Chapter – 27 Air Side Evaporators for Cold Storage and Frozen Food

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The air side evaporators for cold storage and frozen food are unit coolers and product coolers. Bare pipe coil was used in the old days and is rarely being used for modern cold storage installation because of poor efficiency. The construction of unit cooler or product cooler is basically consists of fan assembly, coil assembly, drain pan, casing and defrosting accessories, if any.

The coil is usually rated for either ammonia or halocarbon if coil is constructed with steel or aluminum; however, the coil is only good for halocarbon refrigerant if it is constructed with copper.

Brine capacity rating is available from the cooler manufacturer; information needed for brine selection shall be type of brine, percent by wt. concentration, in and out temperatures, flow rate in GPM, room design temperature and cooling capacity.

Unit Cooler:

Unit cooler is generally referred to the units which are with smaller coil; it is used for smaller cold storage room application. Most unit Coolers are Ceiling Mounted design as shown in Figure 27-1. Most ceiling mounted units are designed for rear air inlet, front air discharge. Figure 27-2 shows the typical unit cooler with multiple fans. Figure 27-3 shows the typical capacity ratings and physical data of the unit coolers. Most unit coolers are with propeller fans; units are available for air, water or hot gas defrosting application. Units are mostly with ¾" OD coil; coil material is aluminum, copper or steel. Fins are 3 or 4 F.P.I.

Product Cooler:

Product cooler generally refers to the units with larger coil for larger capacity; for large cold storage, blast freezing or wind tunnel application. Product coolers have ceiling or floor mounted models. Figure 27-4 is a typical Ceiling Mounting Unit with horizontal rear air inlet, horizontal front air discharge arrangement; Figure 27-5 is a typical Floor Mounting Unit with front horizontal air inlet, horizontal front air discharge. Other discharge and inlet orientations are available for ceiling or floor mounting product units.

Figure 27-6 is the table for typical capacities and physical data for the product coolers. The units are with ¾" OD, 4 FPI steel coils. Other options for product coolers are such 1" OD coils; aluminum or copper coil material.

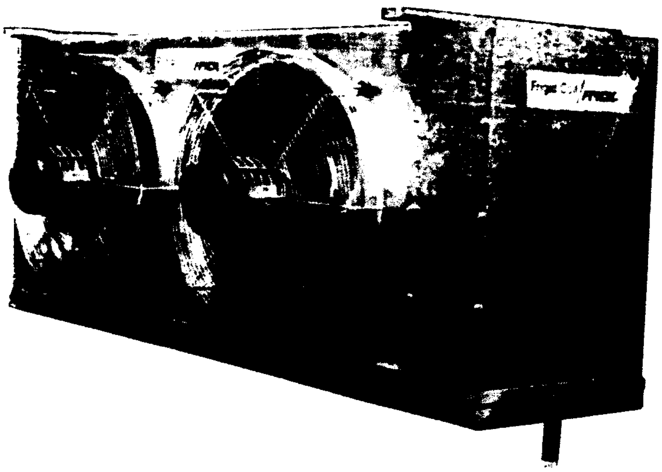

Figure 27-1 Typical Unit Cooler

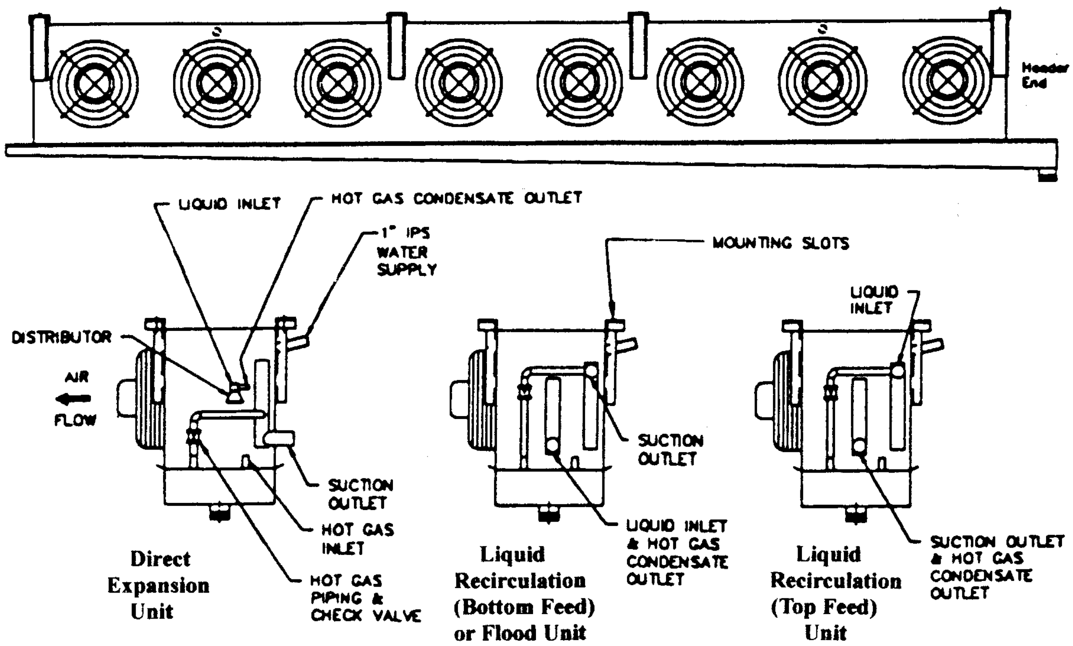

Figure 27-2 Typical Multiple Fans Unit Cooler

Most product coolers are with centrifugal or vane axial fan instead of propeller fans.

Performance of Unit Cooler and Product Cooler:

Capacity ratings of unit cooler and product coolers are similar, both are rated on

