Hermetic Absorption Liquid Chillers

MACHINE OPERATION

START-STOP SYSTEMS

The type of start-stop system for a given machine is established by the customer. Three of the most commonly used systems are covered below. Review these and decide which system applies to your machine. Then follow the Machine Start-Up procedure for that system.

If machine has been shut down for more than 2 days, follow Start-Up After Limited Shutdown or Start-Up After Extended Shutdown procedures

Automatic Start-Stop — Starting and stopping is accomplished by using an automatic controller such as a thermostat or time clock. The machine can also be manually started by placing the START-STOP switch in "Start" position.

Controls for auxiliary equipment are tied in with the machine control circuit and will start when the machine is started. If an automatic time delay is used, machine start-up will be after a preselected time interval.

Semiautomatic Start-Stop — The machine is started by the operator placing the START-STOP switch in "Start" position. Auxiliary equipment is tied in with the machine control circuit and will also start. The machine and auxiliary equipment are stopped by placing the START-STOP switch in "Stop" position. On shutdown, the machine and all auxiliary equipment will continue to run until automatic dilution has been completed.

Semiautomatic System With Manual Auxiliaries — Same as semiautomatic system except auxiliaries are manually controlled.

START-UP PROCEDURES

Start-up procedures differ, depending on how long the machine has been shut down. If shut down from 3 days to 3 weeks, use Start-Up After Limited Shutdown procedures. If shut down over 3 weeks, use Start-Up After Extended Shutdown procedures.

Start-Up After Limited Shutdown — Place START-STOP switch in "Start" position. If the leaving chilled water temperature drops to design, the machine is operating normally. If not, noncondensables may be present in the machine. Amount of noncondensables is determined by taking an absorber loss reading (difference between refrigerant temperature and solution saturation temperature). Refer to the section on absorber loss for procedure.

Machine sizes 077 thru 124 require an absorber loss reading from both ends

Machines with absorber loss readings of 6 F or less can normally operate without danger of solidification. If reading is above 6 F, auxiliary evacuation is recommended. A fully evacuated machine normally has a reading of 2 F or less. Refer to Initial Start-Up Instructions for auxiliary evacuation instructions.

To prevent solidification while evacuating:

1. Place reclaim switch in "Manual" position. *Reclaim valve(s) may cycle on low-level cutout*
2. Throttle steam control valve(s) by turning control point adjuster (electronic) or chilled water controller (pneumatic) adjustment knob clockwise until steam control valve is 1/4 open.
3. Check machine tightness with a noncondensable accumulation rate check. Refer to Initial Start-Up Instructions for procedure.

Start-Up After Extended Shutdown — This procedure is critical. Noncondensables may allow the machine solution to solidify if these procedures are not followed.

1. Start the machine by placing START-STOP switch in "Start" position.
   a. MACHINES WITH ROCKER-TYPE START-STOP SWITCH

      Open steam control valve until refrigerant pump energizes, then close valve. Allow refrigerant pump to remain in operation.
   b. MACHINES WITH PUSH BUTTON START-STOP SWITCH

      Make sure steam valve is closed If absorber solution level is high (above 9 in.) and refrigerant pump is noisy, turn off refrigerant pump, open steam valve until absorber level indicator shows approximately 9 in. of solution, then close steam valve. Place refrigerant pump switch in "On" position.
2. Determine machine absorber loss. The procedure is outlined in Maintenance section.
   a. If absorber loss is less than 6 F, open steam valve and allow machine to go into automatic operation.
   b. If absorber loss is 6 F or greater, auxiliary evacuation is required. When absorber loss of less than 6 F is established, the machine can be placed in automatic operation. After

auxiliary evacuation, check machine tightness with a noncondensable accumulation rate check.

Start-Up With Below Freezing Conditions — Refill all water circuits if previously drained, then follow Start-Up After Extended Shutdown procedures. Reclaim lithium bromide solution from refrigerant circuit using maintenance procedures given in section entitled Reclaim Solution

PARTIAL LOAD OPERATION

Larger size (077 thru 124) machines use only one steam control valve, refrigerant pump and solution pump when operating at low loads. When the machine load increases to a predetermined point, the second steam control valve and second set of pumps will energize. Refer to Fig. 1

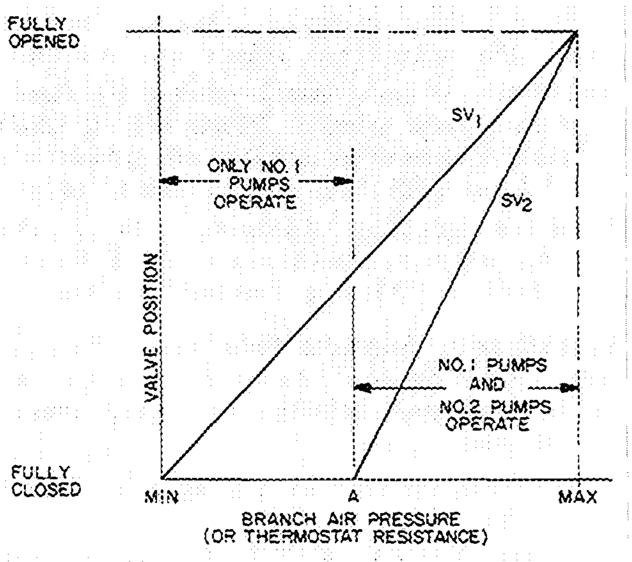

Fig. 1 — Typical Capacity Control Valve Positions (16JA077 thru 124)

