TWO STAGE STEAM ABSORPTION CHILLER
OPERATION AND MAINTENANCE MANUAL

Finetec Century

CONTENTS

1. Caution⚠

1.1 Caution labels on the chiller

Safety-related information, which must be strictly observed by all chiller operators, is given on caution labels. These caution labels are attached to the chiller. Figure 1.1 shows the location of caution labels.

Caution labels contain very critical information, but there are a variety of other cautionary items which all operators must follow. This section is prepared to give important safety-related information based on the caution labels.

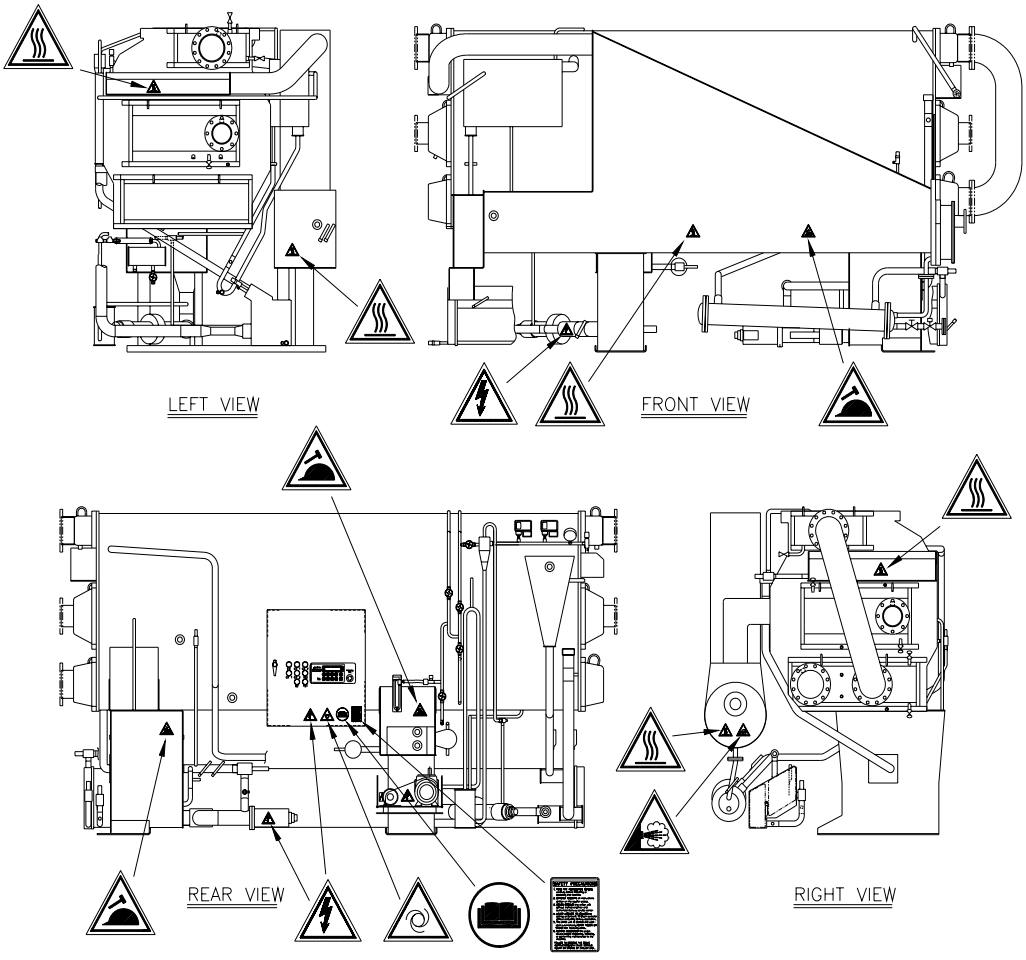


Figure 1.1 The location of caution labels

(1) Safety precautions

The chiller is shipped with a variety of built-in safety devices. However, careless handling of the chiller may lead to serious accidents. To prevent such a situation from occurring, all operators must carefully read this manual.

All important information is written on caution labels which are attached to the chiller at easy-to-see locations. Caution labels contain critical information and must be strictly observed by all operators; failure to observe the caution label information can lead to serious accidents.

The operation setting value is set to the optimum conditions by Finetec Century. Never try to change the chiller setting value without our comments.

⚠ WARNING

The unit shall be handled by only specialists.

Transportation, installation and maintenance including dangerous works shall be done by persons who have full knowledge and experience on the unit and the system.

Control panels of this unit shall be opened only by qualified service engineer or qualified person.

⚠ WARNING

If any abnormal condition occurs, action to the fault shall conform to the manual.

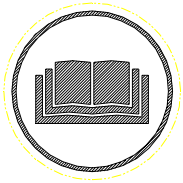
- Confirm the alarm appeared on the control display panel.
- Shut off power supply.
- Request for service shall be done.
- If any failure occur, do not operate the unit.

OTHER PRECAUTIONS

1. **READ THE INSTRUCTION MANUAL** carefully before installing or operating the machine.
2. **STRICTLY OBSERVE** all instructions written on the caution plates.
3. **NEVER OPERATE** the chiller unit without trained enginner and authorized Century service center.
4. **NEVER ATTEMPT TO CHANGE** the settings at Centronic 10 Micom controller without consulting Century coporation.
5. The chiller unit is started and oper-ated automatically, **NEVER TOUCH OR STAND** near revolving parts.
6. **ALWAYS DISCONNECT** the power source before inspecting, repairing, or performing maintenance to the machine.

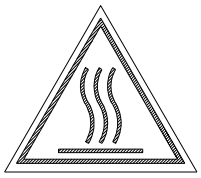
FAILURE TO OBSERVE THE ABOVE INSTRUCTIONS MAY CAUSE SERIOUS INJURY OR DAMAGE OF CHILLER UNIT.

(2) Symbol mark definition

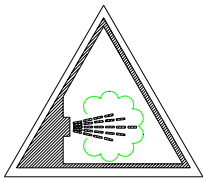


① Read this manual carefully before the chiller operation.

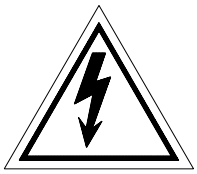
② It is necessary to clothe the safety hat and safety gloves when check and handle the pumps. Caution a keen part of the chiller with a safety hat and watch your head not to be hurt.



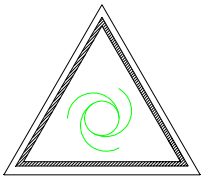
③ Caution a hot surface of the chiller not to be a burn.



④ Caution a joined part with flanges of the steam header not to be a burn by packing leakage.



⑤ Caution the electric shock.



⑥ Don't stop the chiller abruptly.

1.2 General cautions⚠

Read the instruction manual carefully and observe its contents to use the Finetec Century absorption chiller in safe for a long time and manage it economically.

Operation manager and the operator in charge shall not fail to read the instruction manual carefully before starting the operation, and if they have any question, please contact Finetec Century to understand its contents fully and then start operation.

(1) Air-leak may cause severe corrosion.

The chiller uses Lithium bromide(LiBr) solution. Therefore its daily check is very much important to prevent the air-leak into the chiller from outside. In addition, even if the air is not introduced into the chiller extraordinarily, LiBr solution may corrode shell plate and heat transfer tubes. So, corrosion inhibitor must be added to LiBr solution to prohibit such a

corrosion. Corrosion inhibitor has been consumed with losing its function little by little in accordance with the operation so that you have to analyze the solution property periodically to keep its normal value.

(2) You have to check water quality periodically.

Heat transfer tubes, of which the chilled water, cooling water and hot water flow inside, may be seriously damaged by the contamination in the case of bad water quality so as to make heat exchange worse and to deteriorate cooling capacity or heating capacity. Bad water quality may cause heat transfer tube to corrode. Therefore it is necessary to check water quality and heat transfer tube corrosion by eddy current flow detector and the inside diameter of tube periodically to prevent heat transfer tube from being corroded and to avoid the accident in advance.

(3) Finetec Century is not responsible for the defects caused by either careless management or bad water source and irregular power source regardless of the guarantee period.

⚠ Caution

The above mentioned items are very much important to give effect on the life of the chiller. Therefore it is necessary to manage it carefully with referring to this manual for more details.

1.3 Notices and Warnings about Residual Risk

(1) Notice⚠

1) Because each parts of the chiller are very heavy, you may be hurt by depression the chiller on exchanging and repairing the trouble part. But, exchanging work about such heavy parts as shell and heat exchangers cannot be done by users. If such parts have a trouble, contact with Finetec Century or our agents. And those parts is not easily destroyed on the operation.
2) The noise of Finetec Century absorption chiller isn't exceeded above 85 dB. therefore, anti-noise equipments no need. If the noise is severe, check the pump cavitation.
3) Because small particles and welding sludge inside of the chiller is removed in the factory, nozzles of evaporator and absorber are not clogged by foreign material at first. Even if floating material may be produced by corrosion, the particle is not enough large to clog the nozzle. And because this problem result from a leak, it is possible to protect the leak before trouble occurrence.
4) The heat exchangers are welded, not flanged, each other to protect a leak. Because only the crystallization causes the tube to clog, this problem may be solved by decrystallization operation. But if corrosion is proceeded by a leak, tubes may be damaged by a corrosion and the normal cooling operation may be impossible. When it is happened, contact with Finetec Century or our agents.
5) Except the solution pump and refrigerant pump, it is not anything to be maintained by user between the internal parts of the chiller. Most parts are welded each other to protect a leak. Refer to section 10.8 for solution pump and refrigerant pump maintenance.
6) The most important problem of absorption chiller is a leak introducing the ambient air

into the chiller, which result in corrosion and cooling capacity decrease.

7) The air vent and drain valve shall be kept to open after water drain to prepare the cold season.

8) This manual may be reformed without notice to users.

9) Eddy current inspection is based on the principles of electromagnetic induction and is used to identify or differentiate among a wide variety of physical, structural, and metallurgical conditions in electrically conductive ferromagnetic and non-ferromagnetic metals and metal parts. Because eddy currents are created using an electromagnetic induction technique, the inspection method does not require direct electrical contact with the part being inspected. The eddy current method is adaptable to high-speed inspection and, because it is nondestructive, can be used to inspect an entire production output if desired. The method is based on indirect measurement, and the correlation between the instrument readings and the structural characteristics and service ability of the parts being inspected must be carefully and repeatedly established. But, because the eddy current flaw detector is very expensive and complex to use, generally tube flaw detect is performed by experts.

(2) Warning⚠

1) Wet hand should be apart from the control box and electric cable.

2) Don't touch the hot surface of the chiller not to be a burn.

3) Pay attention many sharp edges of the chiller not to be hurt

4) Thermistor connection line is very thin. Pay attention not to be cut.

5) Condensed water outside of the chilled water piping should not drop to the chiller surface and control box.

6) Steam piping is very hot.

7) When manipulating the control panel, pay attention not to be shocked.

8) Pay attention not to be changed the setting values in ASIC controller by neighborhood.

9) Don't drink solution and alcohol and touch by hand.

10) The machinery room filled with explosive gas may result in the explosion by electric spark.

11) After power off, countermeasure the electric components.

12) It is not allowed that chilled and cooling water supply pressure is higher than specified value.

13) Without notice to us, don't disassembly the shell, heat exchangers and 1st stage generator.

14) Pay attention to slowly open the steam manual valve to prevent steam hammer.

15) Pay attention to adequate electric power.

16) Check the tube crack of evaporator, absorber, condenser and 1st stage generator periodically referring to maintenance section.

17) Regularly record the operating condition to the operation record sheet.

18) Don't install the chiller outside building. If not, prepare enough the roof to protect outer climate variation.

19) Without chilled and cooling water supply, don't operate the chiller.

20) Don't use the sea water as cooling water to protect the pollution and corrosion of heat

transfer tube.

21) In case of underground water used, check the water quality.
22) The cooling tower shall be apart from the stack.
23) Don't strike the chiller with hammer or hard material.
24) Don't hit nor kick the solution pump and refrigerant pump.
25) Don't stand and foot on the pumps and pipings. Use the ladder.
26) Close the cap of damper, service valve and angle valve.
27) Don't exchange the sight glass by yourself.
28) Clean the sight glass surface to see inside of shell.
29) Exchange the vacuum pump oil periodically.
30) Check the purge pump oil state regularly referring to this manual.
31) Certainly, perform the maintenance correctly to extend the chiller life.
32) After an accident, don't be confused and follow this manual.
33) Don't add the foreign material into the chiller.
34) Pay attention not to be torn the diaphragm of valve.
35) Don't strike the handle of diaphragm valve.
36) Don't sting to the chiller with sharp tool.
37) Don't mix the vacuum pump oil with water.
38) Check the oil level in the purge pump.
39) Pay attention to the chiller not to be damaged by outer accident.
40) Join tightly the steam header not to be a leak.
41) Don't put on the foreign material inside the control box.
42) Protect the electric line from cutting by neighborhood.
43) Don't throw the hard material to the chiller.
44) Don't eat the vacuum pump oil.
45) Don't spray the water or harmful liquid to the chiller.

2. Operation Principle of Absorption Chiller

2.1 Cooling cycle

Figure 2.1 shows the cycle structure of Finetec Century absorption chiller. The lithium bromide solution is used as the absorbent and water as the refrigerant. When the aqueous LiBr solution is maintained at proper temperature and concentration, the saturated vapor pressure of the solution is far lower than the refrigerant, water, having the same temperature. The difference in the saturated vapor pressures allows the refrigerant to be absorbed into the aqueous LiBr solution. The latent vaporization heat of the refrigerant is utilized for cooling. The cooling cycle, which is kept at a high degree of vacuum, includes (1) evaporator, (2) absorber, (3) 2nd stage generator and (4) condenser (in the shell); (5) 1st stage generator, (6) high-temperature heat exchanger, (7) low temperature heat exchanger, (8) solution pump and (9) refrigerant pump.

The chilled water for air-conditioning is passed through the evaporator tubes, where its heat is removed for cooling due to the latent vaporization heat of the refrigerant, water.

The vaporized refrigerant is introduced to the absorber, where it is absorbed into the aqueous LiBr solution. The absorption heat generated is removed by the cooling water flowing through the absorber tubes. Thereby, the temperature in the absorber is maintained constant at all times.

The aqueous LiBr solution cooled and diluted in the absorber is delivered to the 2nd stage generator through the low temperature heat exchanger and to the 1st stage generator through the high-temperature heat exchanger by the solution pump.

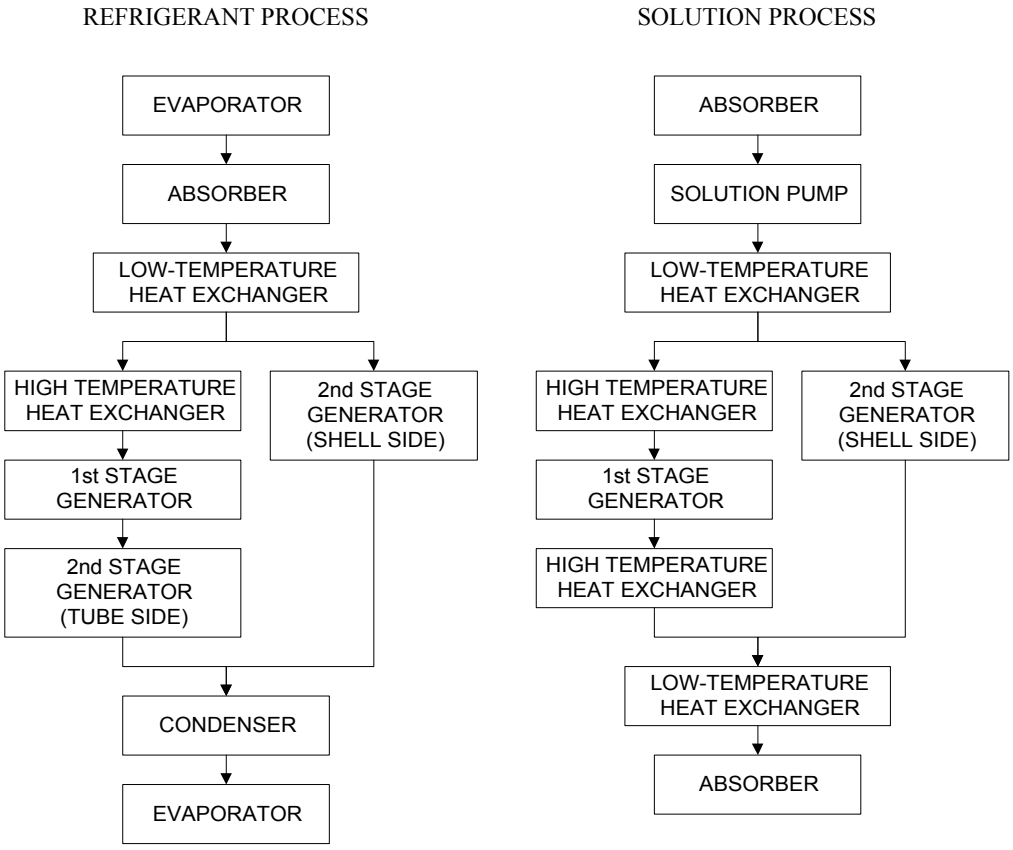


Figure 2.1 Flow diagram of solution and refrigerant

The diluted solution in the 1st stage generator is heated by the high temperature and high pressure steam to generate the refrigerant vapor of high temperature, resulting in the high temperature concentrated solution. On the other hand, the solution in the 2nd stage generator is heated by the refrigerant vapor from the 1st stage generator to produce the refrigerant vapor, resulting in the solution of medium concentration.

The solution concentrated in the 1st stage generator is returned to the absorber through the high temperature heat exchanger, and the solution concentrated in the 2nd stage generator is returned to the absorber through the low temperature heat exchanger. The refrigerant used for the 2nd stage generator heating and produced by the 2nd stage generator are fed to the condenser to be cooled for condensation with the cooling water. The condensed refrigerant is supplied to the evaporator by the gravitational force and pressure difference.