HT & Lt Models: ¾"OD Aluminum Tubes, Ammonia Ratings

MODEL NO.	CAPACITY BTUH /T.D.				FAN & MOTOR DATA			COIL DATA		
	WET COIL		FROSTED COIL					FPI	SUR-FACE FT.²	INT. VOL. FT.³
	DX	REC./FL.	DX	REC./FL.	QTY./HP	CFM	FPM			
HT 254	3523	4098	3171	3688	2-1/3	7140	643	4	681	.77
HT 264	3962	4607	3566	4146	2-1/3	6920	623	4	828	.93
HT 354	5425	6309	4883	5678	3-1/3	10710	612	4	1076	1.22
HT 364	6102	7095	5492	6386	3-1/3	10380	594	4	1308	1.46
HT 454	7095	8250	6386	7425	4-1/3	14280	635	4	1381	1.56
HT 464	7961	9257	7165	8331	4-1/3	13840	615	4	1679	1.88
HT 554	8993	10456	8093	9410	5-1/3	17850	618	4	1776	2.01
HT 564	10134	11784	9121	10606	5-1/3	17300	599	4	2159	2.41
HT 654	10726	12472	9654	11225	6-1/3	21420	607	4	2170	2.46
HT 664	12194	14179	10974	12761	6-1/3	20760	588	4	2638	2.95
HT 754	12773	14853	11612	13503	7-1/3	24990	621	4	2475	2.80
HT 764	14239	16558	12945	15053	7-1/3	24220	602	4	3009	3.36
HT 854	14419	16768	13109	15244	8-1/3	28560	613	4	2865	3.25
HT 864	16266	18915	14788	17196	8-1/3	27680	594	4	3484	3.90
LT 264	–	–	3696	4298	2-1/3	7300	676	4	828	
LT 263	–	–	3931	4572	2-1/2	9400	848	3	641	.93
LT 264	–	–	4192	4876	2-1/2	9200	830	4	828	
LT 364	–	–	5679	6603	3-1/3	10950	626	4	1308	
LT 363	–	–	5993	6969	3-1/2	14100	806	3	1013	1.46
LT 364	–	–	6457	7508	3-1/2	13800	789	4	1308	
LT 464	–	–	7450	8663	4-1/3	14600	649	4	1679	
LT 463	–	–	7861	9140	4-1/2	18800	837	3	1300	1.88
LT 464	–	–	8456	9833	4-1/2	18400	819	4	1679	
LT 564	–	–	9431	10967	5-1/3	18250	631	4	2159	
LT 563	–	–	10052	11689	5-1/2	23500	814	3	1672	2.41
LT 564	–	–	10707	12451	5-1/2	23000	796	4	2159	
LT 664	–	–	11421	13280	6-1/3	21900	620	4	2638	
LT 663	–	–	12052	14013	6-1/2	28200	799	3	2043	2.95
LT 664	–	–	12953	15061	6-1/2	27600	782	4	2638	
LT 764	–	–	13135	15274	7-1/3	25550	635	4	3009	
LT 763	–	–	14011	16293	7-1/2	32900	817	3	2330	3.36
LT 764	–	–	15039	17487	7-1/2	32200	800	4	3009	
LT 864	–	–	15096	17554	8-1/3	29200	627	4	3484	
LT 863	–	–	16112	18736	8-1/2	37600	807	3	2698	3.90
LT 864	–	–	17216	20018	8-1/2	36800	790	4	3484	

Figure 27-3 Typical Capacity Ratings & Physical Data For Unit Cooler

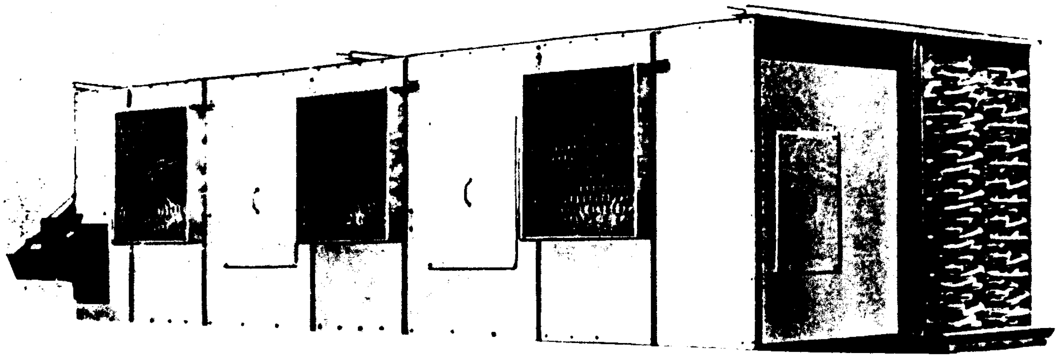

Figure 27-4 Typical Horizontal Ceiling Mounting Product Cooler

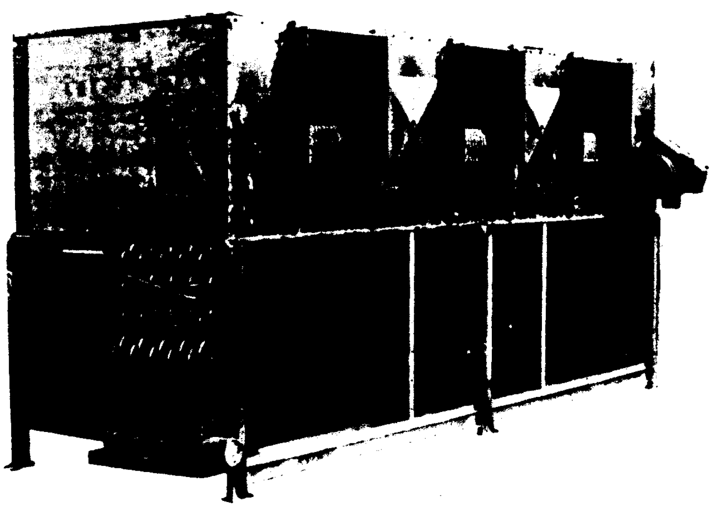

Figure 27-5 Typical Vertical Floor Mounting Product Cooler

CF Model: ¾"OD Steel Coil, Ammonia Ratings

MODEL NUMBER	ROW COIL	CFM @ 600 FPM	NO. OF FANS	FAN SIZE INCHES	FAN MOTOR HP	CAPACITIES BTU/HR – °F TD				TOTAL COIL SURFACE (SQ FT)	
						3 FINS/INCH		4 FINS/INCH			
						DX	FLOODED RECIR.	DX	FLOODED RECIR.	3 FPI	4 FPI
CF 134	4	7,500	2	12	2	2,473	2,875	2,742	3,188	467	603
CF-136	6	7,500	2	12	2	3,419	3,975	3,655	4,250	724	935
CF-138	8	7,500	2	12	3	4,128	4,800	4,515	5,250	958	1236
CF-194	4	11,250	2	17	2	3,711	4,315	4,112	4,781	701	904
CF-196	6	11,250	2	17	3	5,128	5,963	5,483	6,375	1086	1398
CF-198	8	11,250	2	17	3	6,192	7,200	6,773	7,875	1436	1850
CF-234	4	13,500	2	18	3	4,451	5,175	4,935	5,738	841	1085
CF-236	6	13,500	2	18	3	6,153	7,155	6,579	7,650	1303	1678
CF-238	8	13,500	2	18	5	7,430	8,640	8,127	9,450	1724	2220
CF-306	6	18,000	2	21	5	8,204	9,540	8,772	10,200	1737	2243
CF-308	8	18,000	2	21	5	9,907	11,520	10,836	12,600	2298	2966
CF-3010	10	18,000	2	19	7-1/2	11,739	13,650	12,642	14,700	2859	3689
CF-386	6	22,500	3	18	5	10,256	11,925	10,966	12,750	2171	2804
CF-388	8	22,500	3	18	7-1/2	12,384	14,400	13,546	15,750	2872	3708
CF-3810	10	22,500	3	18	7-1/2	14,874	17,063	15,800	18,375	3573	4612
CF-446	6	26,250	3	21	5	11,965	13,913	12,796	14,875	2533	3271
CF-448	8	26,250	3	21	7-1/2	14,448	16,800	15,800	18,375	3351	4326
CF-4410	10	26,250	3	19	10	17,120	19,906	18,437	21,438	4169	5381
CF-536	6	31,500	3	21	7-1/2	14,358	16,695	14,358	17,850	3040	3925
CF-538	8	31,500	3	21	7-1/2	17,336	20,160	18,963	22,050	4021	5191
CF-5310	10	31,500	3	21	10	20,544	23,888	22,123	25,725	5002	6457