If the machine has pneumatic controls, steam control valve no. 1 (SV_1) starts to open when the chilled water temperature rises, causing branch air pressure to increase. When branch air pressure reaches a predetermined point (point A, Fig. 1), steam control valve no 2 (SV_2) starts to open. The pneumatic-electric (PE) switch closes, causing no. 2 solution and refrigerant pumps to energize.

If the machine has electronic controls, the steam control valve (SV_1) opens when the chilled water temperature rises, causing the chilled water thermostat resistance to increase At some predetermined resistance (point A, Fig. 1), SV_1 signals SV_2 to start opening, also energizing no. 2 solution and refrigerant pumps.

MACHINE SHUTDOWN PROCEDURES

Above Freezing Conditions — Place START-STOP switch in "Stop" position and allow machine to go thru automatic dilution. When dilution has been completed, the machine may be left in this condition until spring start-up

Below Freezing Conditions — Place START-STOP switch in "Stop" position and allow machine to go thru automatic dilution. When dilution is completed, connect a hose between the solution pump and refrigerant pump service valves. Open both valves and place switches in positions indicated:

MACHINE SIZES 010 THRU 068

SWITCH	POSITION
Capacity Control	Off
Refrigerant Pump	Off
Reclaim	Off
Solution Pump	On
Start-Stop	Start

MACHINE SIZES 077 THRU 124

SWITCH	POSITION
Capacity Control	Off
Main Pump No. 1 and No. 2	On
Reclaim	Off
Pump No. 2	Manual
Start-Stop	Start

Remove overload heaters from both refrigerant pump starters to de-energize refrigerant pumps on machine sizes 077 thru 124.

Allow solution pump to run for 5 minutes This will mix lithium bromide solution with refrigerant, lowering the refrigerant freezing point.

Place START-STOP switch in "Stop" position. Ensure that all tube bundles are completely drained.

THE PURGE SYSTEM

Description — The purge system automatically removes noncondensables from the machine and accumulates them in a storage chamber where they cannot affect machine performance. This is done by circulating lithium bromide continuously thru the purge while the machine is in operation. Refer to Fig. 2; solution supplied from the solution pump discharge line enters the purge and splits into two streams. One stream enters the transfer tube, creating a lower pressure and picks up noncondensables entering from the absorber (as illustrated). The other stream sprays into the storage chamber creating a lower pressure which causes noncondensables to flow from the condenser to the storage chamber.

Noncondensables accumulate until the solution is forced out of the vent and drain tube and separation pot. This causes the float and reed switch contacts to close, energizing the purge exhaust light on the control panel. This indicates the purge needs to be manually exhausted. The following exhaust procedures are also given on an instruction sticker located on the purge separation pot.