The above mentioned processes can be illustrated in figure 2.2.1~2.2.3.

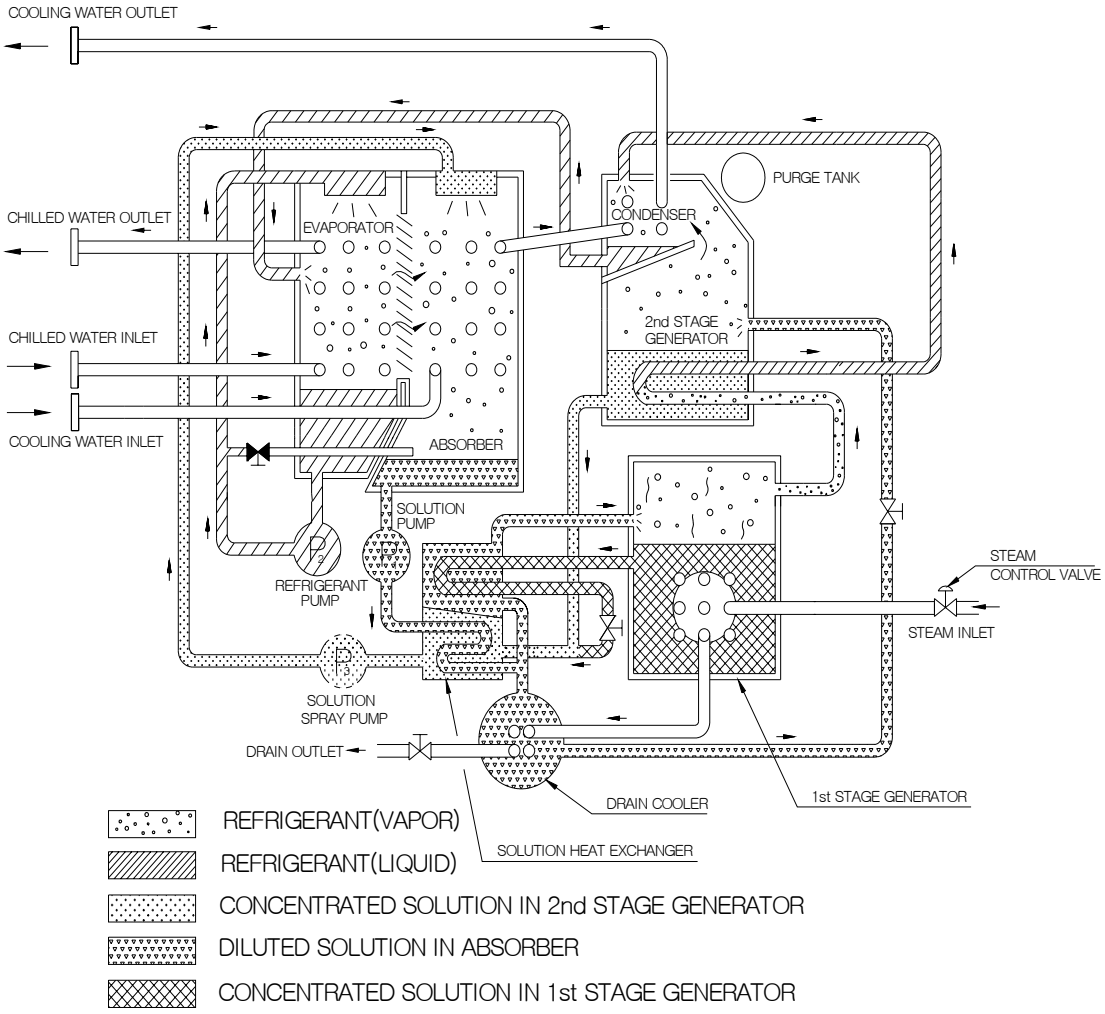


Figure 2.2.1 Cycle diagram of two stage steam absorption chiller(AR-W70~200G2)

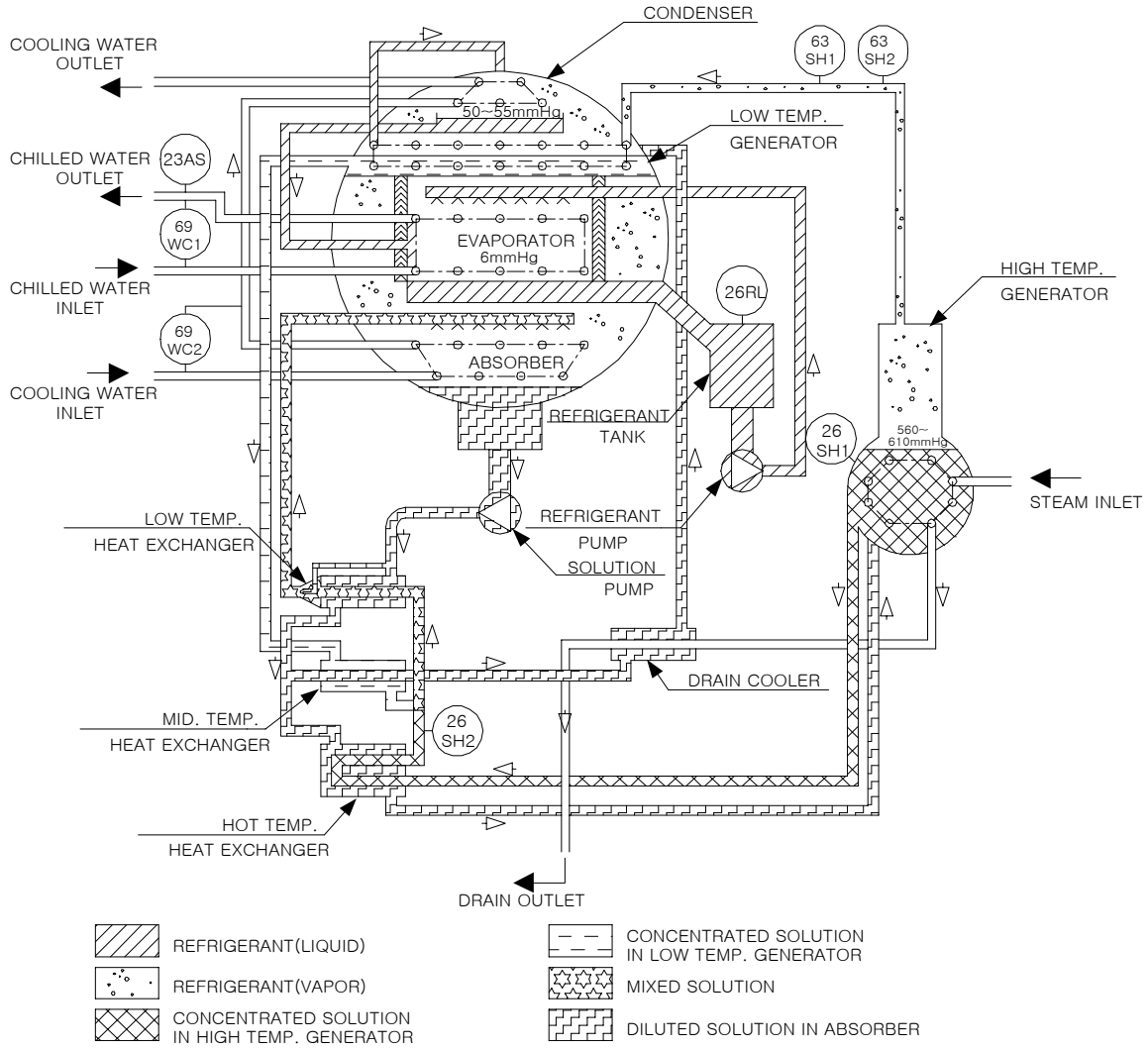


Figure 2.2.2 Cycle diagram of two stage steam absorption chiller(AR-W220~800G2)

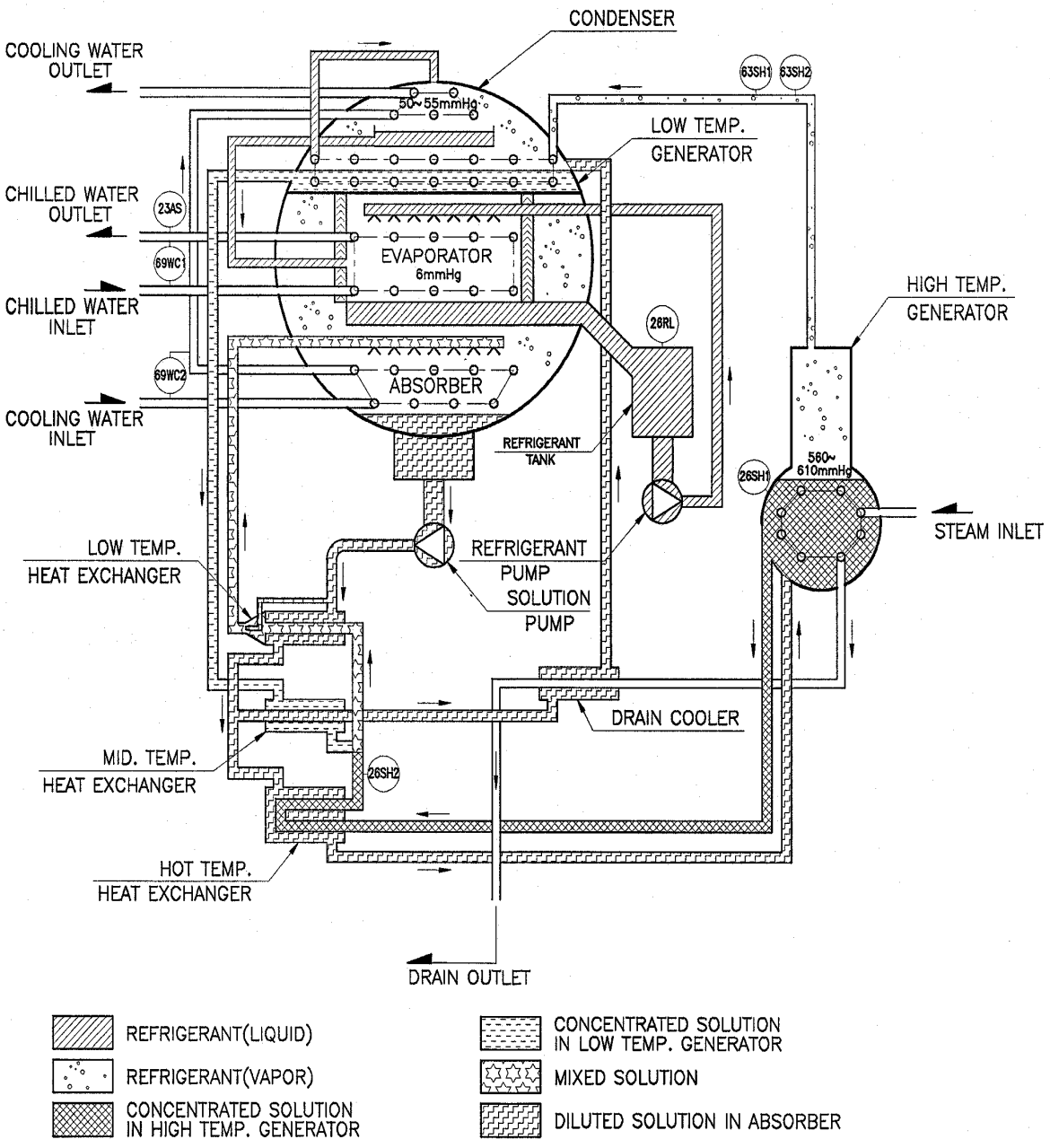


Figure 2.2.3 Cycle diagram of two stage steam absorption chiller(AR-W900~1650G2)

2.2 Duehring diagram

Duehring diagram is a graph to show the relation between concentration, temperature and pressure of LiBr solution. Finetec Century absorption chiller may be displayed in figure 2.3 as follows;

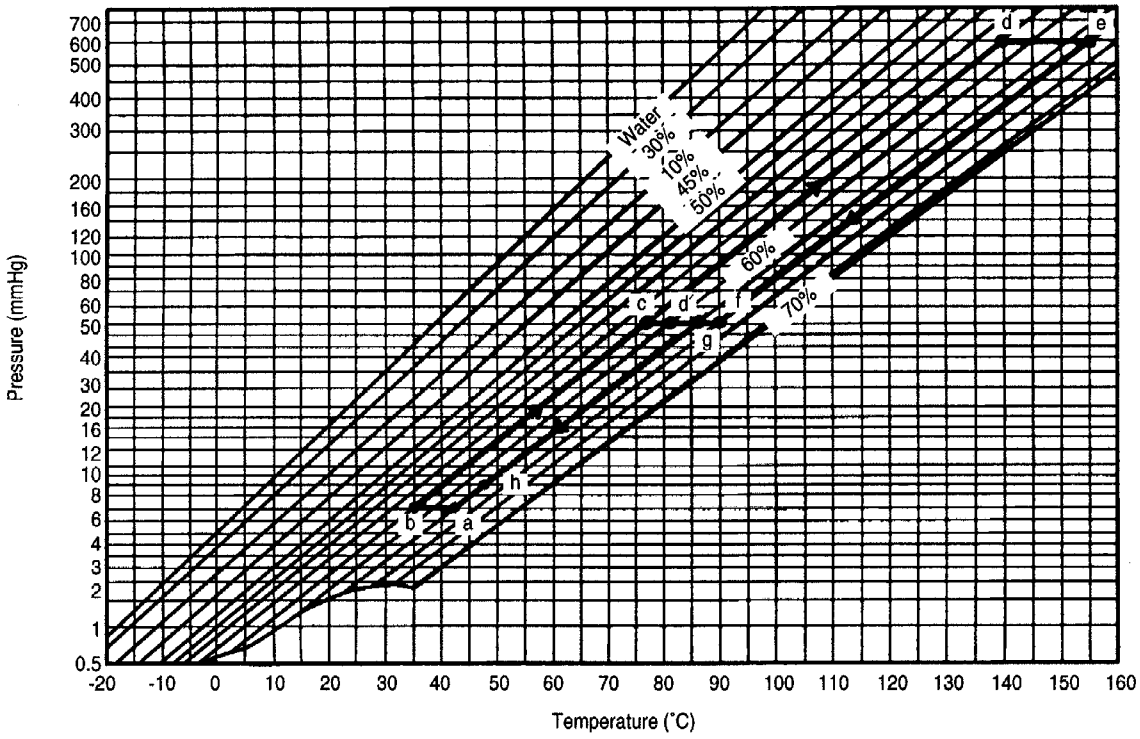


Figure 2.3 Duehring diagram with operation points

The explanation of cycle sequence with duehring diagram

a-b : The concentrated solution in absorber absorbs the refrigerant vapor to be become dilute solution.

b-c : Temperature of dilute solution rises due to heat exchange in low temperature heat exchanger.

c-d : Temperature of dilute solution(about 1/2) through low temperature heat exchanger rises due to heat exchange in high temperature heat exchanger.

c-d' : Dilute solution(about 1/2) through low temperature heat exchanger is concentrated in low temperature generator by latent heat of refrigerant generated in high temperature generator

d-e : The dilute solution is concentrated in high temperature generator and the refrigerant vapor is generated.

e-f : The concentrated solution in high temperature generator is cooled by heat exchange with dilute solution in high temperature heat exchanger.

d'-g-f : The concentrated solution through high temperature heat exchanger is mixed with semi-concentrated solution in low temperature generator and concentration of mixed solution is decreased.

g-h : The mixed solution is cooled by heat exchange with dilute solution in low temperature heat exchanger.

h-a : The mixed solution which is spray in absorber is cooled by cooling water. And, then solution cycle restart at point "a".

3. Structure and Function

3.1 Components

(1) Evaporator

In the evaporator, the refrigerant, water, led to the refrigerant pump from the refrigerant tank is sprayed on the evaporator tubes through the special nozzles. Since the temperature of the chilled water flowing through the tube is higher than that of the refrigerant, the heat is transferred to the refrigerant on the surface of the tube to evaporate the refrigerant, taking the heat from the chilled water for refrigeration. The evaporated refrigerant is fed to the absorber through eliminators.

(2) Absorber

The aqueous LiBr solution having proper temperature and concentration is maintained the pressure in the absorber slightly below that in the evaporator. Therefore, the refrigerant vapor flows continuously from the evaporator to the absorber, where it is absorbed into the aqueous Libr solution. The absorption heat, which is generated when the refrigerant vapor is absorbed, is transferred to the cooling water flowing through the absorber tubes. The absorption process is performed on the surface of the absorber tube bundle, therefore the aqueous LiBr solution from the solution pump is sprayed uniformly on the tube surfaces through the special nozzles.

(3) Low temperature heat exchanger

This device is a heat exchanger of horizontal shell-and-tube type capable of increasing the cycle efficiency through the heat exchange between diluted solution and concentrated solution.

(4) 2nd stage generator (low temperature generator)

In the 2nd stage generator, the thermal energy from refrigerant vapor produced in first stage generator is used to concentrate the dilute solution. The refrigerant vapor is passed inside the tubes, and the solution is applied outside the tubes.

(5) Condenser

The refrigerant vapor formed by the 2nd stage generator is fed to the condenser through the eliminators, and it is cooled and condensed by the cooling water.

(6) High-temperature heat exchanger

This device is a heat exchanger of horizontal shell-and-tube type capable of increasing the cycle efficiency through the heat exchange between diluted solution and concentrated solution. It is equipped on the side of the low-temperature heat exchanger mentioned above.

(7) First stage generator (high temperature generator)

The 1st stage generator serves as a heat exchanger of horizontal shell-and-tube type. To generate the refrigerant vapor, it is heated and concentrates the solution received from the high-temperature heat exchanger by steam.