FINNED COIL CAPACITY CORRECTION FACTORS

FIN SPACING COIL CONDITION & TYPE	FACTOR			MULTIPLY FACTORS BY:
	ROWS DEEP			
	6	8	10	
2/3 FPI	.88	.90	.92	3 FPI Rating
2/4 FPI	.85	.89	.91	4 FPI Rating

LOW SUCTION TEMPERATURE CAPACITY CORRECTION FACTORS

T.D.	SUCTION TEMPERATURE °F				
	-10	-20	-30	-40	-50
10	1.00	1.00	0.95	0.90	0.80
15	1.00	1.00	0.93	0.90	0.80
20	0.95	0.95	0.90	0.85	0.75

Figure 27-6 Typical Capacity Ratings & Physical Data For Product Cooler

Btu/Hr per °F of TD. TD is the temperature difference between the cold room design temperature and the coil design evaporative temperature.

An example for a product cooler selection is shown as the following:

Cooling capacity:	123,000 Btu/hr.
Evaporative temperature:	12°F.
Room temperature:	20°F.
Refrigerant:	Ammonia.
Refrigerant feed:	Liquid recirculation.
Coil fins spacing:	4 FPI.

Design TD = °F Diff = Room Design Temp. – ET (Evaporative Temperature)

Room Design Temperature = 20°F
ET = 12°F

TD = 20 – 12 = 8°F

$$\text{Btu/Hr per } ^\circ\text{F of TD required} = \frac{123{,}000 \text{ Btu/Hr}}{8} = 15{,}375 \text{ Btu/Hr per } ^\circ\text{F}$$

See Figure 27-6, the typical capacity rating for the product cooler, the product cooler model CF-388, 8-row deep coil, 4 FPI for ammonia liquid recirculation is rated at 15,750 Btu/hr./°F TD.

The capacity of model CF-388 is 15,750 x 8 = 126,000 Btu/Hr, which is larger than the capacity specified. Therefore, the product cooler model CF-388 is selected.

From the typical ratings for unit coolers and product coolers shown in Figures 27-2 and 27-6, the capacity for a unit with DX refrigerant feed is lower than flooded or liquid recirculation refrigerant feed, because the heat transfer of a DX coil is less efficient than the coil for flooded or liquid recirculation.

Coil Fins Spacing:

The coil fins spacing for cooler is usually 3 or 4 FPI. A 6 FPI coil only can be used for room temperature above 50°F with ET not lower than 40°F. The coil can be constructed for vari-fin for low temperature application. Vari-fin is to use different fin spacing for the coil, that is to use less fins per inch for entering air side of the coil where heavier frost build-up is likely. For example, an 8-row 4 FPI coil to use 2 FPI on air entering two rows and remaining 6 rows to be 4 FPI. Some units are even available with 1.5 FPI vari-fin spacing option. The capacity of the vari-fin coil should be corrected in accordance with the manufacturer’s recommendation. Other typical capacity corrections for vari-fin are shown in Table 27.1.

Table 27.1 Capacity Correction Factor for Vari-fin

FPI of 2 Rows of Entering Air	FPI for Remaining Rows	Capacity Correction Factors			
		Coil Rows Deep			Multiply to Rating
		6-Row	8 Rows	10 Rows	
1.5 FPI	3 FPI	0.88	0.90	0.91	3 FPI Rating
2 FPI	4 FPI	0.88	0.90	0.91	4 FPI Rating
3 FPI	4 FPI	0.92	0.93	0.94	4 FPI Rating

Cooler Capacity Correction for Low Temperature Application:

The coil capacity should be also corrected in accordance with manufacturer’s recommendation for low temperature application. It is suggested not to use DX feed for evaporative temperature below 0°F. The capacity of the cooler should be corrected if the CFM flow is changed because of 60 Hz for 50 Hz application, if applicable.

Wind Tunnel and Blast Freezers:

Product cooler might not meet the requirements of wind tunnel or blast freezer or for IQF and Spiral Freezers, because the fan and coil for product cooler are mostly fix designed for general cold storage application, therefore, for wind tunnel or blast freezing application, the fan, CFM flow, external static pressure for the fan and coil capacity are to be specially selected for specific installation.

The Relationship between Room Relative Humidity & Design TD for Cold Storage:

The refrigeration capacity for a unit cooler or product cooler is higher at larger TD. Therefore, the cooler size is smaller if the TD is larger for same refrigeration capacity. On the other hand, smaller TD requires large size cooler. The cost for smaller size cooler is cheaper; but the refrigeration equipment could be more expensive and the power consumption will be higher, because larger TD requires lower ET for the same room design temperature. Therefore, the initial cost of the cooler should be balanced out with the refrigeration equipment and the power consumption if no restriction on TD.

The TD should be carefully considered, if the room relative humidity is important for the cold storage room, because the humidity in the room is closely related to the TD. Table 27.2 is the approximate relationship between the room humidity and the design TD:

Table 27.2 Design TD vs Room Humidity

Room Humidity, %RH	Design TD
80% to 90%RH	2°F to 3°F
70% to 90% RH	3°F to 6°F
50% to 70% RH	6°F to 10°F
40% to 50% RH	10°F to 14°F

Defrosting Systems:

All the coolers used for cold storage have frost problem, because most cold storage room temperatures are below freezing. Frost accumulated on the cooler coil is harmful to the refrigeration, because the frost build-up decreases the heat transfer efficiency and dampers the air flow through the coil. Therefore, the ice built-up on the coil must be defrosted periodically, if the cooler is operated in a cold room which the room design temperature is below 34°F. The defrosting function is preferred to be fully automatic.

Several defrosting methods which are commonly used for the ice removal are as the following:

(a) Air Defrost.
(b) Electric Defrost.
(c) Water Defrost.
(d) Hot Gas Defrost.
(e) Combination of Water and Hot Gas Defrost.

The followings are the general considerations for defrosting arrangement:

1) The method of defrosting under consideration should be compatible with the refrigeration system being designed; the initial cost, power consumption, operating and maintenance costs should also be optimized and evaluated.

2) The defrosting period should be as short as possible to minimize the temperature rise in the refrigerated space no matter what type of defrosting method is used.

3) The defrost system should be simple to operate.

4) It is very important that the drain line should be pitched from the cooler unit; the pitch slope should have 3 to 4 inches per foot. A trap should be provided and located outside from the refrigerated space.

5) Defrost all coils in a room at one time, wherever is possible.

6) When all coils in one room are not defrosted at one time, the drain from the coil or group of coils being defrosted should be brought out of the room as soon as possible and trapped before becoming common with other drains from the same room.

7) The drain line inside of the refrigerated space should be wrapped with a heat tape.