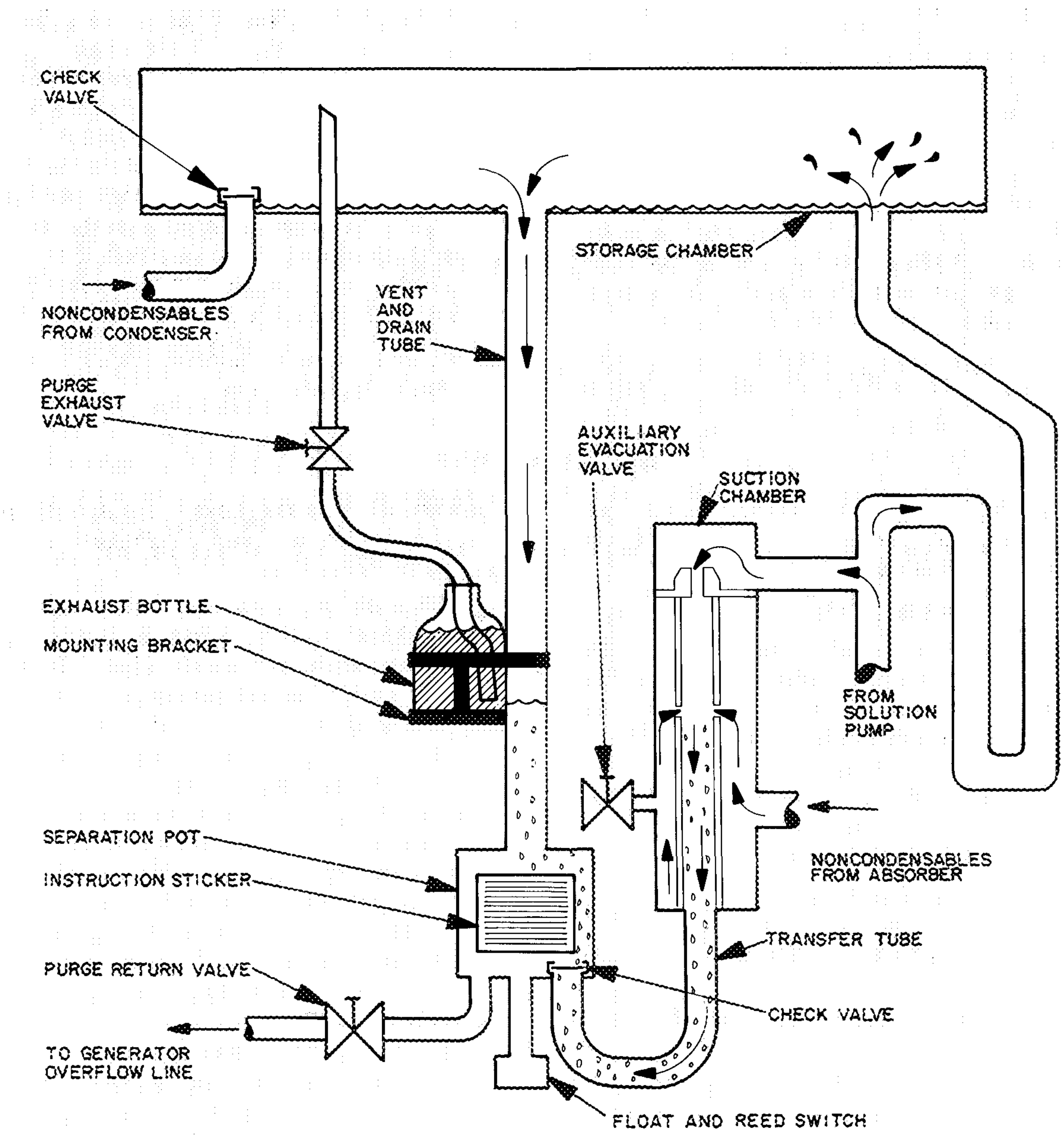

Fig. 2 — Purge System

Exhaust Procedures

1. Close the purge return valve.
2. Wait ten minutes for storage chamber to pressurize.
3. Open purge exhaust valve slowly. If level in container drops, close valve and wait two minutes. Reopen valve. When bubbles appear, leave valve open until bubbles stop. When level in container rises, close exhaust valve. With return valve in open position, open exhaust valve and allow part of the solution in container to be drawn into the purge. Close the exhaust valve before solution level in container nears the end of the tube. *Do not allow air to be drawn into tube*

SOLUTION DESOLIDIFICATION

General — Should solidification occur, it will usually occur in the shell side of the heat exchanger, and will prevent the strong solution in the generator from returning to the absorber thru the strong solution line. However, the strong solution will be returned to the absorber thru the generator overflow tube, thereby desolidifying automatically.

During a long, unscheduled shutdown period without proper dilution, due to prolonged power failure, solidification may occur. If solidification is to the extent that the solution pump will not rotate and the motor overloads trip out, desolidify by using the following procedure.

PROCEDURE

1. Heat the pump casing and adjacent lines with steam until the pump will rotate Be careful not to allow steam and condensate to enter the pump motor or controls. *Special precautions must be taken with hermetic pumps The pump casing may be warmed with steam, but, under no circumstances should heat be applied directly to any flange connection as the very high temperature will deteriorate the gasket material used*
2. Confirm pump rotation. Rotation of a hermetic pump cannot be viewed directly. Install a compound pressure gage on the solution pump service valve. With correct pump rotation, the gage will indicate a positive reading above atmospheric pressure. If the pump is solidified, the gage will indicate atmospheric pressure. If the casing is partially desolidified and the pump will not turn, the pressure gage should indicate a deep vacuum. Continue to heat the casing until the pump is desolidified. Desolidification of the heat exchanger will take place automatically once the pump starts functioning.
3. Refer to Troubleshooting for cause and correction of solidification.

MAINTENANCE

The following are scheduled inspections recommended for normal preventive maintenance on 16JA absorption machines.

AS NEEDED

Log Sheets — We recommend log sheets (Fig. 3) be used to record periodic readings of machine pressure-temperature conditions This will help the operator to recognize machine normal conditions, to plan a maintenance schedule, and to diagnose machine troubles. Log sheets are available in pad form from your Carrier representative.

Solution Or Refrigerant Sampling — A solution sample is taken periodically to check its temperature and specific gravity in order to determine absorber loss. To remove a sample, proceed as follows:

1 Install a hose adapter to solution or refrigerant service valve.

   Do not use copper or brass fittings Copper oxides will form, causing contamination of samples

2. Attach plastic tubing to adapter, fill tubing with water; place other end of tubing in a container filled with water.
3. Open service valve slightly. Be sure tubing end is under water. When water level in container rises, raise tubing and fill sample container.

   Before sampling, be sure machine is operating without side variations in load, or without recent reclaim valve operation

Inhibitor — It may be necessary to partially replenish the inhibitor charge after several thousand hours of machine operation. It is recommended that a sample of machine lithium bromide solution be analyzed on a yearly basis. Results of an analysis will indicate any inhibitor depletion and will also give an indication of machine tightness

Inhibitor analysis service is provided by Carrier. Contact your local Carrier representative for details.