(8) Drain cooler

The steam condensed in the 1st stage generator is cooled below 90℃ here using the solution to be supplied to the 2nd stage generator and also the heat efficiency is enhanced by heating the supplied solution.

(9) Purge unit

The discharging facilities include the outlet tube, purge tank, manual valves, check valve,

oil-trap and vacuum pump. The manual valves are used to start/stop the purging the non-condensable gases from the chiller after the vacuum pump is started. The check valve is provided for the purpose of safety to prevent air from returning into the chiller, even if a power suspension takes place during operation of the vacuum pump. The oil trap is equipped also for safety to prevent oil from returning into the chiller. For handling of the purge unit, refer to section 7.5 "Purging Operation"

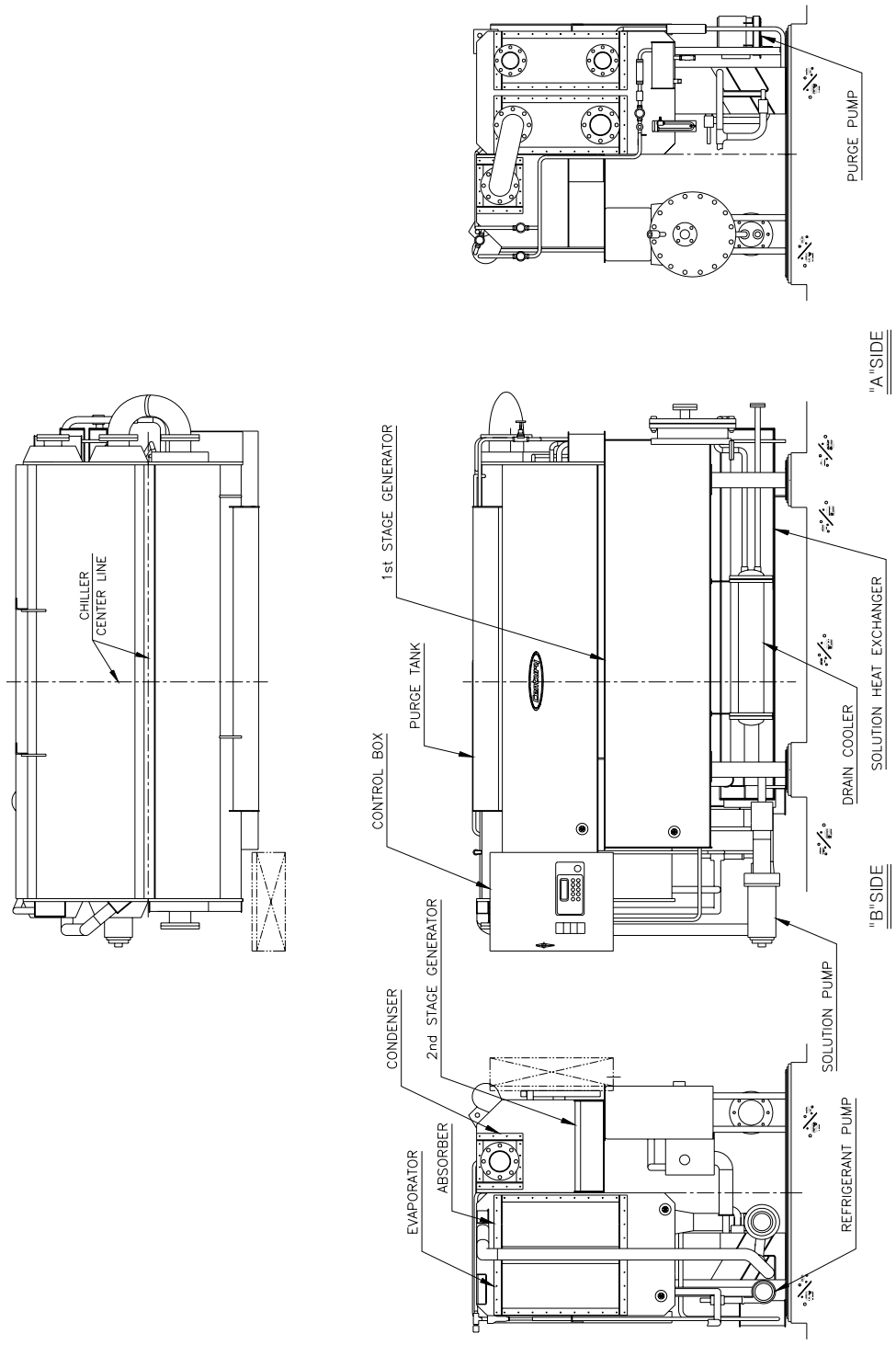


Figure 3.1.1 Assembly drawing(AR-W70~200G2)

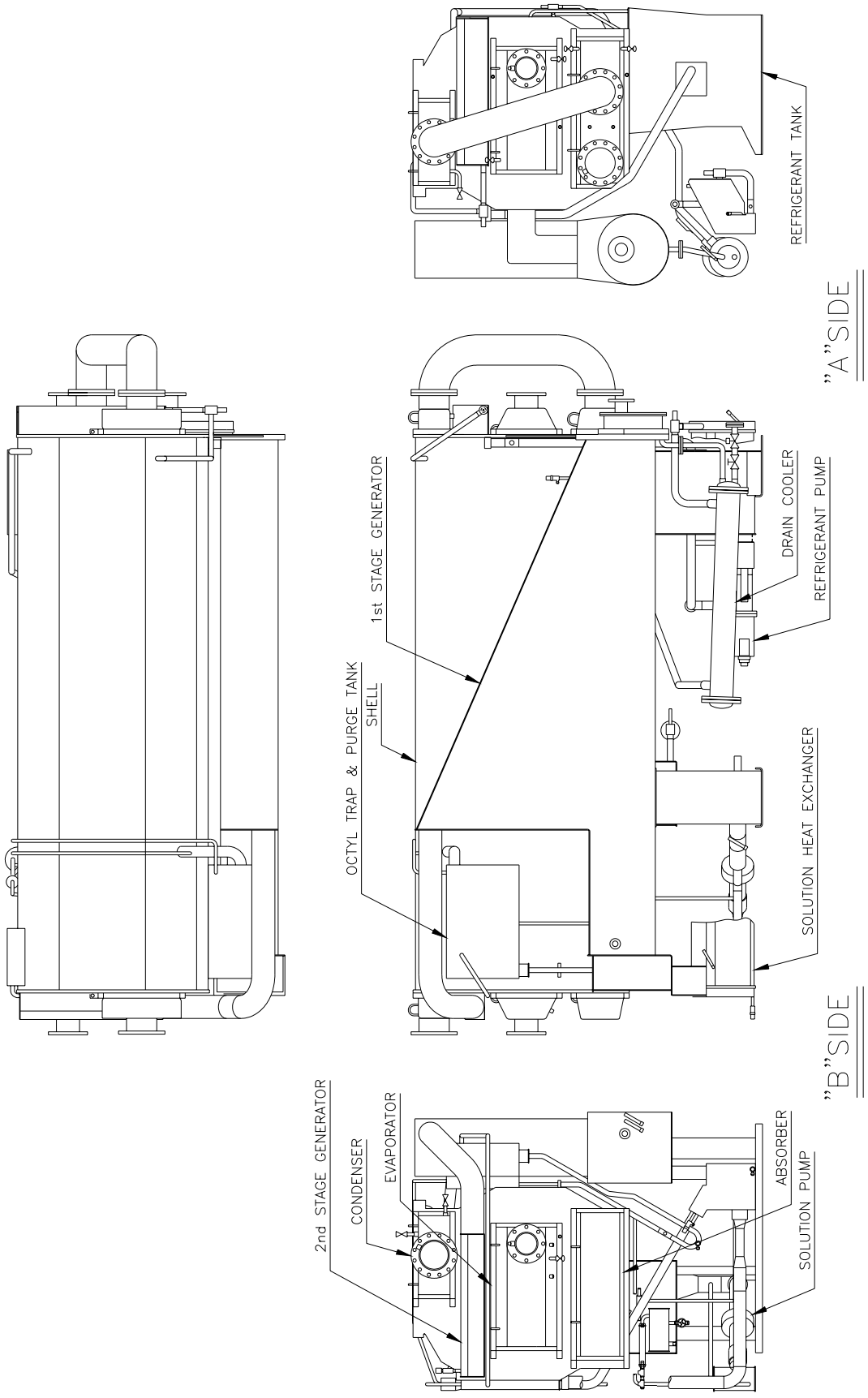


Figure 3.1.2 Assembly drawing(AR-W220~800G2)

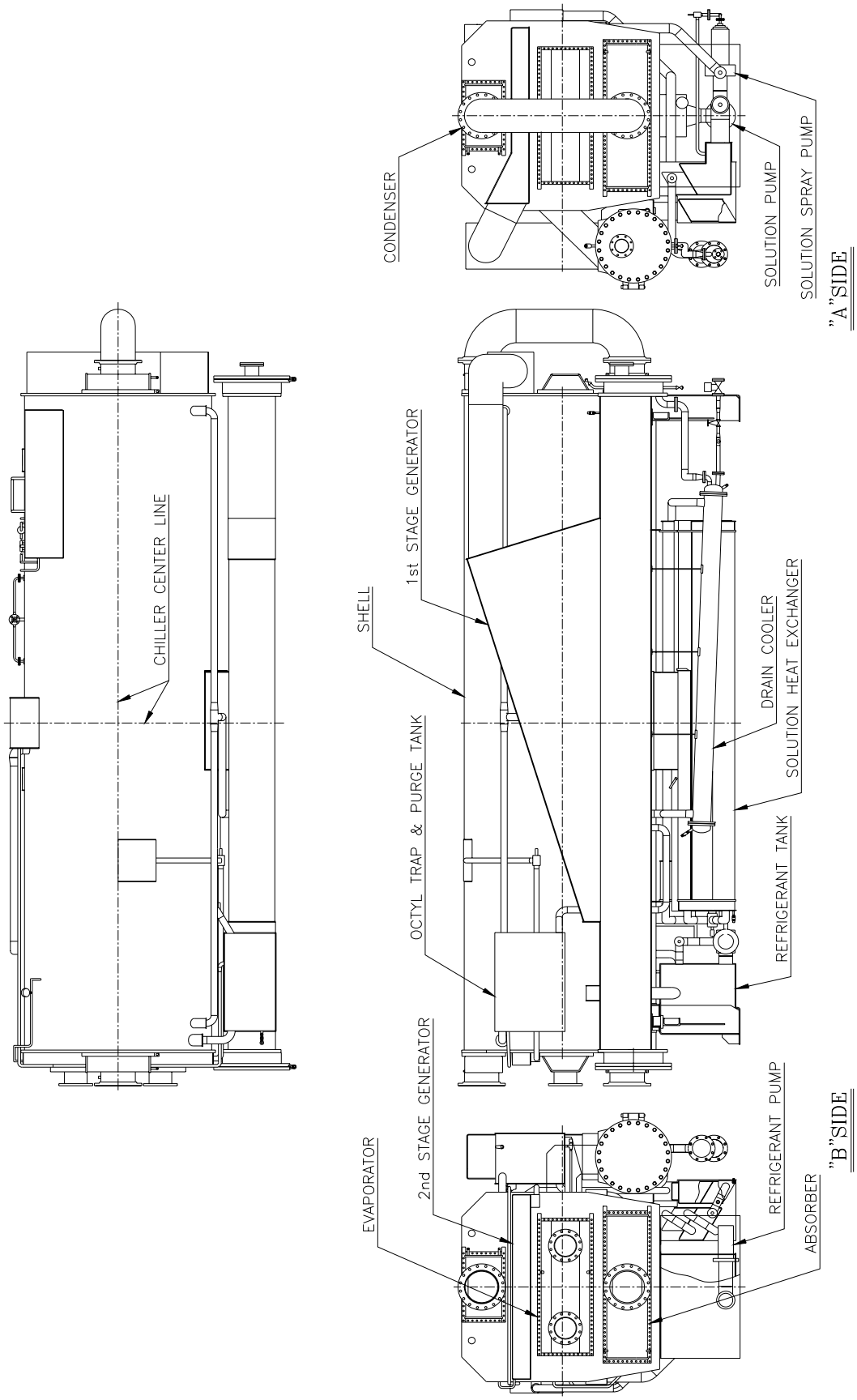


Figure 3.1.3 Assembly drawing(AR-W900~1650G2)

3.2 Outline dimensions

Figure 3.2 and table 3.1 shows the outline dimensions and control panel height.

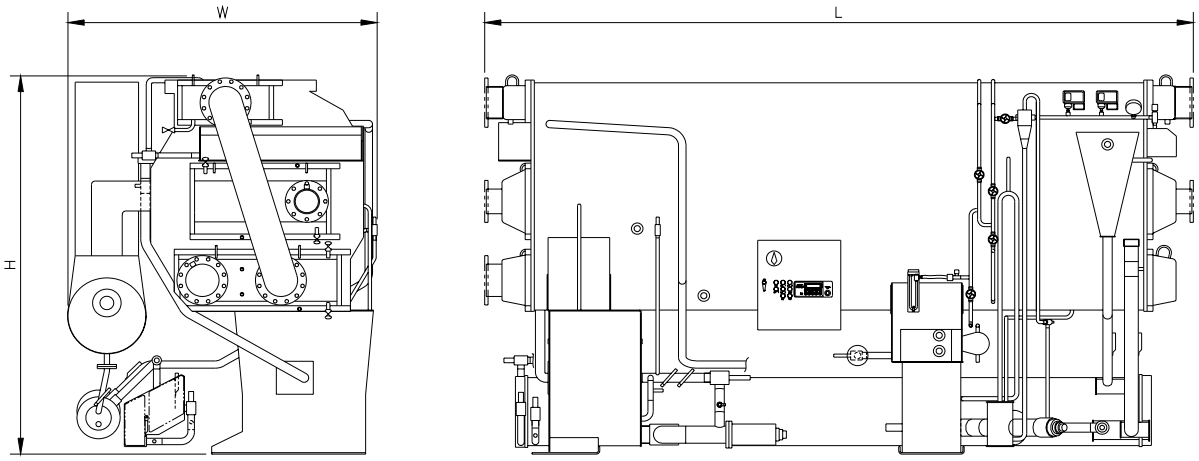


Figure 3.2 Outline dimensions

Table 3.1 Outline dimensions and control panel height[mm]

L : length of chiller H : height of chiller from base

W : width of chiller

※ The chiller is positioned on the concrete base.

	AR-W70G2	AR-W80G2	AR-W90G2	AR-W100G2	AR-W115G2	AR-W125G2	AR-W140G2
L	2,455	2,455	2,455	2,455	3,802	3,802	3,802
W	1,780	1,780	1,780	1,780	1,940	1,940	1,940
H	2,015	2,015	2,015	2,015	2,041	2,041	2,041
	AR-W150G2	AR-W170G2	AR-W200G2	AR-W220G3	AR-W250G2	AR-W270G2	AR-W320G2
L	3,802	3,832	3,832	4,250	4,250	4,250	4,250
W	1,940	1,940	1,940	1,980	1,980	1,980	1,980
H	2,041	2,041	2,041	2,560	2,560	2,560	2,560
	AR-W360G2	AR-W400G2	AR-W450G2	AR-W500G2	AR-W550G2	AR-W600G2	AR-W700G2
L	4,600	4,600	5,600	5,600	6,610	6,610	7,520
W	2,130	2,130	2,130	2,130	2,280	2,280	2,280
H	2,560	2,560	2,560	2,560	2,580	2,580	2,660
	AR-W800G2	AR-W900G2	AR-W1000G2	AR-W1250G3	AR-W1500G2	AR-W1650G2	
L	8,610	7,950	7,950	8,950	8,950	8,950	
W	2,280	3,300	3,300	3,300	3,300	3,300	
H	2,660	3,350	3,350	3,350	3,350	3,350	

4. Characteristics of Lithium Bromide

The LiBr has the following characteristics:

4.1 Chemical quality

① It is stable and similar to salt

② It may greatly corrode metals which is common in inorganic salt series, and cause quick corrosion by the mixture with air. However a special corrosion inhibitor has been added to solution to avoid metal corrosion.

③ It has no harmful and no smell property.

4.2 Physical quality:

① In ordinary temperature the solubility of the saturated solution is about 60%, which shows a considerably high solubility for water.

② Its specific gravity has relatively high and specific gravity of 60% solution which is actually used is about 1.7

③ Its low specific heat makes a good absorptivity.

④ Its low partial pressure of vapor makes an excellent absorption property.

Note : The solution does not use a harmful inhibitor, but high concentrated solution may cause a water absorption reaction when being adhered to skin or clothes. In addition some inhibitors may produce a bad smell so that you have to avoid draining by yourself or touching by hand. Refer to attachment 8"LiBr solution & alcohol".

Table 4.1 Lithium Bromide Properties

Chemical formula	LiBr
Molecular weight	88.856
Composition	Li : 7.99%, Br : 92.01%
Appearance	Colorless transparent crystal particle
Specific gravity	3.464(at 25℃)
Melting point	549℃
Boiling point	1,265℃

Figure 4.1 shows the saturated temperature and pressure of LiBr solution varying with the concentration.

Figure 4.2 shows the gravity of LiBr solution varying with concentration and temperature.