8) The refrigeration system design should provide maximum protection against liquid carryover to the compressor suction; particularly defrost system for DX and flooded coils.

Air Defrost System:

Air defrost may be used for cold storage rooms with design room temperatures not lower than 40°F.

The operation principle is when air defrosting cycle starts; the liquid and suction line solenoid valves are closed. The evaporator fans continue to run. The room air of 40°F or higher flows over the coil melting the frost on the coil; the defrosted water drops into the drain pan of the cooler. It is suggested to use a defrost relief regulating valve with the suction line solenoid valve and a trap at the suction before the compressor suction if refrigerant feed is DX.

Electric Defrost System:

Electric defrost is to place an electric heater network in the coil evaporator assembly. The electric heater is to heat up the entire coil to melt the frosted ice on the coil. Electric heaters are provided for the drain pans and drain lines. Drain pan and drain line are heated during defrost. Electric defrost system requires a longer defrost time and higher energy consumption than the hot gas or water defrost method.

Figure 27-7 shows the typical piping arrangement for direct expansion cooler with electric defrost arrangement. During the cooling cycle, the fans are on; the suction solenoid valve (SSV) and the liquid solenoid valve (LSV) are open. When the unit is activated for defrost cycle; the unit defrost door is closed; the liquid solenoid valve (LSV) and suction solenoid valve (SSV) are closed; the electric heaters are energized. If the refrigerant pressure built-up in the coil is relieved through the defrost relief regulator (DRR). When the time of defrosting is over, the heater is de-energized, solenoid valves are opened. The fan is to be turned on until all the water drained out from the cooler. A suction accumulator is recommended to prevent liquid lug over to compressor suction.

Water Defrost System:

Figure 27-8 is the typical water defrosting piping system for a direct expansion cooler. Water defrost method is an effective way of defrosting. Water defrost unit is equipped with water spray heads above the coil. The water spray over the coil melts the ice off the coil. The water spray rate is approximately about 3 gpm per squire foot of coil face area for a 5 to 15 minutes period.

During the cooling cycle, the fans are on; the suction solenoid valve (SSV) and the liquid solenoid valve (LSV) are open; water solenoid valve (WSV) is closed. When the unit is activated for defrost cycle; the fans are off; the liquid solenoid valve (LSV) and suction solenoid valve (SSV) are closed; the water solenoid valve (WSV) is energized, the water spray over the coil melts the ice on the coil. The refrigerant pressure in the coil is relieved through the defrost relief regulator (DRR). When the time of defrosting is over, the water solenoid valve (WSV) is de-energized. The fan is turned on after all the water drained out from the cooler. A suction accumulator is recommended to prevent liquid lug over to compressor suction.

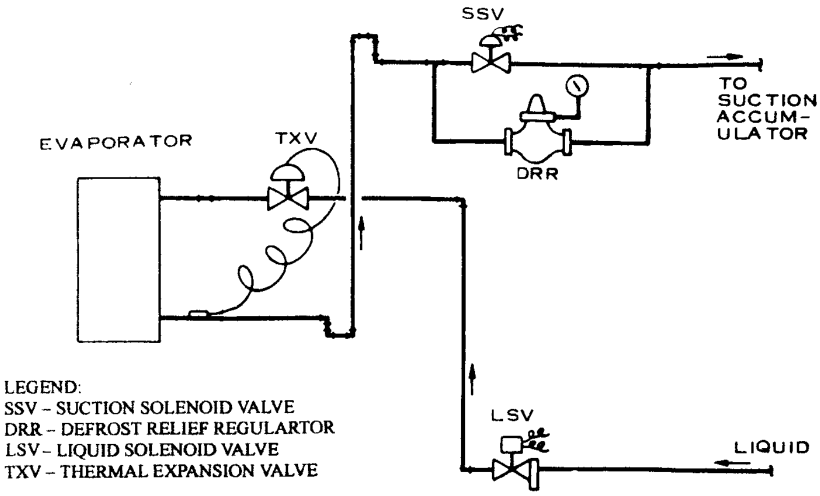

Figure 27-7 Typical Electric Defrost DX Piping Diagram

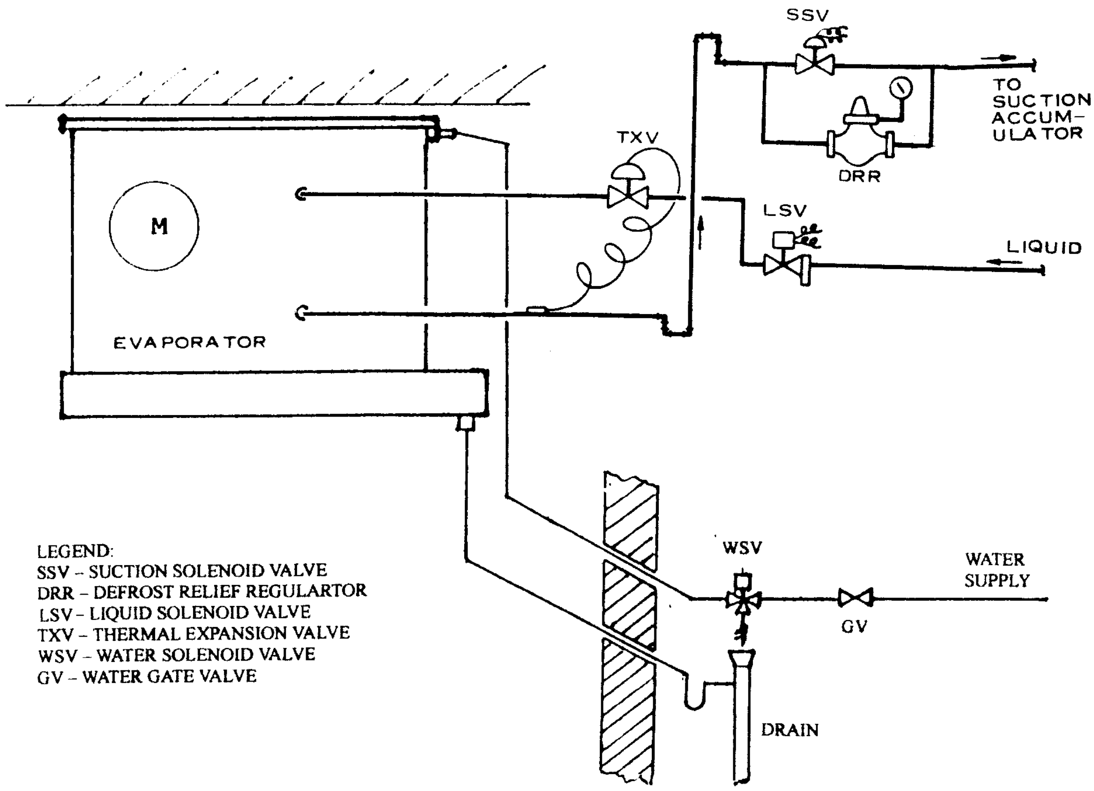

Figure 27-8 Typical Water Defrost DX Piping Diagram

Water defrost is effective and it is economically to install. But, water defrosting system has some disadvantages where they apply:

A. Water temperature must be maintained above 60°F.

B. Sand, scale and other impurities in the water sometimes cause the water solenoid valves to stick open, causing the room to be flooded.