Determine Absorber Loss — Insulate thermometer wells on solution pump discharge and refrigerant pump discharge lines.

Fill wells with heat conductive compound and insert thermometers. Remove a solution sample using procedure previously given. Determine its specific gravity and temperature. Use an equilibrium diagram to plot an intersecting point between specific gravity and temperature. Extend this point to saturation temperature scale (right side of diagram) to determine solution saturation temperature. Record refrigerant temperature at refrigerant pump discharge line(s). Subtract solution saturation temperature from refrigerant temperature. The difference is the absorber loss. More than 3 F is unacceptable. Absorber loss must be checked on both ends of the machine on machine sizes 077 thru 124.

Adding Octyl Alcohol — Octyl alcohol is usually required when the leaving chilled water temperature starts to rise above design (providing the control set point has not been altered). Since a rise in leaving chilled water temperature is also an indication of fouled condensing water tubes, use the following procedure to determine if alcohol is required: Remove a sample of solution from solution pump service valve. If solution has no odor of alcohol (very pungent), then octyl alcohol should be added. Amount to be added depends on machine size.

MACHINE SIZE	GAL.
010 – 021	1
024 – 028	2
032 – 068	3
077 – 124	4

Fill a length of flexible tubing with water. Connect one end of tubing to solution pump service valve. Insert other end in container of octyl alcohol. De-energize solution pump. Open service valve and allow alcohol to be drawn into machine. Close valve before air can be drawn into hose.

ENGINEER ____________________

DATE ____________________

JOB NAME ____________________ SIZE __________ JOB NO. __________ MACHINE SER NO. __________

HOUR METER READING	AT TIME OF DATA										
	AT LAST PURGE DUMP										
PURGE GAS VOLUME (CC OR ML)											
STEAM	PRESS. AT BOILER										
	PRESS. AT MACHINE										
	VALVE POSITION										
REFRIG	TEMP										
	SPECIFIC GRAVITY										
	VAPOR COND TEMP										
COOLER	PRESS. IN										
	PRESS. OUT										
	TEMP IN										
	TEMP OUT										
COND WATER	TEMP IN ABSORBER										
	TEMP OUT ABSORBER										
	PRESS. IN ABSORBER										
	PRESS. OUT ABSORBER										
	TEMP OUT COND										
WEAK SOLUTION	ACTUAL TEMP										
	SAMPLE TEMP										
	TEMP TO GENERATOR										
	LIQ LEVEL - ABSORBER										
	SPECIFIC GRAVITY										
	ALCOHOL IN SAMPLE (YES OR NO)										
STRONG SOLUTION	TEMP OUT GENERATOR										
	TEMP TO ABSORBER										

Fig. 3 – Typical 16JA Absorption Refrigeration Log

EACH MONTH

Reclaim Solution — During normal operation some lithium bromide solution may be carried over into the refrigerant. To determine if contamination exists, remove a refrigerant sample (from both ends on machine sizes 077 thru 124) as previously instructed and measure its specific gravity. If specific gravity value exceeds 1.02, then solution must be reclaimed.

RECLAIM PROCEDURE FOR CONTINUOUS OPERATION — Place reclaim switch in "Manual" position. Wait 15 minutes. Refrigerant will flow into solution circuit where lithium bromide solution is reclaimed. Return reclaim switch to "Auto" position. This will de-energize the refrigerant solenoid valve and will stop refrigerant flow.

RECLAIM PROCEDURE FOR FREQUENT SHUTDOWN — When machine is shut down, reclaim valve will automatically reclaim lithium bromide solution.

If reclaim valve does not energize (audible click), contact your nearest Carrier representative for assistance.

Check Machine Tightness — The most important maintenance item on the absorption machine is maintaining vacuum tightness within acceptable limits. Check machine tightness by determining the noncondensable accumulation rate.

Determine Noncondensable Accumulation Rate — Operate the machine approximately one week before determining noncondensable accumulation rate. Then proceed as follows:

1. Connect a flexible length of tubing to the purge exhaust connection. Fill tubing with water and insert into a container of water. Close purge return valve. Wait 10 to 15 minutes, then open purge exhaust valve slightly. If the liquid level in container recedes, close exhaust valve. Wait several minutes, then repeat this step. Purge is exhausting when bubbles rise thru liquid to surface. Leave valve open until bubbles stop and liquid level rises. Then close valve. Purge is now exhausted.
2. Open purge return valve and allow machine to operate for 24 hours.
3. Fill a 1000 cubic centimeter (or equivalent) bottle with water and invert it in a clean container filled with water.
4. Insert water-filled hose into bottle.
5. Exhaust the purge, following step 1. Noncondensables will displace water in the inverted bottle. Continue until bubbling in bottle ceases and only solution flows from exhaust tubing.
6. Close exhaust valve and mark liquid level on inverted bottle. Remove bottle from container.
7. Open purge return valve.
8. Measure amount of noncondensables removed. If a graduated bottle was used, the amount (volume) of noncondensables removed is indicated by mark on bottle. If a nongraduated bottle is used, empty the bottle, then fill bottle with liquid to exhaust mark. Pour liquid into a graduated container to measure volume displaced.
9. Refer to Table 1 for your machine's maximum allowable noncondensable accumulation leak rate. If accumulation rate exceeds allowable leak rate for your machine, then machine must be leak tested.