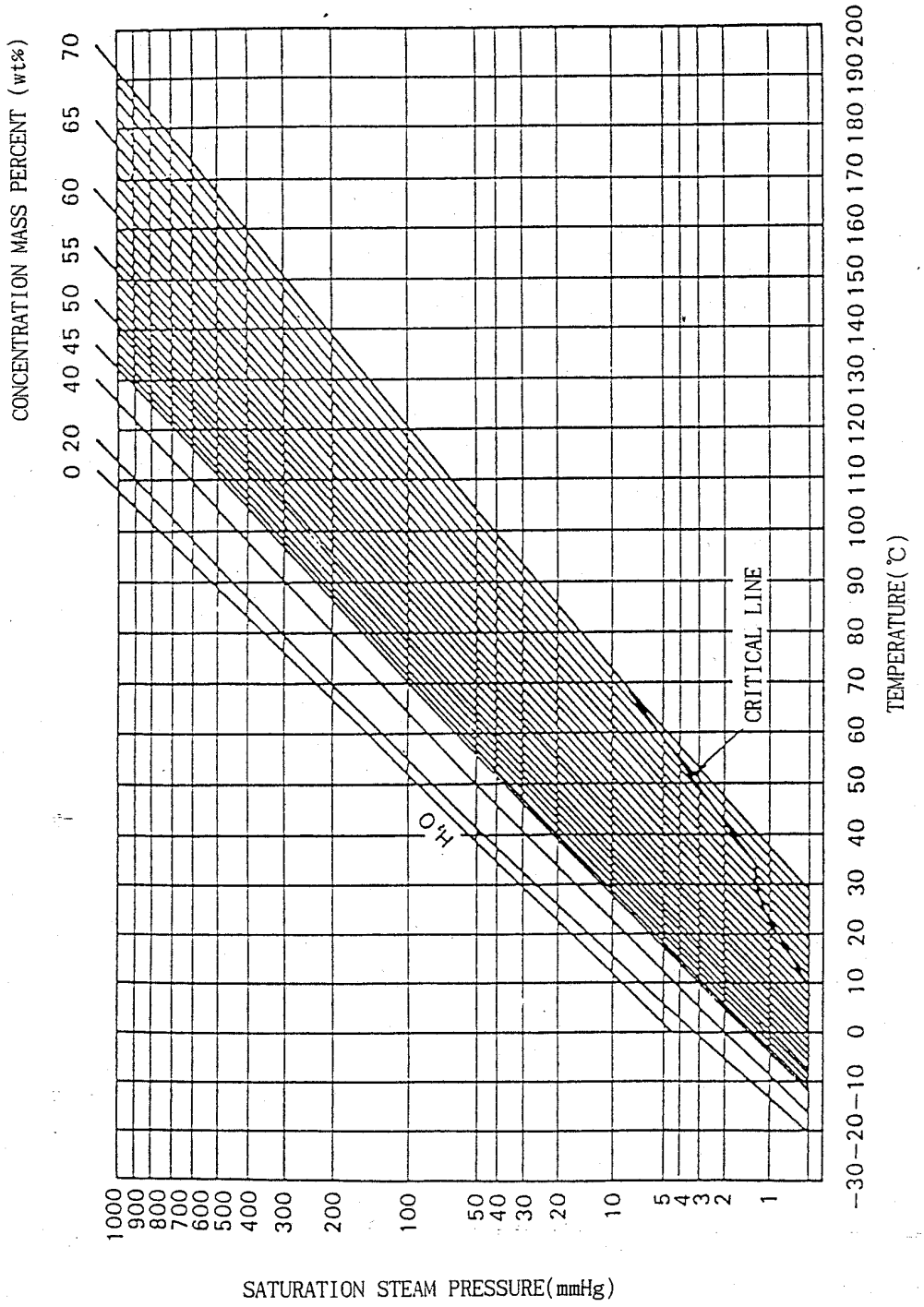


Figure 4.1 Duehring diagram of LiBr solution

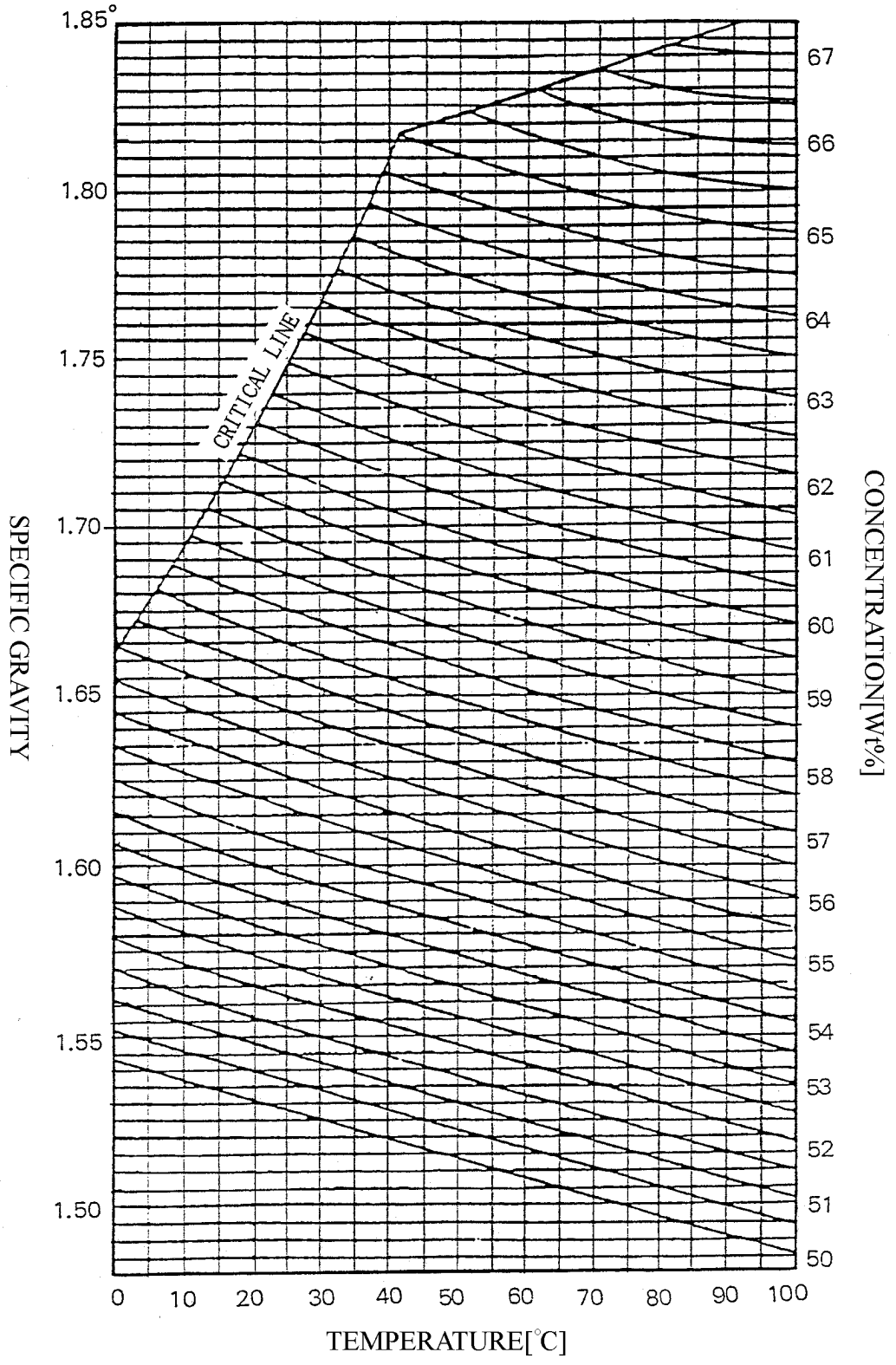


Figure 4.2 Graph for specific gravity varying with temperature and concentration

5. Installation

5.1 Installation

(1) Where to install

① You have to install it at the place where it is not cold nor high in the location but well-ventilated. In the place where is bad-ventilated, you have to install a ventilation equipment. At the place where the temperature is below than 0℃ or over 35℃, you shall not install it until you take a special action.

② Avoid the place where there exist a lot of humidity or dusts which may cause the electrical trouble.

③ Considering the lighting conditions, you have to select a suitable place easy to repair and maintain.

④ Considering its maintenance space, you have to install it easy to clean the absorber, generator, evaporator and condenser etc. according to the submitted assembly drawing. See separate assembly drawings.

(2) Carrying

The chiller consists of main body and first stage generator in one body to carry it as it is. You have to pay special attention to installing wire rope to carry the chiller. In addition when carrying it, you have to raise or lower it in horizontal direction only. You shall avoid such an action that you may drop or give impact on the chiller.

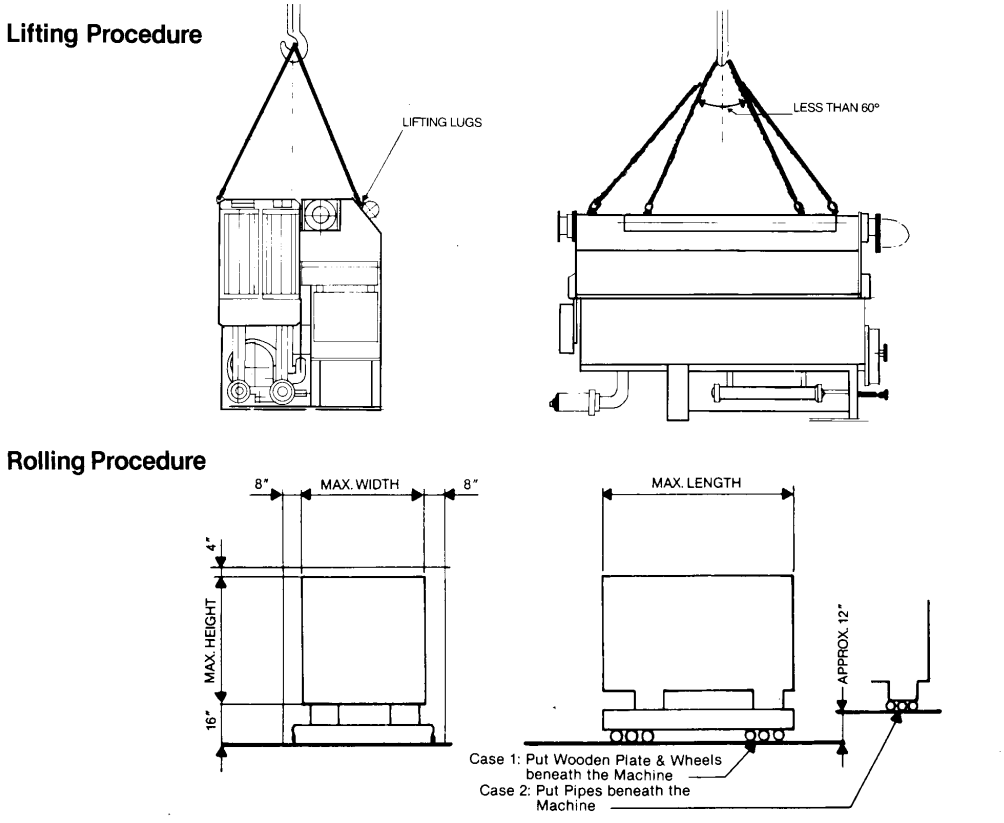


Figure 5.1.1 Rigging and moving method(AR-W70~200G2)

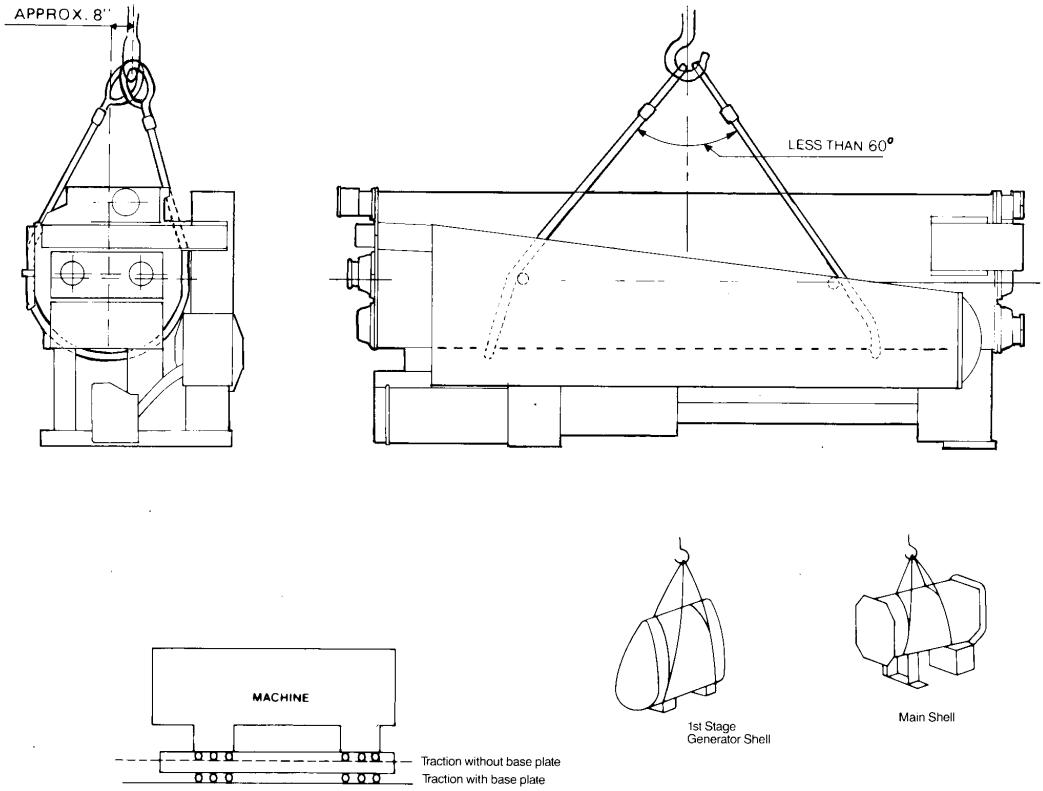


Figure 5.1.2 Rigging and moving method(AR-W220~1650G2)

⚠ Caution

① Bind both ends of the chiller with wire rope one time each when the wire rope's angle shall not exceed 60°

② When carrying it with slope, make sure to let aside be in upward direction.

③ Pay attention to avoid any impact on the chiller.

④ To avoid piping system's breakage, do not apply load to the piping system.

(3) Foundation

The chiller needs not any particular construction work to prepare its base. You may install it on any flat concrete base which has sufficient capability to support the operation of the chiller.

(4) How to install

When you finish to prepare its base, you shall insert a liner between the base of the chiller and the base floor to adjust its horizontal and vertical level. Its horizontal degree shall be no more than 0.5mm / 1meter.

(5) How to check the level

Use a transparent or semitransparent vinyl hose filled with water. As shown in the Figure 5.2, check the levels of points A-B, A-C, B-C, B-D and C-D. The degree of levelness must be within 0.5 : 1000 both lengthwise and sidewise.

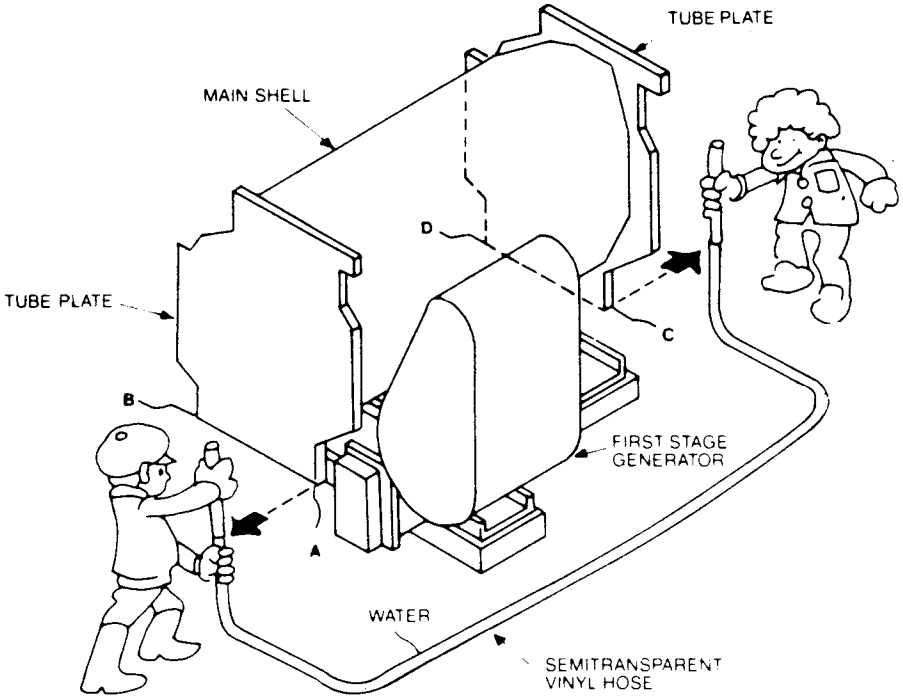


Figure 5.2 Leveling method

(6) Noise level

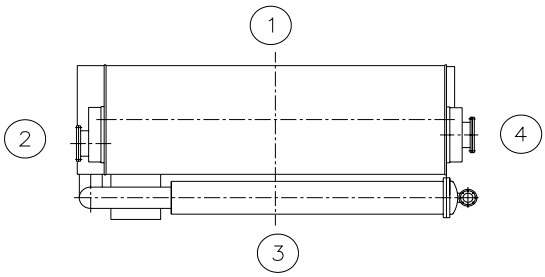


Figure 5.3 Noise level

Table 5.1 Noise level

※ Unit : dB at 1 meter distance form the chiller

location no. / Noise	①	②	③	④
A scale	84	83	82	82.5
B scale	86.5	85	84	84.5
C scale	88	87	87	87.5