C. If unit is used for room below freezing, the cooler unit must be perfectly level. If it is not, the water distribution header within the unit might not completely drain.

Air and Water Defrosting for Liquid Recirculation System:

Figure 27-9 shows the typical air defrost for liquid recirculation system. No separate suction trap is necessary; because liquid recirculation receiver serves as the suction accumulator (See Figure 27-11).

Figure 27-10 shows the typical water defrost for liquid recirculation system. No separate suction trap is necessary; because liquid recirculation receiver serves as the suction accumulator (See Figure 27-11).

Hot Gas Defrosting Systems:

Hot gas defrost is to apply the hot gas from the compressor discharge directly to the evaporator coil and the drain pan. Heat for defrosting is mainly from the latent heat of the compressed vapor, the vapor is condensed in the coil. This condensed liquid must be returned to somewhere, either to an oversized surge drum for flooded cooler; a suction trap for DX system or back to liquid recirculation receiver.

Liquid recirculation system is best suitable for hot gas defrosting application. Figure 27-11 shows a typical liquid recirculation piping with hot gas defrost. The vapor is supplied to coil and drain pan, heat of the gas melts the frost on the coil, the vapor is condensed in the coil; the liquid flows through suction pressure regulating valve and back to the liquid recirculation receiver via the suction piping line.

If the refrigerant feed is direct expansion instead of liquid recirculation, a suction trap before the compressor suction is to prevent liquid slug back to compressor. If the refrigerant feed is flooded, the surge drum should be sized large enough to prevent the liquid slug over during hot gas defrost cycle.

Hot Gas Defrosting for Flooded Cooler:

Figure 27-12 shows a typical flooded evaporator using hot gas defrosting. In this case, the surge drum of the flooded cooler is used to accumulate the condensed liquid, providing that the surge drum is sized large enough for this purpose. The sequence of operation is as the following:

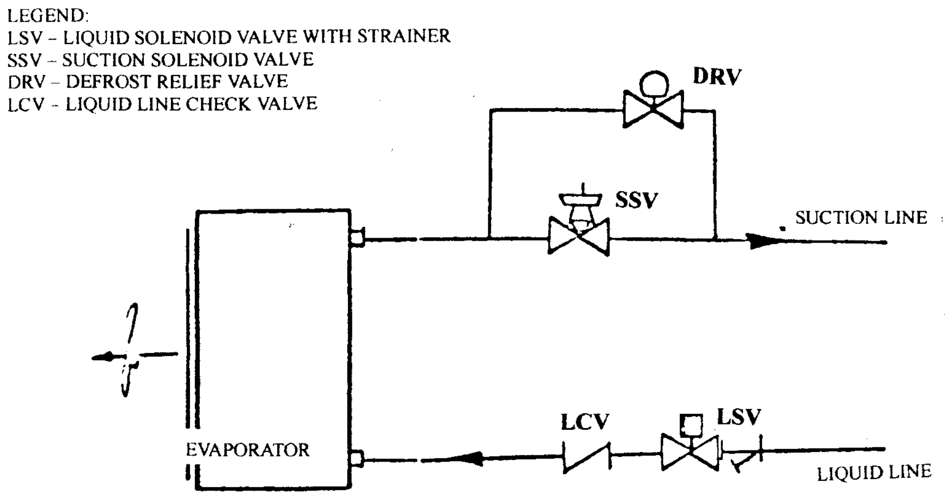

Figure 27-9 Typical Air Defrost
Liquid Recirculation Piping Diagram

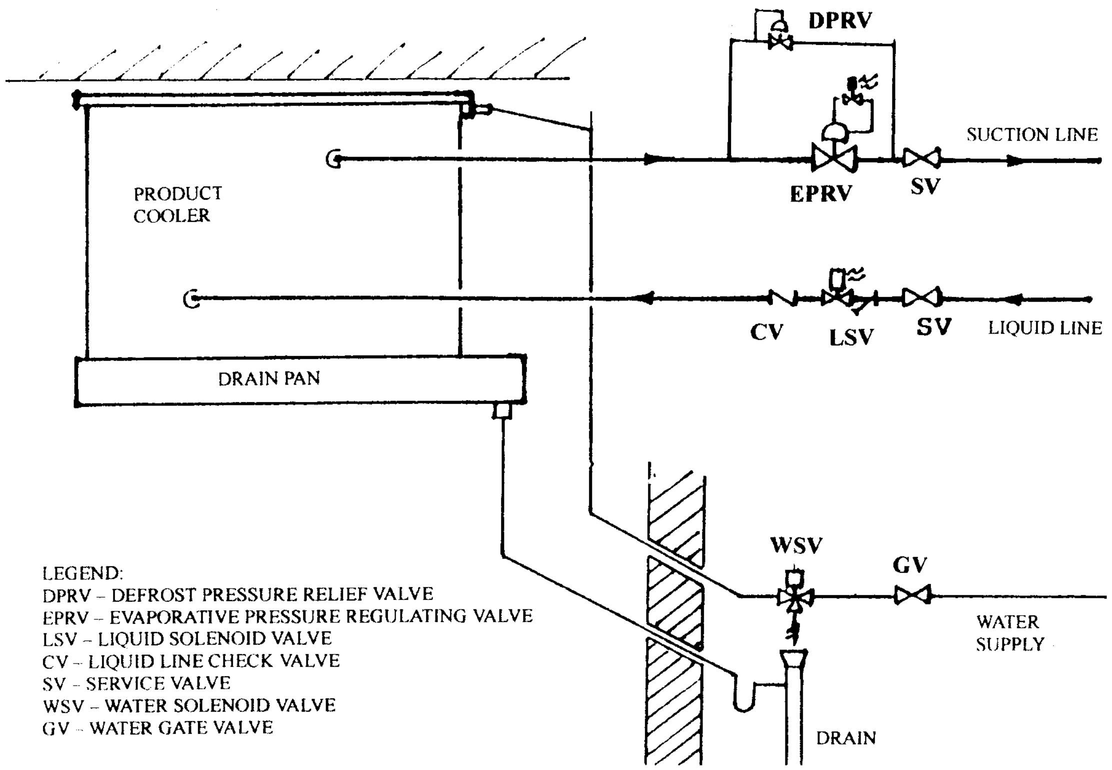

Figure 27-10 Typical Water Defrost
Liquid Recirculation Piping Diagram

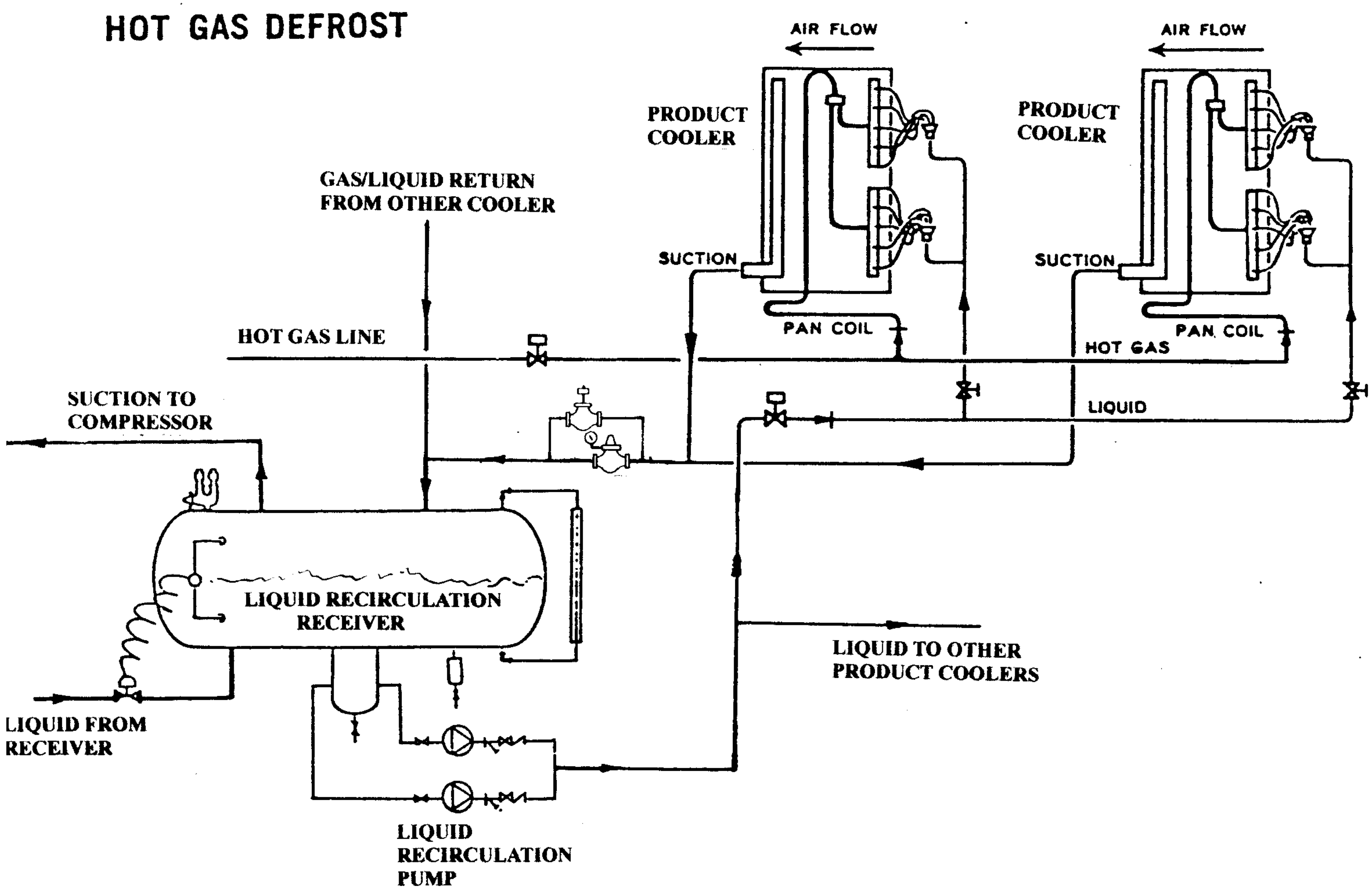

Figure 27-11 Typical Liquid Recirculation Piping Diagram

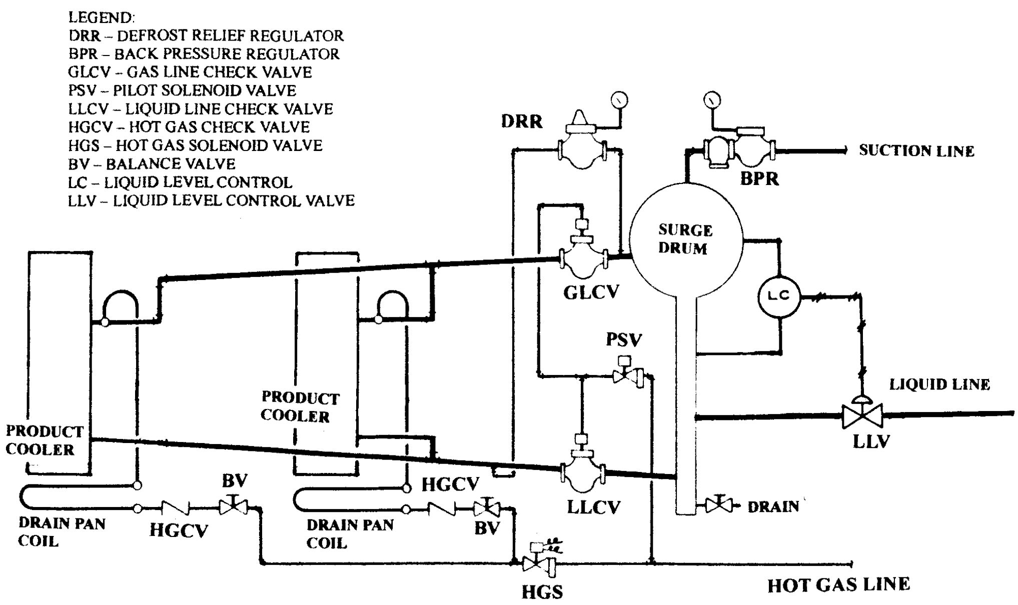

Figure 27-12 Typical Hot Gas Defrost
Flooded Cooler Piping Diagram

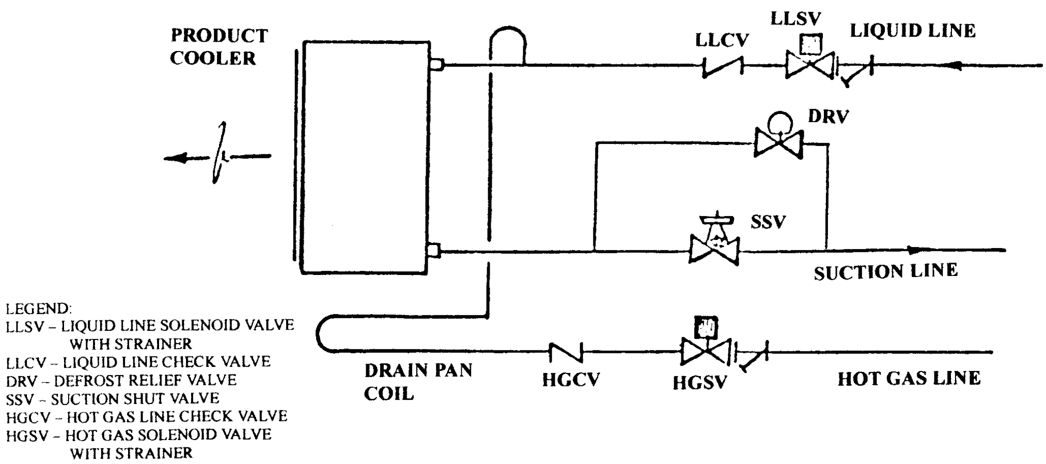

Figure 27-13 Typical Hot Gas Defrost
Liquid Recirculation Piping Diagram

REFRIGERATION CYCLE – The fans are on, the liquid from receiver flows into the surge drum through the liquid line valve (LLV) which is controlled by the liquid level controller (LC); the pilot solenoid valve (PSV), hot gas solenoid valve (HGS) and the defrost relief regulator (DRR) are closed. The liquid line check valve (LLCV) and gas line check valve (GLCV) are open. Suction gas returns to compressor suction through the back pressure regulator (BPR).