Table 1 — Maximum Allowable Noncondensable Accumulation Rate

UNIT 16JA	MAX ALLOWABLE RATE (cu in./hr)	UNIT 16JA	MAX ALLOWABLE RATE (cu in./hr)
010,012,014	0 30	054,057	0 90
018,021	0 45	061,068	1 20
024,028	0 60	077,084	1 40
032,036	0 77	097,107	2.00
041,047	1.00	115,124	2.20

EVERY 2 MONTHS

Check Dilution Thermostat(s) — Dilution thermostat(s) should open when strong solution temperature drops to 140 F. If thermostat contact point is not at 140 F, adjust by inserting screwdriver in slot on face of thermostat (located on strong solution line).

Check Low-Temperature Cutout — Remove control sensing element from low-temperature cutout well(s) on evaporator shell. Place in an ice bath and check cutout point. Control should trip at 5 F below design leaving chilled water temperature or at a minimum of 34 F

Cutout point is dial setting less 3 F differential. When control trips, the machine will shut down immediately without going thru a dilution cycle.

Chilled water pumps will continue to run if standard wiring arrangement is used

EVERY 6 MONTHS

Check Evaporator Water Charge — Tube leakage or excess refrigerant is indicated if reclaim valve is energized continuously during normal machine operation.

Reclaim valve should energize at full load, which is approximately 59.5 percent lithium bromide solution concentration in the absorber. To check this, operate the machine at full load with design entering condensing water temperature and design leaving chilled water temperature. Remove an evaporator water sample from refrigerant pump service valve and check its specific gravity. If value is below 1.02, check absorber loss. Absorber loss should be 2 F or less. If more, purge air from machine. If specific gravity value is greater than 1.02, reclaim solution until specific gravity value falls below 1.02. Then absorber loss can be checked.

Check reclaim line by feel. If line is already cold with audible flow, remove refrigerant until reclaim valve closes (audible click) and refrigerant flow ceases.

When machine is operating at partial load, lithium bromide solution must be concentrated to 59.5 percent before checking evaporator water charge. This is done by raising entering condensing water temperature, then lowering control point adjuster setting to below design leaving chilled water temperature.

Continual removal of water indicates tube leakage.

Check Capacity Control Valve — Check the leaving chilled water temperature. If temperature is not being maintained at design, adjust electronic or pneumatic capacity control as follows.

ELECTRONIC CONTROL ADJUSTMENT — Move control point adjuster clockwise to increase temperature or counterclockwise to decrease temperature.

If this fails to bring leaving chilled water temperature within design, replace vacuum tubes in control motor and clean relay contacts with stiff paper. Be sure new tubes are installed properly.

If this fails to correct the problem, contact your Carrier representative.

PNEUMATIC CONTROL ADJUSTMENT — Reset control point setting to design. If this fails to correct the problem, contact your Carrier representative.

Check Cooling Tower Bypass Control — If control is not maintaining design entering condensing water temperature, recalibrate the control thermostat. For additional information, contact the valve (or control) manufacturer.

EVERY YEAR

Check for Absorber and Condenser Scale — Check absorber and condenser tubes to see if cleaning is required. Soft scale may be removed with tube cleaning brushes. When hard scale has formed, it may be necessary to chemically clean the tubes. If a scale problem occurs, contact a water treatment representative. Annual tube cleaning may not be required if adequate water treatment is maintained.

EVERY 2 YEARS

Replace Service Valve Diaphragms — Requirement to replace valve diaphragms is determined by valve usage or number of machine operating hours Less frequent usage of valves and lower number of machine operating hours results in longer life span for valve diaphragms. With minimum usage, the requirement to replace diaphragms might be 3 years. With maximum usage, they will need to be replaced in approximately 2 years To replace valve diaphragms, break machine vacuum with nitrogen (procedure given in Initial Start-Up Instructions). Remove all solution and refrigerant from machine. Store solution in clean containers for recharging. Remove old valve diaphragms and replace. Torque valve bolts to 3 ft-lb. Retest all affected connections for leakage. Replace solution and refrigerant in machine. The same quantity of solution and refrigerant removed must be replaced. Reevacuate machine after servicing. Machine evacuation procedures are given in Initial Start-Up Instructions.

EVERY 7 YEARS

Inspect Hermetic Pumps — Pumps used on Carrier absorption machines are hermetic and do not require seals. Pump motors are cooled by the fluid being pumped and are thermally protected with high temperature cutouts (Klixons).

Inspect hermetic pumps and motors every 7 years or 30,000 hours, whichever comes first.