(7) Vibration level

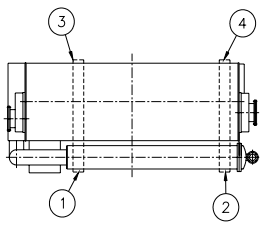


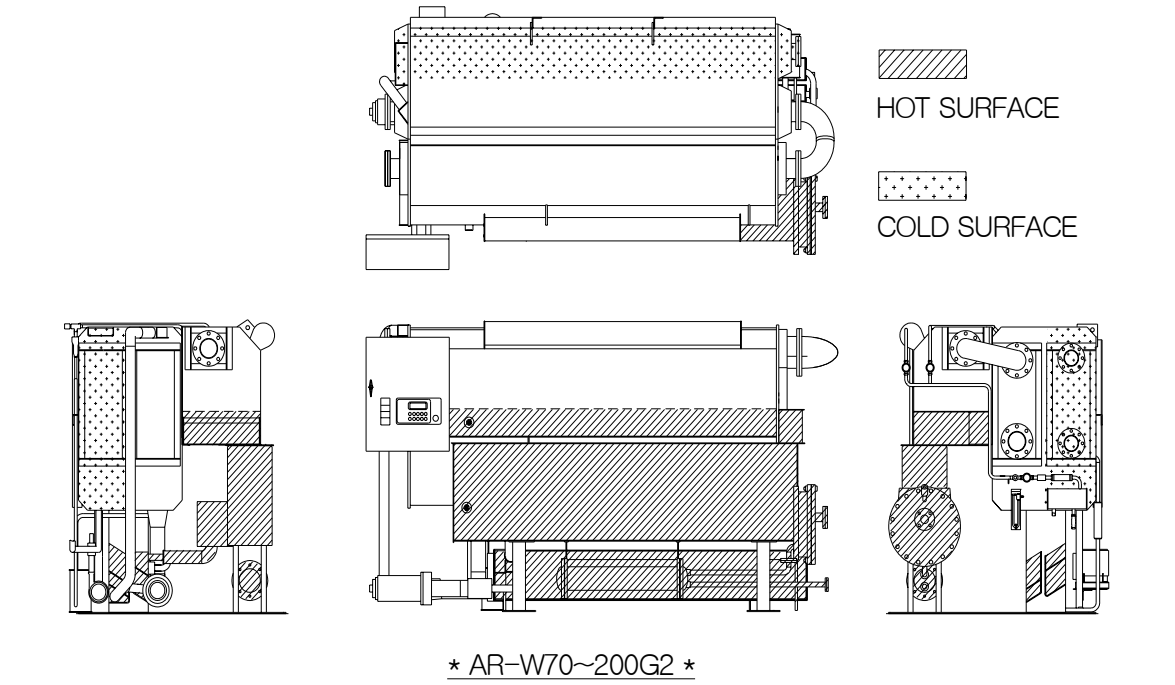
Figure 5.4 Vibration level

Table 5.2 Vibration level

※ Unit : μ(microns)

location no. / Vibration	①	②	③	④
Horizontal	3	2	3	3
Vertical	2	2	2	3
Axial	2	2	2	4

5.2 Insulation



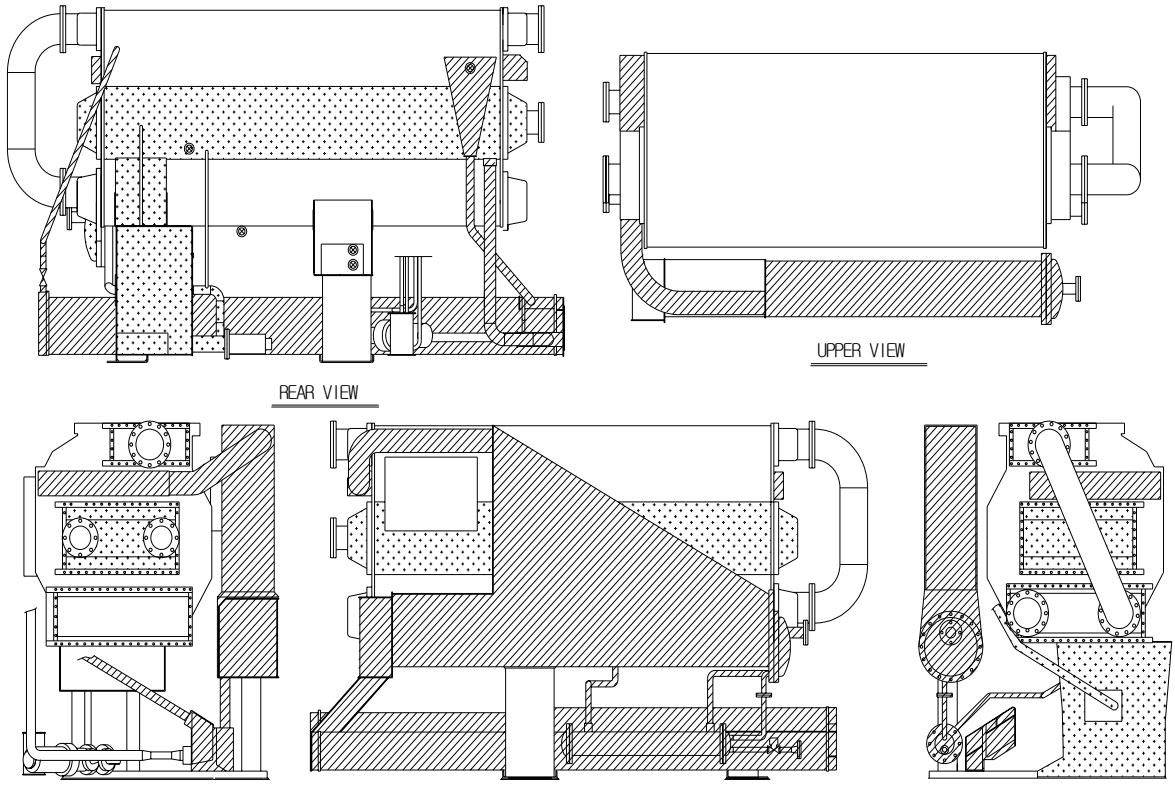


Figure 5.5 Insulation surface

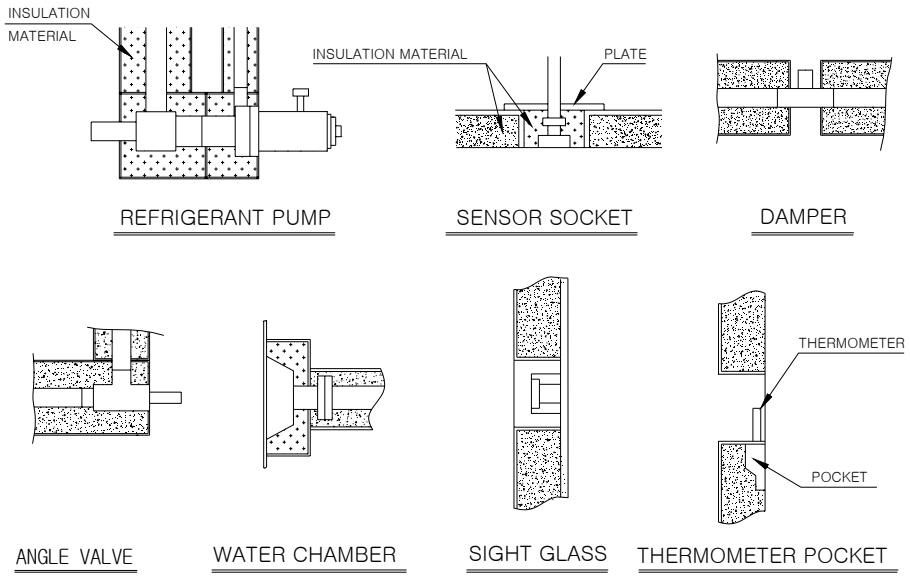


Figure 5.6 Detail drawings for insulation

(1) Before insulation work, the chiller should be placed in its permanent position and checked to make sure it is a air-tight.

(2) To mount insulation materials, use bonding agents, iron wires and bands. Do not use tapping screws or rivets.

(3) Insulation on outer equipment and flange sections should be mounted so that it can be removed easily.

(4) The following insulation surface drawings(see figure 5.5) show the areas to be insulated and the recommended insulation materials and procedures. Follow the drawings(see figure 5.6) and observe the following instructions ;

① Don't cover moving parts(such as damper cap and angle valve cap) with insulation.

② Insulation thickness should be 50mm on high temperature generator and 25mm on all other parts

③ The water chamber or water box will have to be opened sometimes for tube removal and cleaning. Therefore, do not cover the bolts or frame of the water chamber with insulation. Pipe flange insulation follows same method of water chamber.

④ Don't cover the sight glasses(liquid level gauges) with insulation.

⑤ Don't cover the thermometer and sensing bulb wells of the thermostats with insulation

⑥ Insulation auxiliary and instrument piping by wrapping glass wool around it. Do not cover pipe connections, since they must be accessible for pressure and vacuum tests.

⑦ Don't cover pump motors with insulation for maintenance.

⑧ The insulation plate of socket and water chamber should be removed to maintain the chiller.

Table 5.3 Insulation materials

Insulation materials	
Insulation materials	Coating materials of insulation surface
1. Fiber glass 2. Phenolics foam(only for cold surface) or others identical	1. Zink galvanized carbon steel plate or others identical 2. Stainless steel plate 3. Aluminum plate

Table 5.4 Area to keep cold or warm

Model	W70G2	W80G2	W90G2	W100G2	W115G2	W125G2	W140G2
Hot area[m^2]	12	12	12	12	20	20	20
Cold area[m^2]	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Model	W150G2	W170G2	W200G2	W220G2	W250G2	W270G2	W320G2
Hot area[m^2]	20	20	20	25	25	25	25
Cold area[m^2]	7.5	7.5	7.5	8	8	8	8
Model	W360G2	W400G2	W450G2	W500G2	W550G2	W600G2	W700G2
Hot area[m^2]	27	27	27	27	31	31	35
Cold area[m^2]	8	8	8	8	12	12	12
Model	W800G2	W900G2	W1000G2	W1250G2	W1500G2	W1650G2	
Hot area[m^2]	37	50	50	63	63	63	
Cold area[m^2]	12	27	27	30	30	30	

6.3 Water piping

To keep the operation stable and the service life long for the absorption chiller to which water and vapor are supplied, observe the following precautions.

(1) Chilled Water and Cooling Water

① Contamination and corrosion of the tubes of evaporator, condenser and absorber in the absorption chiller depend on the qualities of the chilled water and cooling water to be supplied. Therefore particular care should be given to the chilled water and cooling water qualities.

The low quality water may cause the tubes to be contaminated heavily or damaged due to corrosion, requiring replacement with new ones within one-year operation. It should be avoided that polluted sea water or underground water, the installation of the cooling tower near a smoke stack, and the vigorous air pollution surrounding the cooling tower.

The past experiences show that the tubes are greatly affected by the water qualities. Therefore the water quality control and the periodic tube contamination/corrosion check should be exercised to prevent a serious trouble. Within one month after the initial operation, be sure to analyze the qualities of chilled water and cooling water.

② To prevent the tubes from being clogged with foreign solid materials contained, in the chilled water and cooling water, be sure to attach the strainers of 10-mesh or finer to the chilled water inlet for the evaporator and to the cooling water inlet for the absorber. The strainers should be positioned at the chilled water pump and cooling water pump discharge referring to figure 5.7.

③ The valves are equipped at the chilled water(see figure 5.7 V1) and cooling water inlets(see figure 5.7 V2) to the chiller and at the outlets from the chiller(See figure 5.7 V3, V4). Be sure to fully open the valves at the inlets to the chiller for water supply. Otherwise, a turbulent water flow will occur at the valve, particularly affecting the water introducing port at the end of tube. This may cause damage to the tube. If it becomes necessary to temporarily decrease the flow rate of chilled water or cooling water, use the valve equipped at the outlet from the chiller.

④ Temperature control of cooling water at inlet

If the cooling water temperature is 20℃ or below at the inlet during operation, the cooling performance may be deteriorated. To maintain the cooling water inlet temperature higher than 20℃, provide the thermostat(see figure 5.7 TH) for cooling water temperature control at the inlet part to the absorber. Under control of this switch, keep the proper cooling water temperature by using the two/three-way valve(see figure 5.7) attached on the cooling tower bypass piping or by On/Off control the cooling tower fan.

(2) How to install the water pipings

① The dashed line shows the vendor scope at Figure 5.7. Install the outer piping of dashed line with purchaser.

② You shall arrange the piping to apply less than the specified water pressure to not only chilled water system but cooling water system.

③ Install thermometer and pressure gauge, etc. with water piping to repair and check.

④ Place the strainer of about 10 mesh at the inlet of both chilled water and cooling water. The piping system with dirt may cause to freeze chilled water or increase pressure, or corrode heat transfer tube.

⑤ Perform the On/Off control for cooling tower fan or bypass cooling tower control using 3 or 2 way valve for cooling water inlet temperature to keep more than 20℃ on operating

⑥ Install the air vent valve(see figure 5.7 V5) at upper side of piping and the drain valve(see figure 5.7 V6) at the lower side of piping.

⑦ Water quality analysis shall be carried out sufficiently.

⑧ Plan the steam pressure so that the specified pressure is achieved at the control valve inlet. Keep the piping between the control valve to the high temperature generator short, so that loss is minimized.

⑨ The steam control valve(see figure 5.7 V7) and steam inlet pressure gauge will be delivered as single pieces, so attach them to the indicated locations. The secondary wiring for the control valve is not included in the scope of supply.

⑩ Install the safety valve(see figure 5.7 V8) on the steam piping.

⑪ Install a drain trap below the primary piping of the control valve, so that drain does not flow into the high temperature generator. If a large quantity of mist is included in the steam, install a mist separator.

⑫ Install the back pressure setting valve(see figure 5.7 V9) and pressure gauge indicated in the figure 5.7 to the drain piping, so that drain back pressure can be adjusted. The standard drain back pressure is 1.0 kg/cm^2G for 8 kg/cm^2G steam, and 0.5 kg/cm^2G for 5 kg/cm^2G steam. Therefore, plan the drain tank starting water head and pressure loss values above.

⑬ The drain from the chiller is thoroughly supercooled condensed water, so that a drain

trap in the drain piping is not necessary.

⑭ Because standard supply pressure of steam is 8 kg/cm^{2}G, the first stage generator is designed to endure that pressure in tube side and chamber. Therefore, don't supply the higher pressure than the designed value.

⑮ The normal design value of chilled and cooling water pressure is 8 kg/cm^{2}G, if except the chillers for high pressure water according that users call for the chiller that endure higher water supply pressure. refer to submitted "equipments installation drawing".

Note : Above steam control valve(see figure 5.7 V7), solenoid valve(see figure 6.3 V29) and needle valve(see figure 6.3 V28) are explained in attachment 6~7 with specification and drawings.

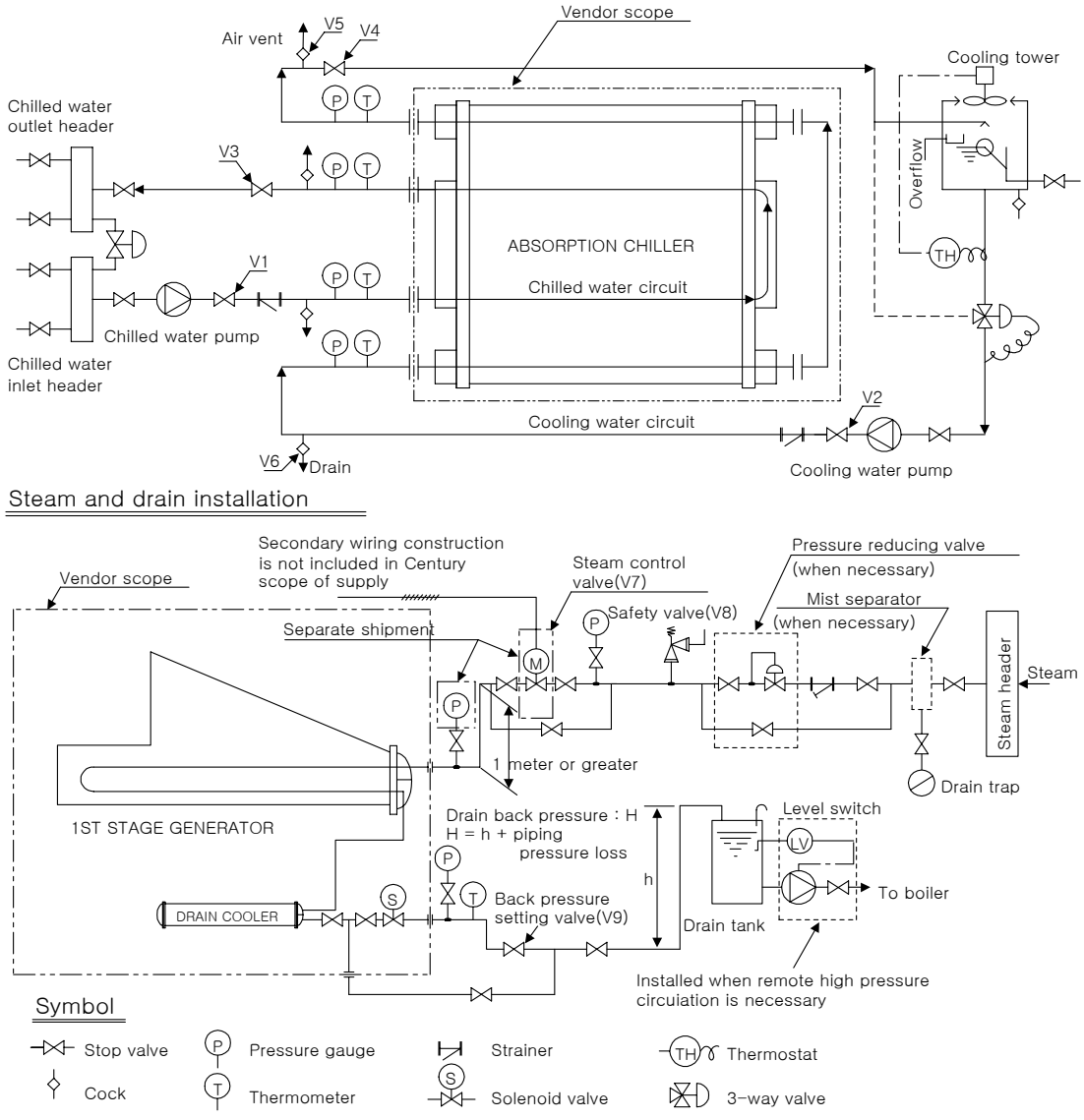


Figure 5.7 Piping diagram

(3) Cooling water quality criteria

Cooling water in cooling tower is exposed to the atmosphere easily to absorb the pollutants in the air and become contaminated little by little. When cooling water quality is bad, the scale may adhere to the interior of heat transfer tube which may cause bad operation and water leakage accident in the chiller by corrosion. Therefore you have to pay

attention. To improve water chiller's efficiency and extend its life time, control the cooling water quality according to following table. But, the water quality analysis should be performed by experts. If you want to analyze the water quality, collect small amount of cooling water, about 500cc, from the drain valve(see figure 5.7 V6) and send to Finetec century or our agents because water quality analysis is hard to be performed by user.