DEFROST CYCLE – The fans are off, the liquid line valve (LLV) is closed; the pilot solenoid valve (PSV), hot gas solenoid valve (HGS) and the defrost relief regulator (DRR) are open. The liquid line check valve (LLCV) and gas line check valve (GLCV) are closed. The hot gas flows through the drain pan coil and to the coil of the evaporator to defrost the ice on the coil. The hot gas is condensed inside of the coil, the liquid condensate flows to surge drum through defrost relief regulator (DRR). The defrost relief valve is to be set to a 70 psig back pressure in case of ammonia on the coil during defrost cycle; the hot gas pressure for the defrosting should be at least 110 psig.

Hot Gas Defrosting for Liquid Recirculation Evaporator:

Figure 27-13 shows a typical piping system for hot gas defrosting liquid recirculation evaporator.

REFRIGERATION CYCLE – Fans are on, liquid line solenoid valve (LLSV) and suction shut valve (SSV) are open, defrost regulating valve (DRV) and hot gas solenoid valve (HGSV) are closed.

DEFROSTING CYCLE – Fans are off, liquid line solenoid valve (LLSV) and suction shut valve (SSV) are closed, defrost regulating valve (DRV) and hot gas solenoid valve (HGSV) are open. The hot gas flows through the drain pan coil and to the coil of the evaporator to defrost the ice on the coil. The hot gas is condensed inside of the coil, the liquid condensate flows through suction line back to liquid recirculation receiver through defrost relief valve (DRV).

Top Feed or Bottom Feed for Liquid Recirculation Coil:

Figure 27-14 shows a product cooler with liquid recirculation coil. The coil has two headers, inlet and outlet. The inlet header feeds number of tubes; the tubes are routed back and forth through the length of the evaporator. Each tube passage, from liquid header to the suction heater; this tube passage is called circuit. If the refrigerant liquid is unevenly distributed the circuits, due to pressure differences, the liquid usually “starves” the top circuits of the coil. There, orifices should be inserted into the tube openings in the liquid header to resolve this problem as shown in Figure 27-15.

Figure 27-15 also shows “Top Feed” and “Bottom Feed” arrangements for the liquid recirculation coil. There is no definite conclusion as which one method is better than the other.

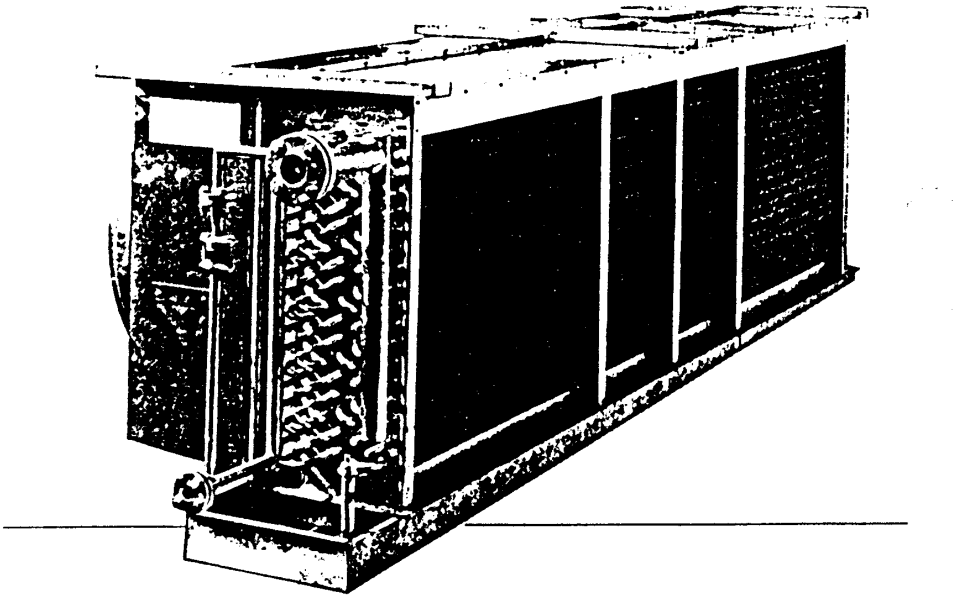

Figure 27-14 Typical Liquid Recirculation Unit Cooler

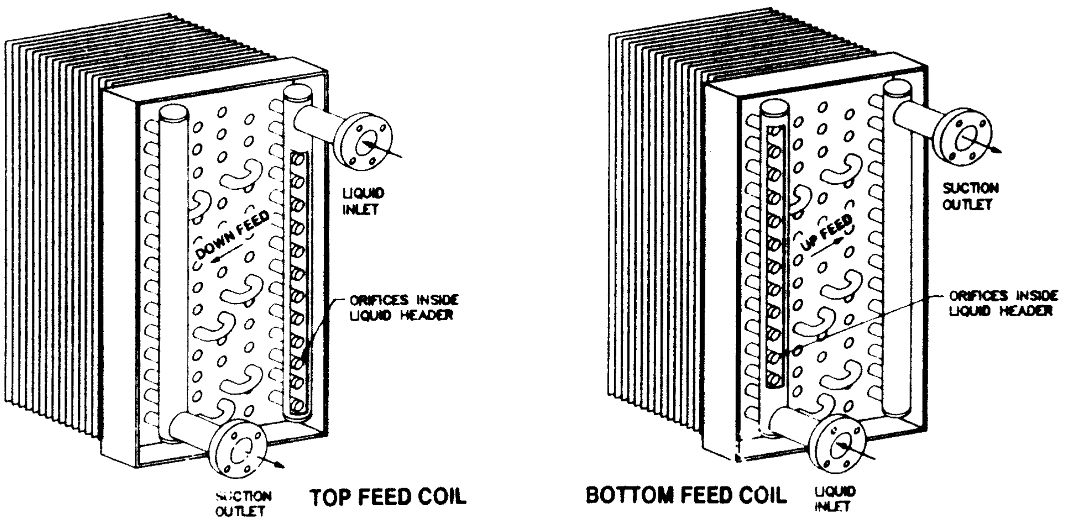

Figure 27-15 Top Feed Vs Bottom Feed
Liquid Recirculation Coil

Data Required for Product Cooler or Unit Cooler Selection:

- Refrigeration capacity, Btu/Hr.
- Room design temperature.
- Evaporative temperature.
- Refrigerant.
- DX, Flooded, Liquid Recirculation or Brine.
- Coil material.
- Coil FPI. 3, 4, or 6 FPI.
- Vari-fin application.
- Type of fan and motor, power supply.
- Type of defrosting.
- Other options.