ORDERING SPARE PARTS

Order spare parts from your nearest Carrier office. To speed up the process of filling parts orders, supply the following information:

1. Delivery address.
2. Machine size and machine serial number.
3. Part name, part number, and quantity required.
4. Orders for pump parts must show pump motor serial number found on motor nameplate

TROUBLESHOOTING GUIDE

SYMPTOM OR DIFFICULTY	POSSIBLE CAUSE	REMEDY
SOLIDIFICATION AT START-UP	Condensing water too cold	Adjust cooling tower bypass valve or fan control for design conditions
	Air in the machine	Purge the machine
	Improper purging	Check purge valve positions against instruction sticker on purge assembly Check machine leak rate
SOLIDIFICATION DURING MACHINE OPERATION	Condensing water too cold	Adjust cooling tower bypass valve or fan control for design conditions
	Steam pressure above design	Reset for design conditions
	Vapor condensate temperature below 114 F at full load	Reduce condensing water flow
	Machine needs octyl alcohol	Add octyl alcohol
	Improper purging	Check purge valve positions against instruction sticker on purge assembly. Check machine leak rate
	Air leakage	Leak test the machine
LOW CAPACITY	Air in the machine	Find and repair leak. Purge the machine
	Condenser tubes dirty (Vapor condensate temperature above 114 F)	Clean the tubes Determine if water treatment is needed.
	Improper purging	Check purge valve positions against instruction sticker on purge assembly Check machine leak rate
	Machine needs octyl alcohol	Add octyl alcohol
	Improper capacity control valve setting	Reset valve to design temperature by rotating control point adjuster (ccw)
	Insufficient condensing water flow or temperature too high	Adjust tower bypass valve Check operation of fans Check strainer
	Solution temp in generator below design at full load	Raise steam pressure to design Check strainers and traps
MACHINE SHUTS DOWN ON SAFETY CONTROL	Condensing water pump or chilled water pump overloads tripped out	Reset Determine reason for failure
	Refrigerant or solution pump overloads tripped out	Reset. Determine reason for failure
	Shut down on low temperature cutout	Check cutout control setting Adjust control point adjuster setting or chilled water controller to maintain design leaving chilled water temperature Check condensing water temp control
SOLIDIFICATION DURING SHUTDOWN	Dilution cycle not long enough	Adjust the dilution thermostat setting to 140 F If solidification continues, reset to a lower cutout temp
	Improper closing of capacity control valve	Check valve closure Desolidify
HIGH ABSORBER LOSS	Leakage in vacuum side of machine	Determine noncondensable accumulation rate Leak test and repair any leaks.
	Inhibitor depleted.	Make a solution analysis to determine extent of depletion
VACUUM LOSS AT SHUTDOWN	Leakage in vacuum side of machine	Leak test the machine Repair any leaks
FAILURE TO KEEP MACHINE PURGED	Leak rate above the pumping rate of the purge	Perform leak rate check Leak test the machine. Repair any leaks
	Purge valves not functioning	Check valve positions
	Purge solidified	Desolidify.
	Lack of solution flow from solution pump to purge	Contact your Carrier representative

16JA ABSORPTION CYCLE

The 16JA machine is basically constructed of two shell and tube assemblies. The larger shell is the absorber-evaporator section. The upper shell is the condenser-generator section. A solution pump and a refrigerant pump are used to circulate fluids. A capacity control valve automatically controls machine capacity.

Flow Description — Basic flow circuits (Fig. 4) are as follows:

Warm water or fluid to be chilled enters the evaporator tube bundle and is cooled by sprayed refrigerant. Then it is pumped to air-handling or process equipment where it will be used for air conditioning or cooling.

The sprayed refrigerant picks up heat and, due to low pressure, is vaporized. These vapors migrate to the absorber section and are absorbed by the lithium bromide solution. As the solution becomes diluted, the absorption rate decreases, necessitating reconcentration of the solution. This is done by pumping the solution thru a heat exchanger where it picks up heat (improves cycle efficiency), then thru the generator chamber where it is heated by steam or hot water to boil the refrigerant out of the solution. The reconcentrated solution flows back thru the heat exchanger and into the absorber spray section, completing its cycle.

The refrigerant boiled out of the solution in the generator rises and condenses on the condenser tube bundle. It then flows back to the evaporator chamber thru the vapor condensate line and into the refrigerant sump, completing its cycle.

The capacity control valve operates by a controller which senses leaving chilled water temperature. At full load conditions, the control valve is wide open. As the chilled water temperature drops below design temperature, the control valve will be throttled. At no load conditions the control valve will be closed.