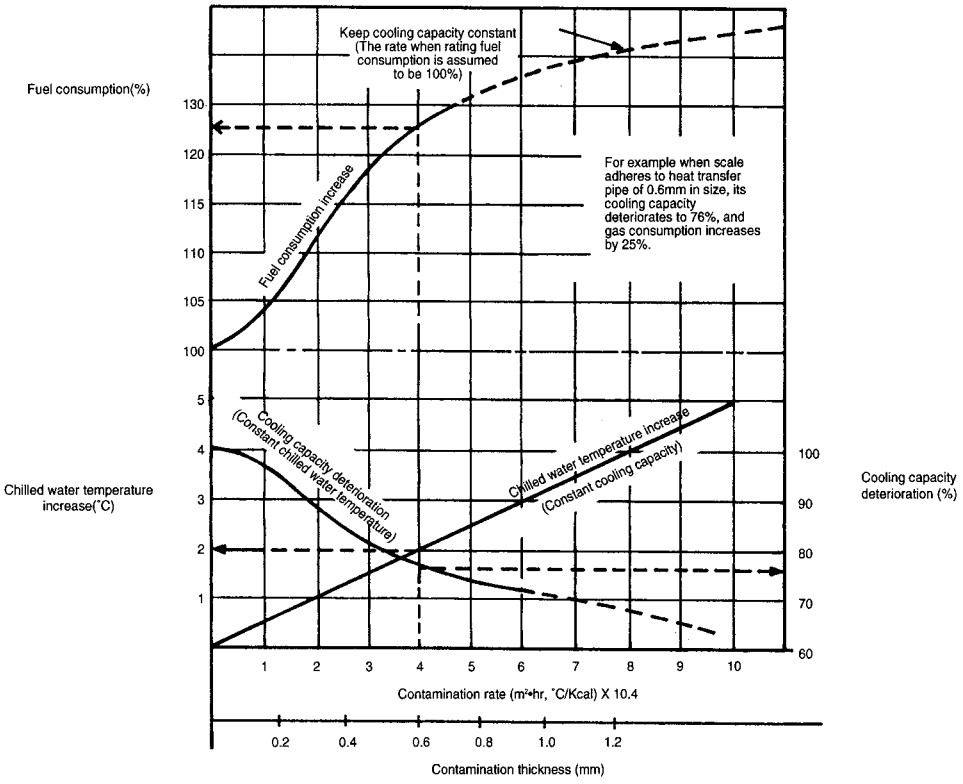


Figure 5.8 Contaminated cooling water effect on absorption chiller

Table 5.5 Water quality criteria

Item	Cooling water			Supply water
	Standard	Phenomenon		standard
		Corrosion	Scale	
PH(25℃)	6.5~8.0	○	○	6.0~8.0
Conductivity(25℃) [μS/cm]	800 or below	○	○	200 or below
Ionic chloride Cl^- [$mgCl^-/\ell$]	200 or below	○		50 or below
Ionic lactic acid SO_4^{2-} [$mgSO_4^{2-}/\ell$]	200 or below	○		50 or below
Oxygen rated value(PH4.8) [$mgCaCO_3/\ell$] (M alkali degree)	100 or below		○	50 or below
Transient degree [$mgCaCO_3/\ell$]	200 or below		○	50 or below
Ionic Fe [$mgFe/\ell$]	1.0 or below	○	○	0.3 or below
Ionic emulsion S^{2-} [mgS^{2-}/ℓ]	Not detected	○		Not detected
Ionic ammonium NH_4^+ [$mgNH_4^+/\ell$]	1.0 or below	○		0.2 or below
Ion phase silica SiO_2 [$mgSiO_2/\ell$]	50 or below		○	30 or below

6. Control Equipments

In Finetec Century absorption chiller of full automatic type, the operation can be continued without any trouble even if the load varies. The control panel contain the electric circuits and relays necessary for operation control and safety control.

6.1 Capacity control

The automatic capacity control is performed by regulating the steam flow rate to the 1st stage generator in proportion to the chilled water outlet temperature. The capacity control device consists of a proportional temperature controller and a steam control valve.

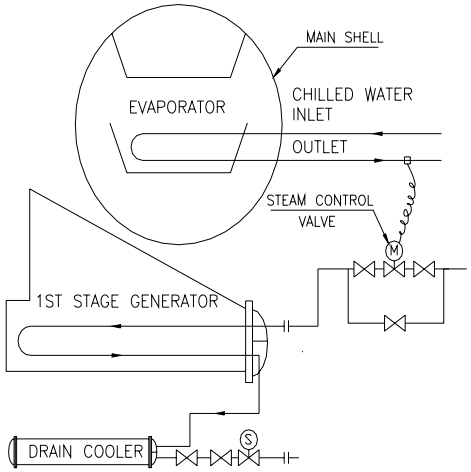


Figure 6.1 Capacity control diagram diagram

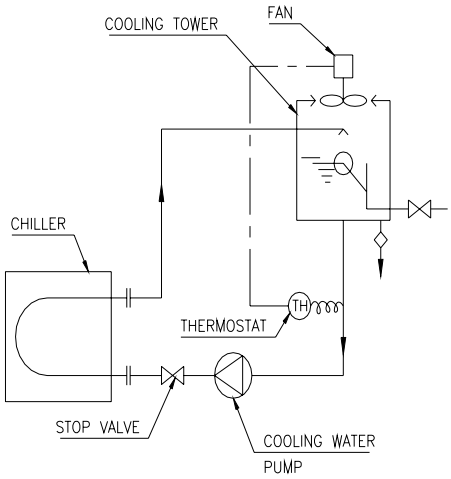


Figure 6.2 Cooling water control

6.2 Operation control

The chiller operation is automatically performed as illustrated in the control panel sequence diagram. The chilled water suspension cutout switch(69WC1), the solution high temperature switch (26SHI), the refrigerant low temperature cutout switch (26RL) and the 1st stage generator high pressure cutout switch (63SHI) are interlocked with the start circuit. Under the condition that the interlock circuit is normal, pressing the start button causes the steam control valve to gradually open from a fully closed state with raising the temperature of the solution in the 1st stage generator up to a boiling point. Then the pressure in the 1st stage generator increases gradually to turn on the pump starting relay(63SH2). Thereby, the solution pump is started. If the refrigerant pump switch(K2M) is set to an "ON" position, the refrigerant pump is started simultaneously with the solution pump. The refrigeration can be effected concurrently with the start of the refrigerant pump.

Then, even if the refrigeration load varies with the opening degree of the steam control valve by the chilled water temperature controller, the temperature of the chilled water is kept constant at the outlet. This temperature control is performed by regulating the solution concentration and vaporized refrigerant amount in the equipment. When the temperature of the chilled water is detected lower than setting value by the automatic star/stop switch(23AS,

TH1) at the low load state, the operation is immediately stopped. Then, when the chilled water temperature rises up to a predetermined degree, the said switch(23AS) restarts the operation.

If cooling water inlet temperature is over 20℃, no control is needed. However, if it is below than 20℃, the thermostat for cooling tower must be installed in the absorber inlet of the cooling water piping to raise the temperature to more than 20℃, and let thermostat turn cooling tower fan On/Off, or install cooling tower bypass piping to control by two/three way valve, or otherwise maintain cooling water inlet temperature over 20℃ by using the above two kinds of method together. Figure 6.2 shows that method schematically.

When the refrigerating operation is stopped, the steam control valve is fully closed immediately. However, Even after the stop of the refrigerating operation, the solution pump and the refrigerant pump are kept to running by the solution dilution switch(26SH2) to mix the diluted solution and the concentrated solution. Thus, crystallization is prevented which may occur if the solution temperature reaches room temperature. It should be noted that the chilled water and cooling water must be supplied during a dilution operation.

Table 6.1 Recommended thermostat

Type	Manufacturer	Temperature range	Differential	Switch
SWS-2050	Saginomiya	5~50℃	2~5.6℃	SPDTXI
Y675A	Yamatake Honeywell	-15~35℃	1.7~5.6℃	SPDTXI
Thermostat setting value - OFF : 20℃, ON : 25℃				

6.3 Safety devices

The safety devices are used to detect an irregularity in each section during operation. If an irregularity is found, the cooling operation is stopped immediately to prevent the crystallization and freezing. This absorption chiller includes the following safety devices.

(1) Chilled water suspension cutout switch (69WC1)

When the chilled water flow becomes below the preset value, it is activated to prevent the temperature decrease of cycle, insufficient cooling capacity and chilled water freezing due to decrease in the amount of chilled water.

(2) Low refrigerant temperature cutout switch (26RL, TH2)

When the refrigerant temperature in the tank becomes below the preset value, it is activated to prevent the refrigerant from freezing. This role is embedded in ASIC-controller.

(3) Solution high temperature switch (26SHI)

When the temperature of the concentrated solution delivered from the 1st stage generator becomes higher than the preset valve, It is activated to prevent the solution crystallization due to high concentration.

(4) Solution dilution switch (26SH2, TH3)

When the temperature of the concentrated solution delivered from the generators becomes lower than the preset value in a stopped state of the refrigerating operation, it stop the pump. The solution is diluted by the pump until activation of this relay to prevent the solution crystallization due to decrease the solution temperature after stop of the

refrigerating operations. This role is embedded in ASIC-controller.

(5) Pump starting relay (63SH2)

When the refrigerant vapor pressure of the 1st stage generator becomes higher than the preset value at the start of the refrigerating operation, it cause the pump to be driven. The pump is stopped to prevent the mist-up due to a rise of the solution level in the 1st stage generator until activation of this switch.

(6) 1st stage generator high pressure cutout switch(63SH1)

When the refrigerant vapor pressure of the 1st stage generator becomes higher than the preset value, it is activated in order to protect the vessel.

For the preset values, refer to the test result report and control panel circuit diagram. And for the switch, refer to section 6.5.(3).

⚠ Warning : the following trouble may be occurred. Then if the problems is not solved, normal operation is not proceeded. Check the cause referring to the preset value or troubleshooting.

① the sensor is damaged.
② the sensor is installed at the wrong location.
③ the sensor is short-circuit.
④ the sensor is heated or cooled by outside heat source.

6.4 Measuring instruments

The following table lists the measuring instruments attached.

Table 6.2 Measuring instruments

Instrument		Specification	Q'ty	Location
Pressure gauge	Vacuum gauge manometer	0~-76cmHg -60~60mmHg	1	Shell side
	Steam pressure gauge	-760mmHg~10kg/cm^{2}G	1	Steam inlet pipe
	1st stage generator pressure gauge	-760mmHg~2kg/cm^{2}G	1	Vapor duct of 2nd generator
Thermometer	Chilled water inlet	0~100℃	1	Well
	Cooling water inlet/outlet	0~100℃	1	Well

⚠ Note : Above instruments, sensors and switches are explained in attachment 3~5 with specification and drawings.

6.5 Valves, sight glasses, sensors and wells location & function

This section describes the purpose and location of valves, dampers, sight glasses, sensors, switches and wells, which is to avoid the confusion with the above devices. Each valves and dampers are its own purpose and using method.

⚠ Note : If you open the valve, for example a service valve, surely to be closed at particular state, the chiller may be abnormally operated and be damaged by outer condition. Even if fortunately this chiller have the safety devices for abnormal manipulation, you should know the control methods about every devices for the safety. Certainly refer to

this section.

(1) Valves and dampers

Next figures 6.3.1~6.3.3 shows the location of valves and dampers installed in chiller. Listed valves are classified to service and stop valve by purpose. Service valves are used for extraction to measure states of refrigerant and solution : solution concentration, refrigerant contamination and etc.. Stop valves are installed for maintenance and repair. Any valves and dampers control the amount of fluid flows. A fully open valve allows for maximum flow ; a fully closed valve stops the flow.

(2) Sight glasses

Next figures 6.3.1~6.3.3 shows the location of sight glasses installed in chiller. Sight glasses are used to inspect operation states of each part.

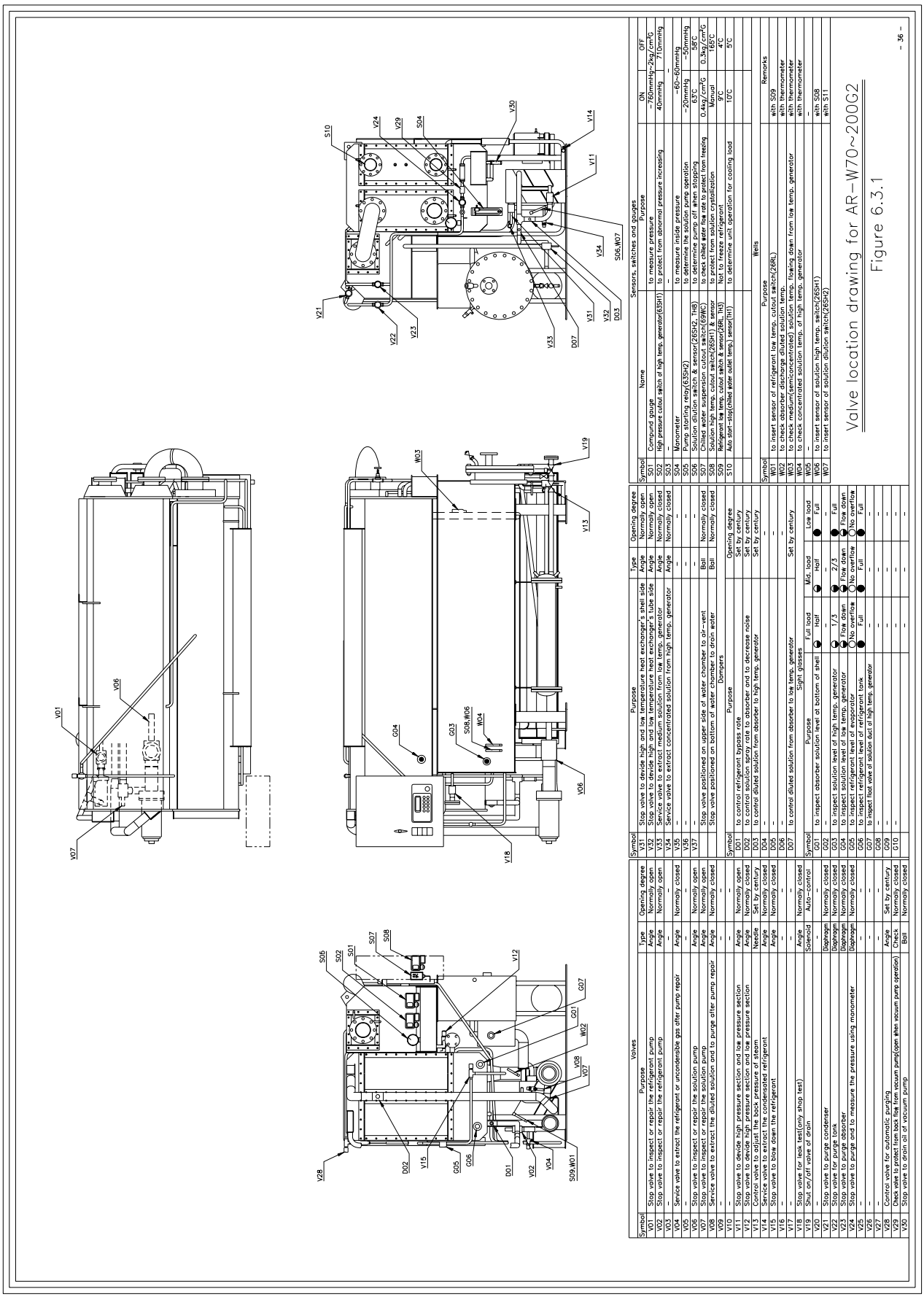
(3) Sensors, switches and gauges

Next figures 6.3.1~6.3.3 shows the location of sensors. Most of sensors are installed in socket and well and connected to control box to protect the chiller from abnormal operation.

(4) Wells

Next figures 6.3.1~6.3.3 shows the location of wells. At any wells, an operator can insert rod type thermometer to read the temperature of fluid inside chiller.

⚠ Note : Next valves, sensors and switches are explained in attachment 3~6 with specification and drawings.



