapor. Practically the entire charge of liquid left in the evaporator at shut-down is suddenly thrown up into the surge drum.

The minimum cross sectional flow area of a surge drum needed to allow satisfactory liquid separation velocities is dependent upon both the refrigeration load and the suction pressure. To attain the correct separation velocity for vertical surge drums under various load and pressure conditions, the selection can be made from TABLE 1.

The surge drum volume in many flooded systems is governed principally by volume of liquid that may be in the coil at the moment of shut-down. Generally, the following volumes of surge drums are recommended for various types of work:

TYPE OF APPLICATION	DRUM VOLUME TO EVAPORATOR VOLUME
AIR COOLING UNITS (FIN COIL)	100%
AIR COOLING UNITS (BARE PIPE)	40-60%
BEER AND WORT. COOLERS	40-60%
ICE CREAM FREEZERS	100%

TABLE 1
MAXIMUM TONS IN VERTICAL SURGE DRUMS -- AMMONIA

NOMINAL DRUM DIAM.	VOLUME ft^3/ft	20" VAC -64° F	10" VAC -42° F	0 PSIG -28° F	5 PSIG -17° F	20 PSIG 5.5° F	30 PSIG 17° F	45 PSIG 30° F
8	0.35	6.1	8.7	10.7	12.3	16.1	18.4	21.2
10	0.56	9.6	13.7	16.9	19.5	25.5	29	34
12	0.8	13.8	19.6	24.1	28	36	42	48
14	1.0	17.2	24.5	30	35	45	52	60
16	1.3	22.4	32	39	45	59	67	78
18	1.7	29	41	50	58	76	86	100
20	2.0	35	49	60	70	91	104	119
24	3.0	52	73	90	104	137	155	179
30	4.6	79	113	139	160	210	239	275
36	6.7	115	164	202	233	306	348	400
42	9.2	157	235	285	320	420	477	550
48	12.0	205	290	360	410	540	600	700
54	15.8	255	360	450	515	680	770	890
60	19.5	320	455	560	650	850	970	1100
66	23.7	385	550	675	780	1040	1160	1360
72	28.0	450	640	780	910	1200	1350	1550
78	33.0	535	765	940	1070	1430	1630	1870
84	38.0	625	890	1100	1270	1660	1900	2180
96	50.0	810	1160	1430	1650	2170	2400	2840

Horizontal Drums

The separation space in a horizontal surge drum is decreased as the liquid level rises. This factor requires careful consideration when designing the horizontal surge drum. To insure liquid separation under all operating conditions, the flow area must be adequate when the liquid level is at its highest point in the drum. This condition will be just after maximum volume of liquid has surged from the evaporator.

When a horizontal drum is required on an installation where no previous experience has been acquired relative to drum size, it is recommended that PHILLIPS be consulted. Full information would be required, such as refrigerant, load, suction pressure, type of coil, size and length of pipe circuit, number of outlets for the gas, and any other factors involved.

Gas Returns

An important factor in good operation of a flooded system is the size of the gas return(s) from the evaporator back to the surge drum. Since the gas return is also carrying liquid droplets entrained with the gas, the effect could be an increase in the pressure drop that penalizes the compressor. TABLE 2 gives the recommended maximum tons that should be returned through extra-heavy pipe to 2" IPS, and standard weight 2 1/2" IPS and up. When liquid level in the drum is at or below the gas outlet of the evaporator, the gas return should be made at least one pipe size larger.

TABLE 2

GAS RETURNS
FROM EVAPORATOR TO SURGE DRUM
MAXIMUM TONS -- AMMONIA

IPS GAS RETURN	10" VAC -42° F	0 PSIG -28° F	5 PSIG -17° F	20 PSIG 5.5° F	45 PSIG 30° F
3/4	.26	.33	.39	.52	.68
1	.52	.66	.77	1.1	1.4
1-1/4	1.1	1.4	1.7	2.2	2.9
1-1/2	1.7	2.2	2.5	3.4	4.5
2	4.1	5.2	6.1	8.2	10.7
2-1/2	6.8	8.6	10	13.5	17.5
3	11.5	14.5	17	23	30
3-1/2	17.2	21.8	26	34	45
4	24	31	36	48	63
5	44	56	65	88	115
6	72	91	107	143	187
8	148	187	220	295	386

Liquid Legs

A discussion of surge drums cannot be complete without mention of proper sizing of the liquid leg. Liquid velocities must be slowed down enough that oil may be allowed to settle out in the space below the liquid coil inlet to the evaporator. This helps keep the evaporator oil free and insures good heat transfer. Oil must be periodically drained. When an integral oil pot somewhat larger than the liquid drop leg is built as part of the liquid leg at the bottom, the liquid leg tons may be doubled. TABLE 3 gives a good selection of liquid leg sizes for various tonnages.

TABLE 3

LIQUID LEGS
MAXIMUM TONS – AMMONIA

IPS (IN)	TONS	IPS (IN)	TONS
3/4	1	3	30
1	2	3-1/2	45
1-1/4	4	4	60
1-1/2	6	5	105
2	11	6	160
2-1/2	18	8	330

TABLE 4 indicates nominal ammonia suction line capacities at approximately 1 psi pressure drop per 100 ft. of equivalent line, and is shown for convenience.

TABLE 4

SUCTION LINE
MAXIMUM TONS – AMMONIA

IRON PIPE SIZE	10" VAC -42° F	0 PSIG -28° F	5 PSIG -17° F	20 PSIG 5.5° F	30 PSIG 17° F	45 PSIG 30° F
1/2	.34	.46	.6	1.1	1.4	2.0
3/4	.68	.93	1.2	2.2	2.8	4.1
1	1.26	1.62	2.2	4.0	5.0	7.5
1-1/4	2.52	3.36	4.4	8.0	10	15.0
1-1/2	3.77	4.86	6.4	11.8	15	21.6
2	7.10	9.30	12.1	22.2	28	42
2-1/2	11	14.60	19.1	35.5	45	65
3	19	24.30	31	59	75	108
4	38	49	64	118	150	240
5	64	85	117	208	260	385
6	103	134	175	306	395	600
8	180	230	315	540	685	1040
10	280	380	490	850	1100	1680
12	400	535	700	1225	1580	2400
14	565	730	960	1680	2170	3280

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