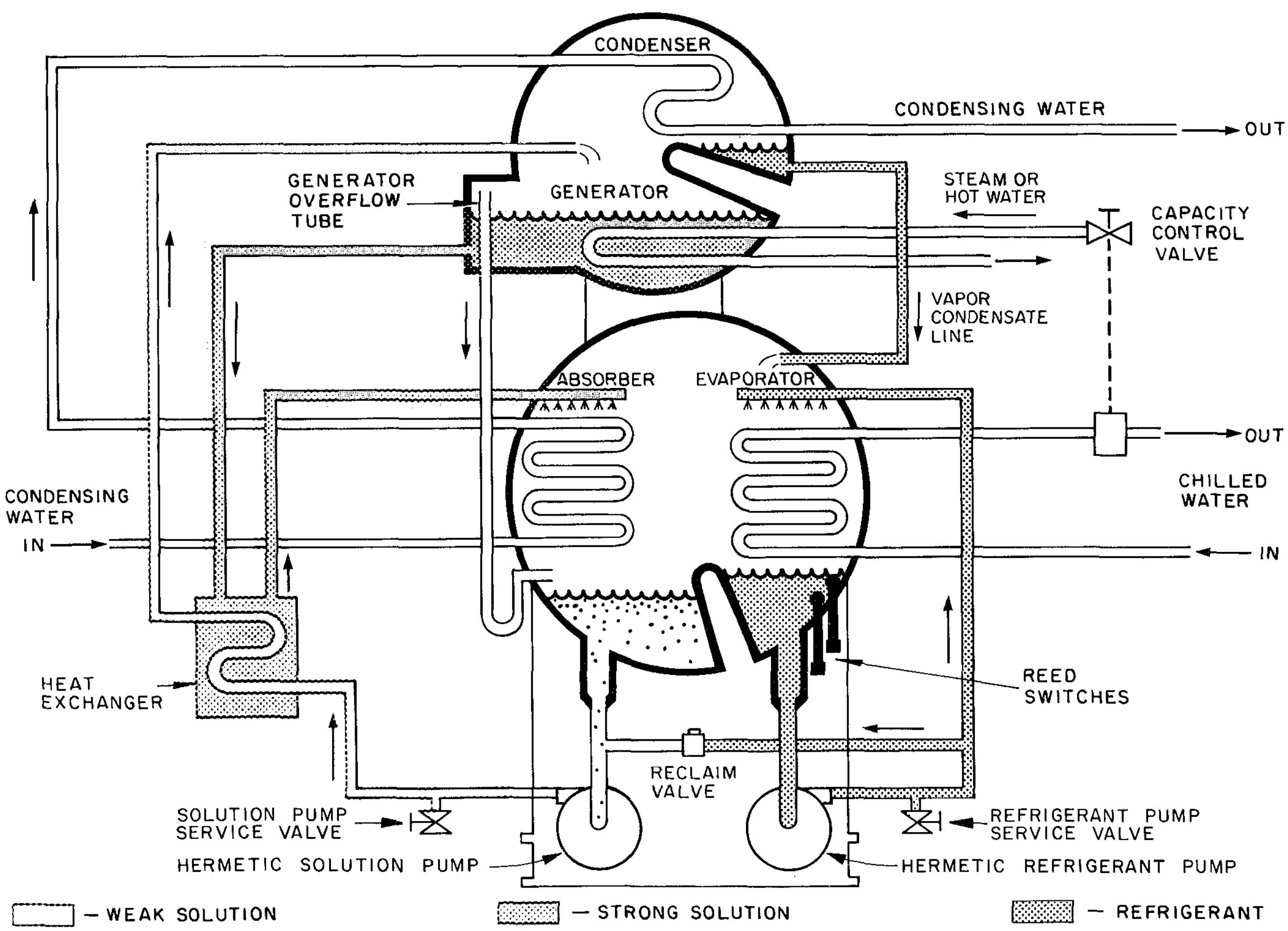

Fig. 4 — 16JA Absorption Cycle

EQUILIBRIUM DIAGRAM

Solution concentration in an absorption machine must be controlled within certain limits in order to maintain equilibrium conditions. The Equilibrium Diagram (Fig. 5) is used to plot and determine solution concentration.

Description — The crystallization line (lower right corner) indicates conditions where solution can change from a liquid to a solid. All points of an absorption cycle should fall above this line. Crossing the line does not necessarily result in solidification if subcooling does not progress too far. When lithium bromide solution temperature drops below the crystallization line, only a portion of the salt solution will solidify. The rest of the solution becomes more dilute but does not solidify. Solidification does not harm the machine but it can interrupt service.

The left scale (horizontal lines) indicates solution vapor pressure at equilibrium conditions. The right scale is the corresponding saturation temperatures. This scale is located on the right side of the chart to avoid confusion

The bottom scale (vertical lines) represents solution concentration. For example, a lithium bromide concentration of 60 percent actually means 60 percent lithium bromide and 40 percent water by weight

The curved lines running left to right are solution temperature lines. *Do not confuse these with saturation temperature lines*

The curved lines extending upward from the bottom of the diagram are specific gravity lines. They are used to determine solution concentration. Percent of concentration can be determined by measuring the specific gravity with a hydrometer and checking the solution temperature. Then plot the intersecting point for these values on the diagram. Read down to determine the percent of lithium bromide

A typical absorption cycle is plotted on Fig. 5. Points 1 thru 7 represent a complete cycle. Specific values for each point are given in Table 2.

→ **Table 2 — Cycle Data**

POINT	SOLUTION TEMP (F)	VAPOR PRESS (in. Hg)	PERCENT LITHIUM BROMIDE SOL	SATURATED TEMP (F)
1	101	0 25	59 5	42
2	165	1 65	59 5	95
3	192	3 20	59 5	115
4	215	3 20	64 0	115
5	134	0 45	64 0	55
6	119	0 30	63 0	45
7	115	0 25	63.3	42

An explanation of each point and lines drawn between is as follows.