Valves

Symbol	Purpose	Type	Opening degree
V01	Stop valve to inspect or repair the refrigerant pump	Angle	Normally open
V02	Stop valve to inspect or repair the refrigerant pump	Angle	Normally open
V03	–	–	–
V04	Service valve to extract the refrigerant or uncondensible gas after pump repair	Angle	Normally closed
V05	–	–	–
V06	Stop valve to inspect or repair the solution pump	Angle	Normally open
V07	Stop valve to inspect or repair the solution pump	Angle	Normally open
V08	Service valve to extract the diluted solution and to purge after pump repair	Angle	Normally closed
V09	–	–	–
V10	–	–	–
V11	Stop valve to devide high pressure section and low pressure section	Angle	Normally open
V12	Stop valve to devide high pressure section and low pressure section	Angle	Normally closed
V13	Control valve to adjust the back pressure of steam	Needle	Set by century
V14	Service valve to extract the condensated refrigerant	Angle	Normally closed
V15	Stop valve to blow down the refrigerant	Angle	Normally closed
V16	–	–	–
V17	–	–	–
V18	Stop valve for leak test(only shop test)	Angle	Normally closed
V19	Shut on/off valve of drain	Solenoid	Auto-control
V20	–	–	–
V21	Stop valve to purge condenser	Diaphragm	Normally closed
V22	Stop valve for purge tank	Diaphragm	Normally closed
V23	Stop valve to purge absorber	Diaphragm	Normally closed
V24	Stop valve to purge and to measure the pressure using manometer	Diaphragm	Normally closed
V25	–	–	–
V26	–	–	–
V27	–	–	–
V28	Control valve for automatic purging	Angle	Set by century
V29	Check valve to protect from back flow from vacuum pump(open when vacuum pump operates)	Check	Normally closed
V30	Stop valve to drain air of vacuum pump	Ball	Normally closed
V31	Stop valve to devide high and low temperature heat exchanger's shell side	Angle	Normally open
V32	Stop valve to devide high and low temperature heat exchanger's tube side	Angle	Normally open
V33	Service valve to extract medium solution from low temp. generator	Angle	Normally closed
V34	Service valve to extract concentrated solution from high temp. generator	Angle	Normally closed
V35	–	–	–
V36	–	–	–
V37	–	–	–
	Stop valve positioned on upper side of water chamber to air-vent	Ball	Normally closed
	Stop valve positioned on bottom of water chamber to drain water	Ball	Normally closed

Dampers

Symbol	Purpose	Opening degree
D01	to control refrigerant bypass rate	Set by century
D02	to control solution spray rate to absorber and to decrease noise	Set by century
D03	to control diluted solution from absorber to high temp. generator	Set by century
D04	–	–
D05	–	–
D06	–	–
D07	to control diluted solution from absorber to low temp. generator	Set by century

Sight glasses

Symbol	Purpose	Full load	Mid. load	Low load
G01	to inspect absorber solution level at bottom of shell	◑ Half	● Full	
G02	–	–	–	–
G03	to inspect solution level of high temp. generator	◑ 1/3	● 2/3	● Full
G04	to inspect solution level of low temp. generator	◑ Flow down	● Flow down	● Flow down
G05	to inspect refrigerant level of evaporator	◑ No overflow	● No overflow	● No overflow
G06	to inspect refrigerant level of refrigerant tank	● Full	● Full	● Full
G07	to inspect float valve of solution duct of high temp. generator	–	–	–
G08	–	–	–	–
G09	–	–	–	–
G10	–	–	–	–

Sensors, switches and gauges

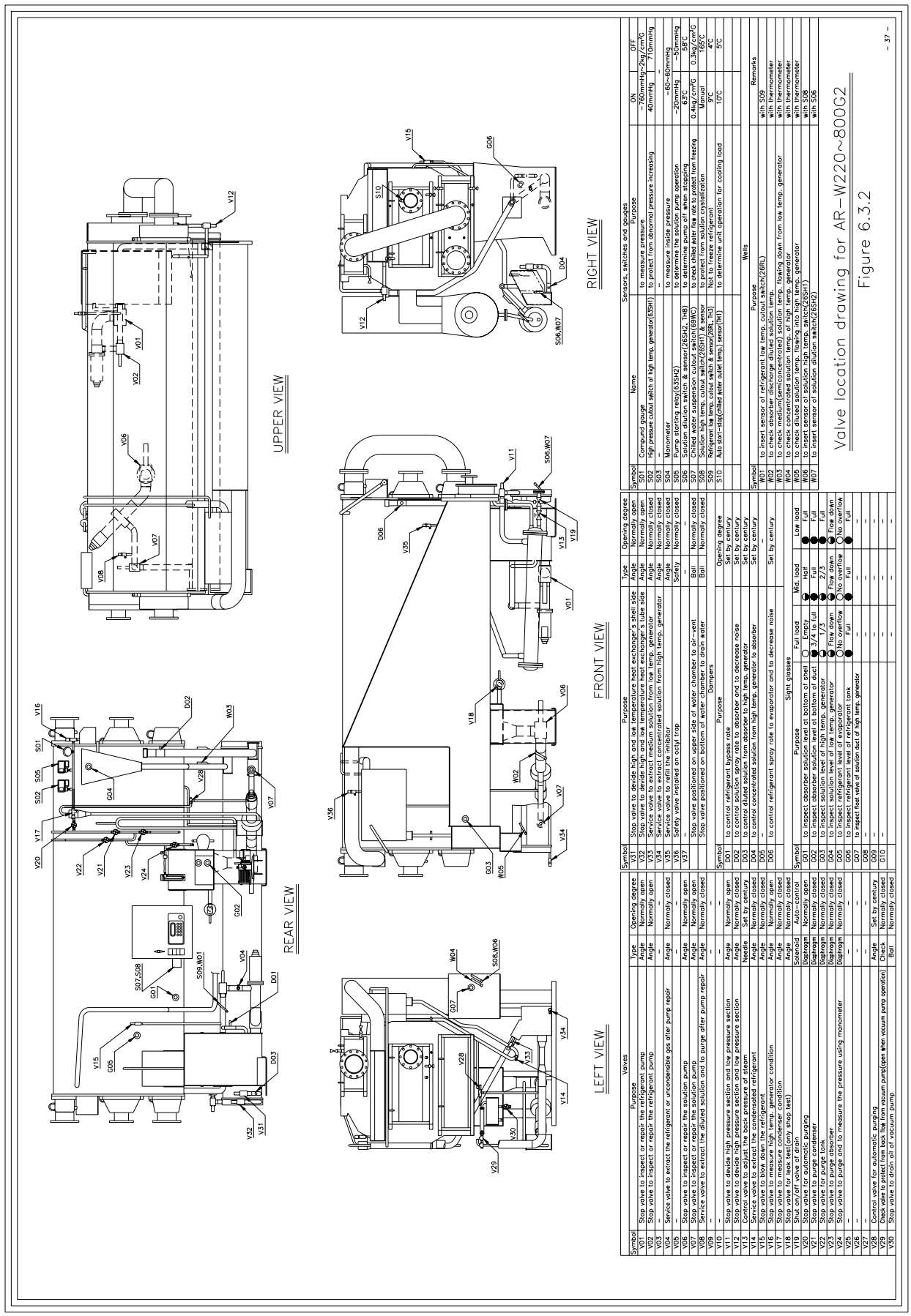
Symbol	Name	Purpose	ON	OFF
S01	Compound gauge	to measure pressure	−760mmHg~2kg/cm²G	
S02	High pressure cutout switch of high temp. generator(63H1)	to protect from abnormal pressure increasing	40mmHg ~ 710mmHg	
S03	–	–	–	–
S04	Manometer	to measure inside pressure	−60~60mmHg	
S05	Pump starting relay(63H+2)	to determine the solution pump operation	−20mmHg	−50mmHg
S06	Solution dilution switch & sensor(26SH2, TH6)	to determine pump off when stopping	63°C	58°C
S07	Chilled water suspension cutout switch(69WC)	to check chilled water flow rate to protect from freezing	0.4kg/cm²G	0.3kg/cm²G
S08	Solution high temp. cutout switch(26SH1) & sensor	to protect from solution crystallization	Manual	165°C
S09	Refrigerant low temp. cutout switch & sensor(26RL,TH3)	Not to freeze refrigerant	3°C	4°C
S10	Auto start-stop(chilled water outlet temp.) sensor(TH1)	to determine unit operation for cooling load	10°C	5°C

Wells

Symbol	Purpose	Remarks
W01	to insert sensor of refrigerant low temp. cutout switch(26RL)	with S09
W02	to check absorber discharge diluted solution temp.	with thermometer
W03	to check condenser refrigerant outlet solution temp. flowing down from low temp. generator	with thermometer
W04	to check concentrated solution temp. of high temp. generator	with thermometer
W05	–	–
W06	to insert sensor of solution high temp. switch(26SH1)	with S08
W07	to insert sensor of solution dilution switch(26SH2)	with S11

Valve location drawing for AR-W70~200G2

Figure 6.3.1



Valve location drawing for AR-W220~800G2

Figure 6.3.2

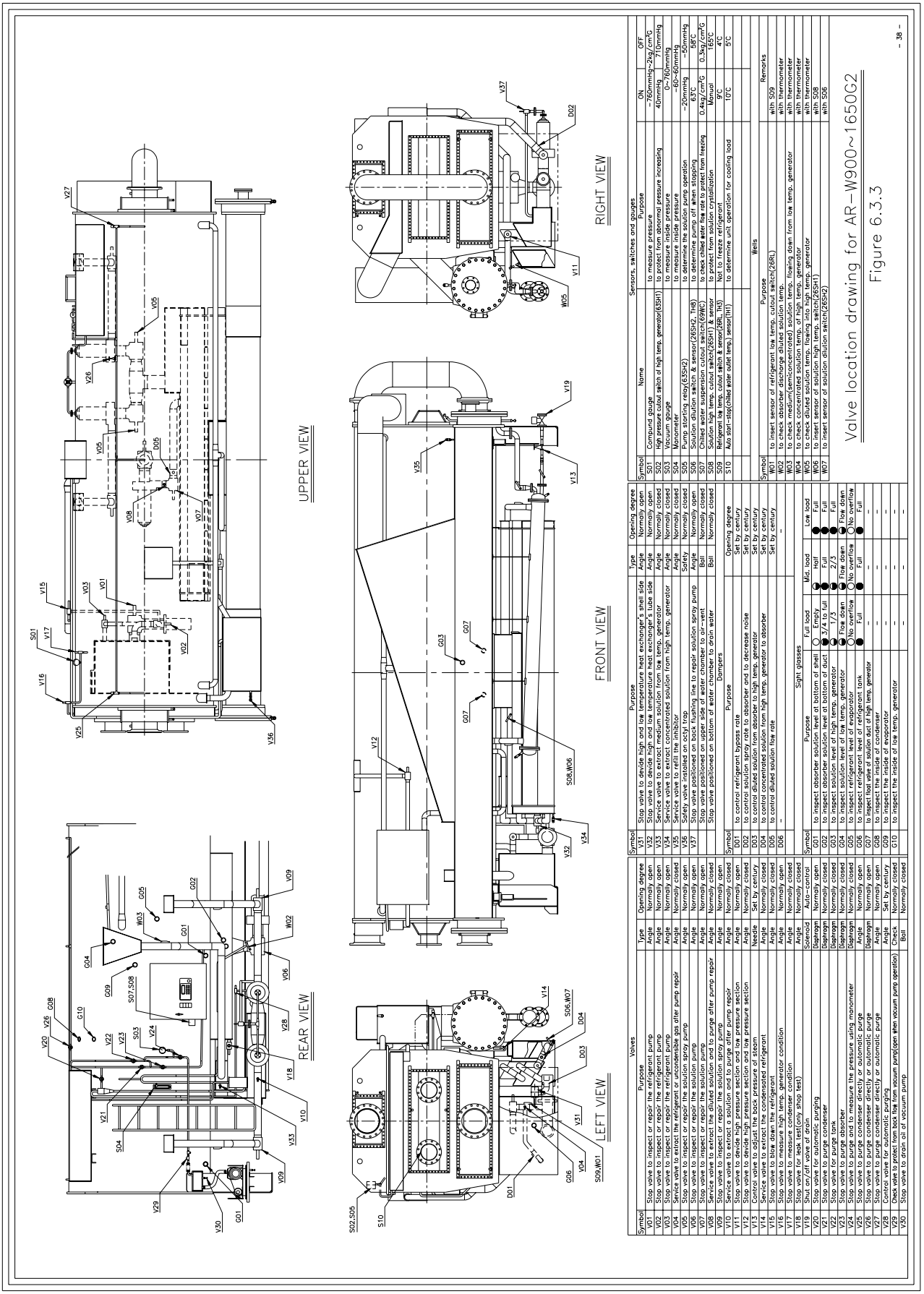
Symbol	Valves: Purpose	Type	Opening degree
V01	Stop valve to inspect or repair the refrigerant pump	Angle	Normally open
V02	Stop valve to inspect or repair the refrigerant pump	Angle	Normally open
V03	-	-	-
V04	Service valve to extract the refrigerant or uncondensible gas after pump repair	Angle	Normally closed
V05	-	-	-
V06	Stop valve to inspect or repair the solution pump	Angle	Normally open
V07	Stop valve to inspect or repair the solution pump	Angle	Normally open
V08	Service valve to extract the diluted solution and to purge after pump repair	Angle	Normally closed
V09	-	-	-
V10	-	-	-
V11	Stop valve to devide high pressure section and low pressure section	Angle	Normally open
V12	Service valve to devide high pressure section and low pressure section	Angle	Normally closed
V13	Control valve to adjust the back pressure of steam	Needle	Set by century
V14	Service valve to extract the condensated refrigerant	Angle	Normally closed
V15	Stop valve to blow down the refrigerant	Angle	Normally closed
V16	Stop valve to measure high temp. generator condition	Angle	Normally open
V17	Stop valve to measure condenser condition	Angle	Normally closed
V18	Solenoid valve for leak detect, shop test)	Solenoid	Normally closed
V19	Shut on/off valve of drain	Auto-control	-
V20	Stop valve for automatic purging	Diaphragm	Normally open
V21	Stop valve to purge condenser	Diaphragm	Normally closed
V22	Stop valve for purge tank	Diaphragm	Normally closed
V23	Stop valve to purge absorber	Diaphragm	Normally closed
V24	Stop valve to purge and to measure the pressure using manometer	Diaphragm	Normally closed
V25	-	-	-
V26	-	-	-
V27	-	-	-
V28	Control valve for automatic purging	-	-
V29	Check valve to protect from back flow from vacuum pump(open when vacuum pump operation)	Angle	Set by century
V30	Stop valve to drain oil of vacuum pump	Check	Normally closed
V31	Stop valve to devide high and low temperature heat exchanger's shell side	Ball	Normally closed
V32	Stop valve to devide high and low temperature heat exchanger's tube side	Ball	Normally closed
V33	Service valve to extract medium solution from low temp. generator	Angle	Normally closed
V34	Service valve to extract concentrated solution from high temp. generator	Angle	Normally closed
V35	Service valve to refill the inhibitor	Angle	Normally closed
V36	Safety valve installed on ecity trap	Safety	-
V37	-	-	-
V38	Stop valve positioned on upper side of water chamber to air-vent	Ball	Normally closed
	Stop valve positioned on bottom of water chamber to drain water	Ball	Normally closed

Symbol	Purpose	Opening degree
	Dampers	
Symbol	Purpose	Opening degree
D01	to control refrigerant bypass rate	Set by century
D02	to control solution spray rate to absorber and to decrease noise	Set by century
D03	to control diluted solution from absorber to high temp. generator	Set by century
D04	to control concentrated solution from high temp. generator to absorber	Set by century
D05	-	-
D06	to control refrigerant spray rate to evaporator and to decrease noise	Set by century

Symbol	Purpose	Sight glasses	Full load	Mid. load	Low load
G01	to inspect absorber solution level at bottom of shell	○ Empty	◑ Half	● Full	● Full
G02	to inspect absorber solution level at bottom of duct	◕ 3/4 to full	● Full	● Full	● Full
G03	to inspect solution level of high temp. generator	◑ 1/3	◕ 2/3	● Full	● Full
G04	to inspect solution level of low temp. generator	◑ Flow down	◑ Flow down	◑ Flow down	◑ Flow down
G05	to inspect refrigerant level of evaporator	○ No overflow	○ No overflow	○ No overflow	○ No overflow
G06	to inspect refrigerant level of refrigerant tank.	● Full	● Full	● Full	● Full
G07	to inspect float valve of solution duct of high temp. generator	● Full	-	-	-
G08	-	-	-	-	-
G09	-	-	-	-	-
G10	-	-	-	-	-

Symbol	Sensors, switches and gauges: Purpose	ON	OFF
S01	to measure pressure	-760mmHg~2kg/cm²G	
S02	to protect from abnormal pressure increasing	40mmHg	710mmHg
S03	-	-	-
S04	to measure inside pressure	-	-60~80mmHg
S05	to determine the solution pump operation	-20mmHg	-50mmHg
S06	to determine the solution pump operation	63℃	58℃
S07	to check chilled water flow rate to protect from freezing	0.4kg/cm²G	0.3kg/cm²G
S08	to protect from solution crystallization	Manual	165℃
S09	Not to freeze refrigerant	9℃	4℃
S10	to determine unit operation for cooling load	10℃	5℃

Symbol	Wells: Purpose	Remarks
W01	to insert sensor of refrigerant low temp. cutout switch(26RL)	with S09
W02	to check absorber discharge diluted solution temp.	with thermometer
W03	to check medium(semiconcentrated) solution temp. flowing down from low temp. generator	with thermometer
W04	to check concentrated solution temp. of high temp. generator	with thermometer
W05	to check diluted solution temp. flowing into high temp. generator	with thermometer
W06	to insert sensor of solution high temp. switch(26SH1)	with S08
W07	to insert sensor of solution dilution switch(26SH2)	with S06