Liquid Spray No-Frost Cooler:

The liquid spray no-frost cooler is to use a brine solution such as propylene glycol or ethylene glycol, the brine is spray continuously over the evaporator coil to keep the coil from frosting. But, this type of spray cooler is not widely used for modern cold storage facilities except that the brine solution is Lithium Chloride (LiCL) or Tri-Ethylene Glycol (TEG) for hygienic applications.

The liquid spray no-frost cooler system consists of two sections as shown in Figure 27-16. The No-Frost evaporator section is to be located inside the cold room or outside of the cold room connected with supply and return air ducts. The Solution Concentrator or Regenerator section is to be located outdoor.

The no-frost cooler section consists of the fan assembly, the refrigeration coil, pump and spray assembly, eliminator assembly and the casing with solution sump. No-frost liquid or brine solution is pumped and sprayed over the evaporator coil; the cooler fan circulates the air from the refrigerated space through the coil, the eliminator and back to the cold storage area. The no-frost liquid solution washes the frost on the coil surface continuously. The no-frost liquid solution then becomes diluted and is pumped to the solution concentrator which is located at the outdoor.

The Solution Concentrator (or regenerator) section consists of fan assembly, the heating coil, pump and spray assembly, eliminator assembly and the casing. The diluted solution from the no-frost cooler is pumped to the solution concentrator through a heat recovery heat exchanger. The diluted solution is sprayed in the regeneration section where excessive moisture is evaporated from the liquid mixture by circulating outside air and also with supplement heat from a heating coil, if needed. The enriched and regenerated solution is then circulated through the heat recovery heat exchanger, back to the no-frost cooler.

Hygienic No-Frost Coolers:

The operation theory for the hygienic no-frost cooler is same as shown in Figure 27-16. Hygienic no-frost cooler is used for those installations where sterilization is required.

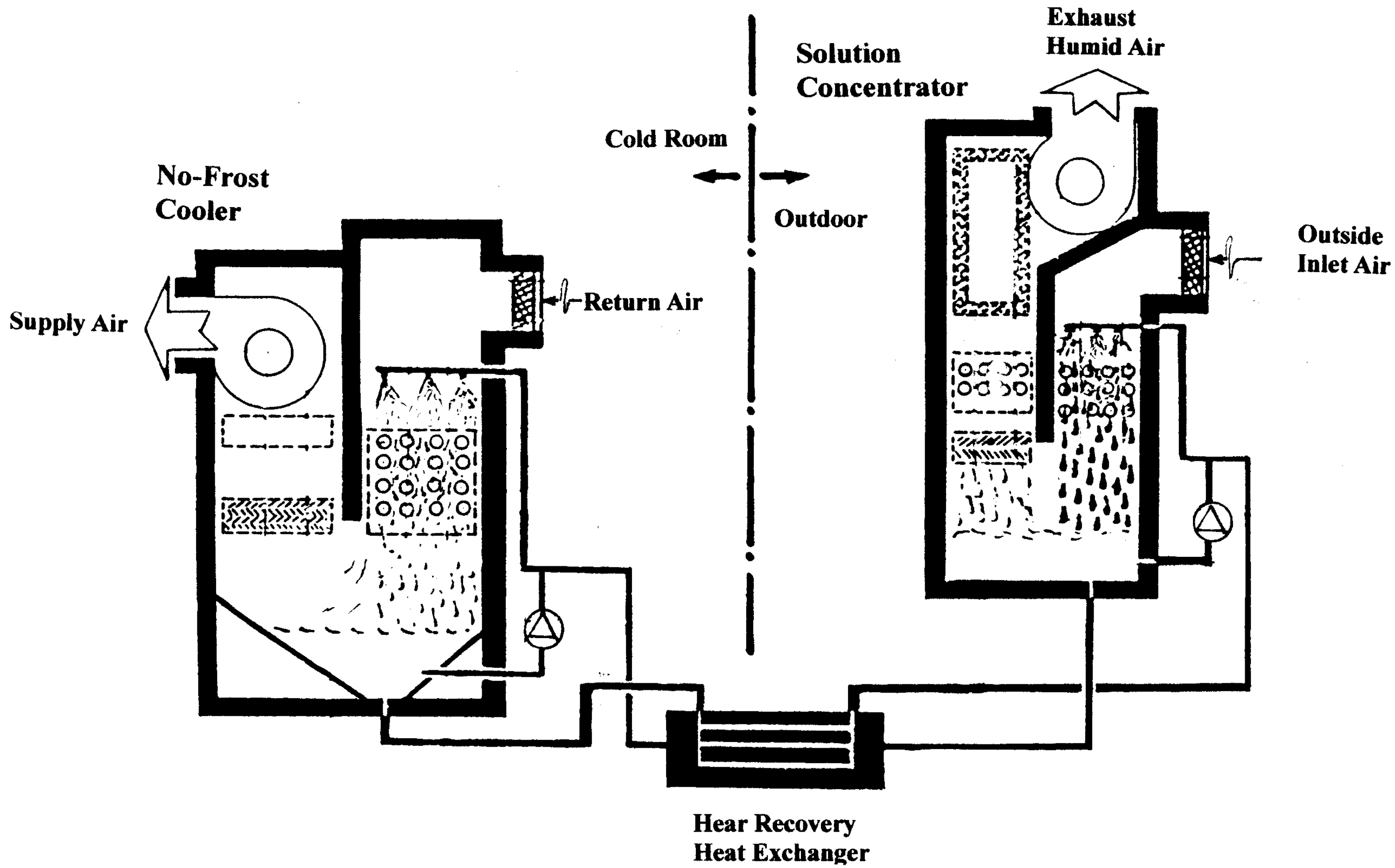

Figure 27-16 No-Frost Cooler System

The hygienic type no-frost cooler removes airborne mold spores, bacteria, particles, germs and micro-organism. Therefore, the hygienic no-frost cooler is mostly used for food processing, breweries and hospital rooms, etc. Also, it might be used for area that great amount of washing such as aging and fermenting tank in brewery or area produces extremely high latent loads; it also use for meat packing, food processing plants, food distribution centers, frozen food warehouse, chemical plants and laboratories.

There are basically two types of liquid absorbents used for no-frost hygienic application, Lithium Chloride (LiCL) and Tri-Ethylene Glycol (TEG). Lithium Chloride (LiCL) is a corrosive and toxic material, therefore, the eliminator efficiency must be very good for this type of solution. On the other hand, Tri-Ethylene Glycol is a non-toxic and non-corrosive material; it meets the approval of USDA and CFIA for use with food grade application.