Point 1 represents weak solution leaving the absorber, entering the heat exchanger.

Point 2 represents weak solution leaving the heat exchanger. Line 1–2 represents heat gained by the solution in the heat exchanger.

Point 3 represents weak solution in the generator. Line 2–3 represents amount of heat required to boil the weak solution in the generator.

Point 4 represents maximum solution concentration in the generator after refrigerant has boiled out. Line 3–4 represents amount of heat required to boil off the refrigerant.

Point 5 represents strong solution leaving the heat exchanger. Line 4–5 represents the amount of heat lost by the solution in the heat exchanger.

Point 6 represents strong solution entering the spray nozzles.

Point 7 represents strong solution spraying out of the absorber nozzle, starting to absorb refrigerant. Line 7–1 represents absorption of refrigerant (diluting the solution).

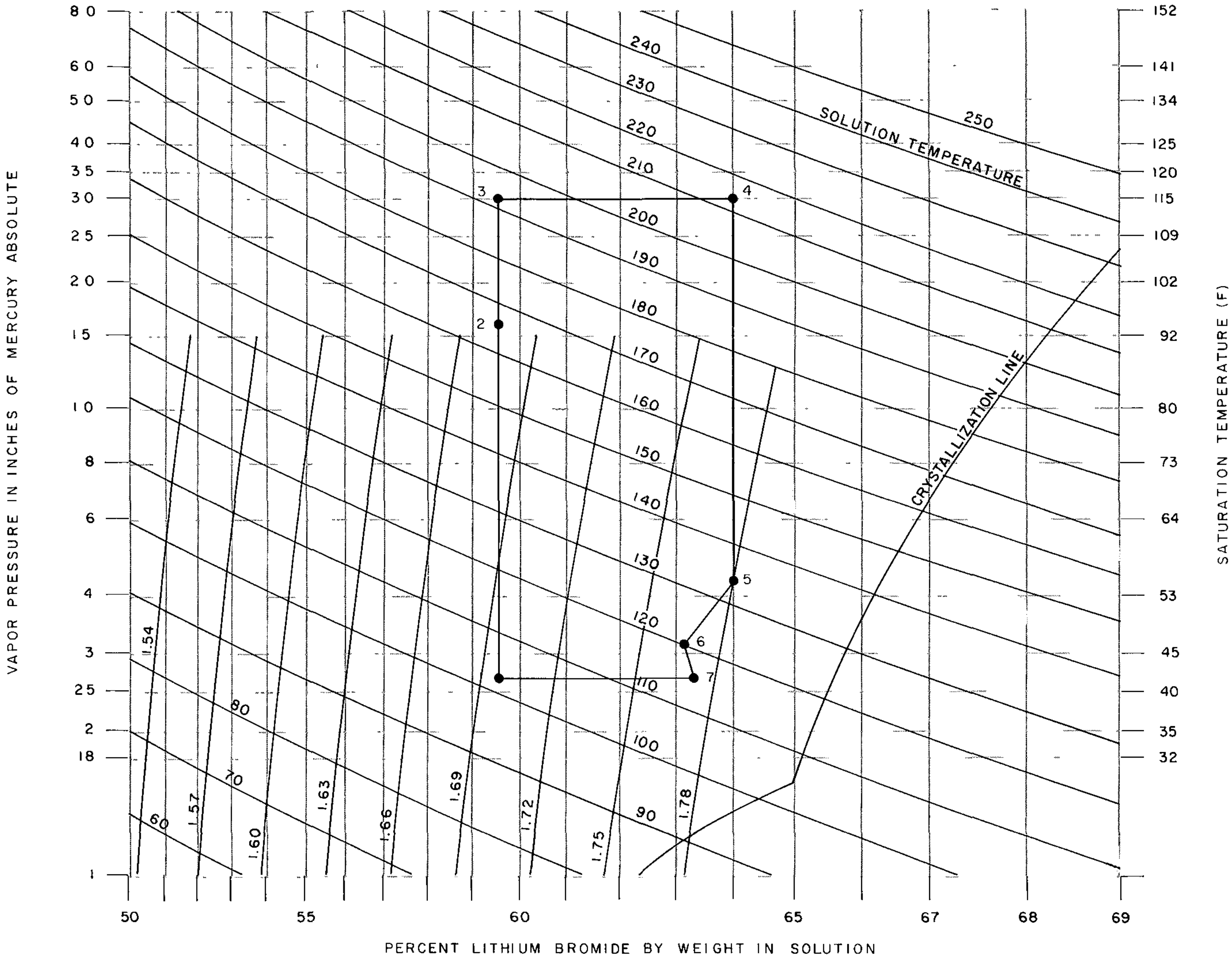

Fig. 5 – Equilibrium Diagram

For replacement items use Carrier specified parts.

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Tab 15 Form 16JA-4SO Supersedes 16JA-2SO, 16JA-3SO Printed in U S A 5-70 PC 211 Catalog No 531-647

Book	2
Tab	5b