Valve location drawing for AR-W900~1650G2

Figure 6.3.3

Symbol	Valves Purpose	Type	Opening degree
V01	Stop valve to inspect or repair the refrigerant pump	Angle	Normally open
V02	Stop valve to inspect or repair the refrigerant pump	Angle	Normally open
V03	Stop valve to inspect or repair the refrigerant pump	Angle	Normally open
V04	Service valve to extract the refrigerant or unicondensable gas after pump repair	Angle	Normally closed
V05	Service valve to refill the inhibitor	Angle	Normally open
V06	Stop valve to inspect or repair the solution pump	Angle	Normally open
V07	Stop valve to inspect or repair the solution pump	Angle	Normally open
V08	Service valve to extract the diluted solution and to purge after pump repair	Angle	Normally closed
V09	Stop valve to inspect or repair the solution spray pump	Angle	Normally open
V10	Service valve to extract a solution and to purge after pump repair	Angle	Normally closed
V11	Stop valve to divide high pressure section and low pressure section	Angle	Normally open
V13	Control valve to adjust the back pressure of steam	Needle	Set by century
V14	Service valve to extract the condensated refrigerant	Angle	Normally closed
V15	Stop valve to blow down the refrigerant	Angle	Normally closed
V16	Stop valve to measure high temp. generator condition	Angle	Normally open
V17	Stop valve to measure condenser condition	Angle	Normally closed
V18	Stop valve for leak test(only shop test)	Angle	Normally closed
V19	Shut off valve of electric purging	Solenoid	Auto-operation
V20	Stop valve to purge absorber	Diaphragm	Normally open
V21	Stop valve to purge condenser	Diaphragm	Normally closed
V22	Stop valve for purge tank	Diaphragm	Normally closed
V23	Stop valve to purge absorber	Diaphragm	Normally closed
V24	Stop valve to purge and to measure the pressure using manometer	Diaphragm	Normally closed
V25	Stop valve to purge condenser directly or automatic purge	Angle	Normally open
V26	Stop valve to purge condenser directly or automatic purge	Diaphragm	Normally open
V27	Stop valve to purge absorber directly or automatic purge	Angle	Normally open
V28	Control valve for automatic purging	Angle	Set by century
V29	Check valve to protect from back flow from vacuum pump(open when vacuum pump operation)	Check	Normally closed
V30	Stop valve to drain oil of vacuum pump	Ball	Normally closed
V31	Stop valve to devide high and low temperature heat exchanger's shell side	Angle	Normally open
V32	Stop valve to devide high and low temperature heat exchanger's tube side	Angle	Normally open
V33	Service valve to extract medium solution from low temp. generator	Angle	Normally closed
V34	Service valve to extract concentrated solution from high temp. generator	Angle	Normally closed
V35	Service valve to refill the inhibitor	Angle	Normally closed
V36	Service valve to purge the solution spray pump	Angle	Normally open
V37	Stop valve positioned on back flushing line to repair solution spray pump	Angle	Normally open
	Stop valve positioned on upper side of water chamber to air-vent	Ball	Normally closed
	Stop valve positioned on bottom of water chamber to drain water	Ball	Normally closed
	Dampers		
Symbol	Purpose	Opening degree	
D01	to control refrigerant bypass rate	Set by century	
D02	to control solution bypass rate to absorber and to decrease noise	Set by century	
D03	to control diluted solution from absorber to high temp. generator	Set by century	
D04	to control concentrated solution from high temp. generator to absorber	Set by century	
D05	to control diluted solution flow rate	Set by century	
D06	-	-	
	Sight glasses		
Symbol	Purpose	Mist load	Low load
G01	to inspect absorber solution level at bottom of shell	○ Empty	● Half
G02	to inspect absorber solution level at bottom of duct	● 3/4 to full	● Full
G03	to inspect solution level of high temp. generator	1/3	2/3
G04	to inspect solution level of low temp. generator	● Flow down	● Flow down
G05	to inspect refrigerant level of evaporator	○ No overflow	○ No overflow
G06	to inspect refrigerant level of refrigerant tank.	● Full	● Full
G07	to inspect float valve of solution out of high temp. generator	–	–
G08	to inspect the inside of absorber	–	–
G09	to inspect the inside of evaporator	–	–
G10	to inspect the inside of low temp. generator	–	–

Symbol	Sensors, switches and gauges Name	Purpose	ON	OFF
S01	Compound gauge	to measure pressure	-760mmHg~2kg/cm²G	
S02	High pressure cutout switch of high temp. generator(63H1)	to protect from abnormal pressure increasing	40mmHg	710mmHg
S03	Vacuum gauge	to measure inside pressure	0~760mmHg	
S04	Manometer	to measure inside pressure	-80~60mmHg	
S05	Pressure controlling relay(63H2)	to protect from abnormal pressure operation	-20mmHg	-30mmHg
S06	Solution dilution switch & sensor(26SH2, TH8)	to determine pump off when stopping	63℃	58℃
S07	Chilled water suspension cutout switch(69WC)	to check chilled water flow rate to protect from freezing	0.4kg/cm²G	0.3kg/cm²G
S08	Solution high temp. cutout switch(26SH1) & sensor	to protect from solution crystallization	Manual	165℃
S09	Refrigerant low temp. cutout switch & sensor(26RL, TH5)	Not to freeze refrigerant	9℃	4℃
S10	Auto start-stop(chilled water outlet temp.) sensor(TH1)	to determine unit operation for cooling load	10℃	5℃
	Wells			
Symbol	Purpose	Remarks		
W01	to insert sensor of refrigerant low temp. cutout switch(26RL)	with S09		
W02	to check absorber discharge diluted solution temp.	with thermometer		
W03	to check medium(semiconcentrated) solution temp. flowing down from low temp. generator	with thermometer		
W04	to check concentrated solution temp. of high temp. generator	with thermometer		
W05	to insert diluted solution temp. flowing into high temp. generator	with thermometer		
W06	to insert sensor of solution high temp. switch(26SH1)	with S08		
W07	to insert sensor of solution dilution switch(26SH2)	with S06		

7.Operation

7.1 Check before Operation

(1) Check if the degree of vacuum is proper in the chiller.

Operate the solution pump independently and measure the concentration and temperature of the solution to obtain its saturation pressure. To perform the independent operation of the solution pump, follow the procedure mentioned below in Note. Carry out this operation when checking the pressure in the machine before seasonal service.

⚠ Note : Independent operation of solution pump

The solution pump can be operated independently by setting the solution pump switch(K1M) at "Manual" position with the refrigerant pump switch(K2M) turned "off".

(2) Check the steam pressure

Make adjustment to the specified pressure using the pressure reducing valve.

(3) Check if the refrigerant blow valve is opened.

If the operation is performed with the refrigerant blow valve(see figure 8.1.1~8.1.3 & figure 6.3.1~6.3.3 V15) opened, the refrigerant pump may cause cavitation and insufficient cooling capacity.

(4) Adjust the back pressure at the drain outlet only in the trial operation with back pressure setting valve(V9) in figure 5.7.

7.2 Start/stop

(1) Start at the beginning of week (daily)

① Supply chilled water and cooling water.

② Open the manual main valve of steam.

③ Press the start button. The cooling operation is started and the "operation" lamp goes on.

⚠ Note : In the automatic operation, the refrigerant pump switch is turned "on", the manual valve opening degree of steam is fully opened and the solution pump switch is positioned at the "auto". In the manual operation, it is possible that the valve opening of steam is adjusted.

(2) Start at the beginning of warm season (after long out-of-service)

① Preparation

Before starting the chiller, carry out the following checkup and maintenance.

1) Perform the monthly and yearly maintenance procedures.

2) Using the vacuum pump, purge nitrogen gas in the chiller to provide vacuum. The judgment on the degree of vacuum should be determined according to the saturated vapor pressure graph for LiBr solution(see figure 4.1).

3) Supply chilled water and cooling water into the chiller.

② Start

Start the machine as mentioned above weekly/daily starting.

1) Make sure that the refrigerant pump switch is turned "off".

2) press the "start" button.

3) The refrigerant is regenerated through the above steps. About 20 minutes later, check the level of the regenerated refrigerant through the sight glass(see figure 6.3.1~6.3.3 G06).

4) Then, turn "on" the refrigerant pumps switch.

As followed steps, the chiller is operated automatically.

⚠ Caution : Crystallization may take place if the operation is continued for a long period with the refrigerant pump stopped. Before a long-period operation, be sure to turn "on" the refrigerant pump switch to avoid the independent operation of the solution pump.

Low cooling water inlet temperature during operation : If the cooling water inlet temperature is 20℃ or below, the specified value is 32℃ for standard, it is required to refill the refrigerant, distilled water, before start or the operation. The amount to be refilled and the replenishment method should contact with Finetec Century.

(3) Stop at the end of week(daily)

① Press the "stop" button.

② After stop of the chiller followed the dilution operation, stop the chilled water pump and the cooling water pump. When the pump interacting operation contact is used, the chilled water pump and the cooling water pump are stopped upon completion of the dilution operation.

③ Close the manual steam valve. When the chiller stops for more than two hours, the manual steam valve shall be closed to prevent from solution crystallization by steam leak into the 1st stage generator.

(4) Stop at the beginning of cold season

① Carry out the above three steps for the stop at the end of week.

② While operating the refrigerant pump and the solution pump independently, open the refrigerant blow valve(see figure 8.1.1~8.1.3 & figure 6.3.1~6.3.3 V15) to return refrigerant into the absorber. Then stop the pumps.

③ Drain chilled water and cooling water.

④ Charge 0.1 to 0.2kg/cm^{2}G of nitrogen gas in the chiller.

⑤ Completely extract refrigerant through the plug of the refrigerant tank(see figure 8.1) and the service valve of refrigerant return pipe(see figure 6.3.1~6.3.3 V14) according to section 8.3.(2) "extracting(total amount)". Store the refrigerant so that it can be reused for the next season.

⑥ Check the cooling tower and the pumps.

⑦ Open the NFB and turn off the main power switch.

⑧ Record the pressure in the chiller periodically.

⚠ Notice : It is not required to charge nitrogen gas and extract refrigerant in those instances where the out-of-service period of the chiller is four to five months, the periodical inspection can be implemented for this period and also the ambient temperature does not decrease below 0℃ during cold season. In case that the

chiller is left in a vacuum state, be sure to check weekly if the degree of vacuum is not lowered.

If the intermittent operation is desired during cold season and the ambient temperature decreases below 0℃, the special treatment is required.

7.3 Check during Operation and Cautions on Handling

(1) Keep the operating record daily. For details, refer to the chapter 10 "operation record".

(2) On the sight glass, check the level of solutions in the absorber. For the relation between the cooling capacity and the solution level at the specified cooling water temperature, refer to the test result report. Crystallization may result if the level of solution is at least 20mm lower than the l00% level during the operation. For troubleshooting, refer to chapter 9.

(3) During operation, the steam pressure should not exceed the specified value by more than 0.5kg/㎠. The lower deviation of approx. 1.0kg/㎠ for the specified range is allowed.

(4) Regulate the cooling water inlet temperature so that it will become higher than 20℃ before about 30 minutes after the start during cold season.

(5) Sample the diluted solution through the manual service valve(see figure 6.3.1~6.3.3 V08) located at the solution pump discharge pipe, and measure the specific gravity and temperature to obtain the concentration referring to Figure 4.2. The measurement should be made every two weeks or so.

⚠ Caution : The solution should be sampled during operation. After the sampling, be sure to close the service valve.

(6) To measure the degree of vacuum in the chiller using a manometer, be sure to purge with the vacuum pump before opening the manual valve(see figure 6.3.1~6.3.3 V24). After measurement, close the manual valve. the manual valve should be closed except for the measurement time.

(7) The lift of the steam control valve has been adjusted in the Finetec Century factory, therefore readjustment is not required at site. Refer to the control valve manual submitted with the chiller.

(8) Check to see if the refrigerant is not overflowed. If a refrigerant overflow found, take the proper countermeasure referring to chapter 9 "Trouble shooting".

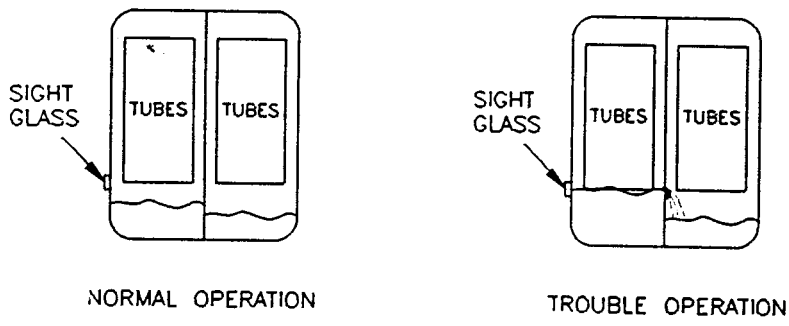


Figure 7.1.1 Refrigerant overflow schematics(AR-W80~200G2)

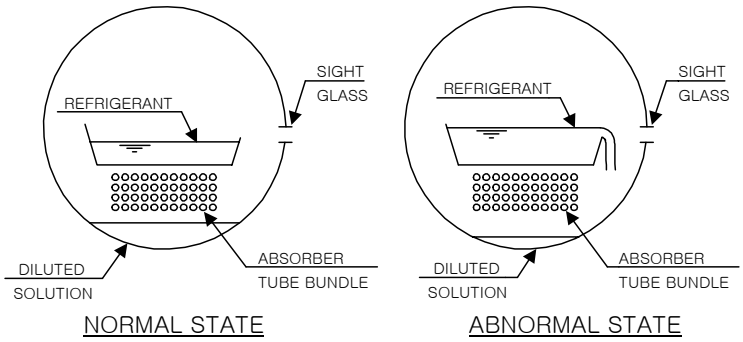


Figure 7.1.2 Refrigerant overflow schematics(AR-W220~1650G2)

(9) During the dilution operation after operation stop, be sure to keep the chilled water and cooling water being supplied. Otherwise, the solution cannot be diluted, which may cause crystallization.

(10) Check the vacuum pump for the degree of vacuum achieved at all times.

7.4 Countermeasure against Power Suspension

(1) Power suspension during the operation

In the event of power suspension encountered with the chiller in service, the concentration of the solution is kept 60~65%. Crystallization may take place due to the cooling by ambient air for the period of power suspension. To avoid this, take the proper countermeasure for recovery from power suspension as promptly as possible. For a short period of power suspension, the restart can be possible after its recovery. For a long period of power suspension more than one hour, take the following procedure against probable crystallization.

① Start normal minimum load operation.

② Observing the solution level in the absorber, watch the normal operation to be continued for about 30 minutes. The normal operation does not result in crystallization.

③ If a cavitation takes place in the solution pump within 30 minutes, crystallization must be induced. Immediately press the "stop" button and also turn off the power switch, NFB in the control panel, to stop the chiller. If crystallization is recognized, take the following steps.

④ In the event of a cavitation, press the stop button, turn off the power switch and wait for about 30 minutes.

⑤ If it is found through the sight glass of the absorber that the solution level has been raised, crystallization is not considered so severe. Repeat the minimum load operation and the stop again, and crystallization will be disappeared.

⚠ Caution : If the solution level of the absorber cannot be raised, perform the decrystallization operation referring to section 8.6 or contact Finetec Century or our agents.

(2) Restart after short-period power suspension

For a short period power suspension, the temperature of solution in the chiller is kept

considerably high. The dilution solution switch is held on, the bell sounds, and the water suspension indicator lamp is lit. Restart the chiller in the following manner.

① Set the alarm switch to the "stop" position.

② Press the "stop" button.

③ Turn the solution pump switch to the "manual" position to drive the solution pump and the refrigerant pump independently, and open the refrigerant blow valve(see figure 6.3.1~6.3.3 V15).

④ The solution in the chiller is mixed and diluted and the solution temperature becomes low, causing the solution dilution switch to be turn off. The dilution switch released extinguishes the water suspension indicator lamp. Close the refrigerant blow valve. When blowing the refrigerant, take care to prevent cavitation in the refrigerant pump. If cavitation takes place, immediately stop the refrigerant pump by turning off the refrigerant pump switch.

⑤ Set the auto/manual switch to the "auto" position to stop the pump.

⑥ Set the operation switch to the "start" position.

⑦ When the normal operation can be achieved, perform the sufficient purging from the absorber to prevent non-condensed gas from blowing from the 1st stage generator into the main shell in the event of power suspension.

⚠ Note : After emergency stop or when NFB is off by anyone, restart the chiller immediately, before at least 60minutes. If crystallization is generated, follow the above steps about power suspension.

7.5 Purging Operation

(1) Structure of Purging Facilities

The purging facilities include following parts. Figure 7.2.1~7.2.2 shows the structure of the purging facilities.

① the purge tank for automatically collecting non-condensed gas during operation

② the purge pump, vacuum pump, for purging non-condensed gas and discharging it outside.

③ the check valve for preventing a small amount of air from flowing back to the chi1ler from the outside through the purge pump due to power suspension during the purge operation.

④ the manometer for checking the purging performance and measuring the pressure in the chiller.

Table 7.1 Valve opening/closing for purge operation

Item \ Valve no.(figure 7.2.1~7.2.2 and figure 6.3.1~6.3.3)		W70~200G2					W220~1650G2				
		A	B	C	D	E	A	B	C	D	E
		V28	V22	V24	V21	V23	V20	V22	V24	V21	V23
Performance check of the purge pump		–	×	○	×	×	○	×	○	×	×
For charging solution and refrigerant		○	○	○	○	○	○	○	○	○	○
After installation & before trial operation	through L-5 for low & high pressure section	–	○	○	○	○	○	○	○	○	○
	through L-5 for high pressure section directly	–	×	○	○	×	○	○	○	○	×
During cooling operation	before cooling(Refer to Note②)	–	○	○	○	×	○	×	○	○	×
	with purge pump when purge tank pressure is 50~100 mmHg	–	○	○	×	×	○	○	○	×	×

⚠ Note

① ○ : fully opened, × : fully closed

② In cooling operation, purge operation shall be done for about 30 minutes before operation one or two times every week.

⚠ Note : When purging the low pressure side through the L-4, check that the solution level of absorber is lower than sight glass(see figure 6.3.1~6.3.3 G01 & G02 and figure 7.2.1~7.2.2 "absorber level gauge") equipped to lower part of absorber to prevent solution from introducing to purge pipings.

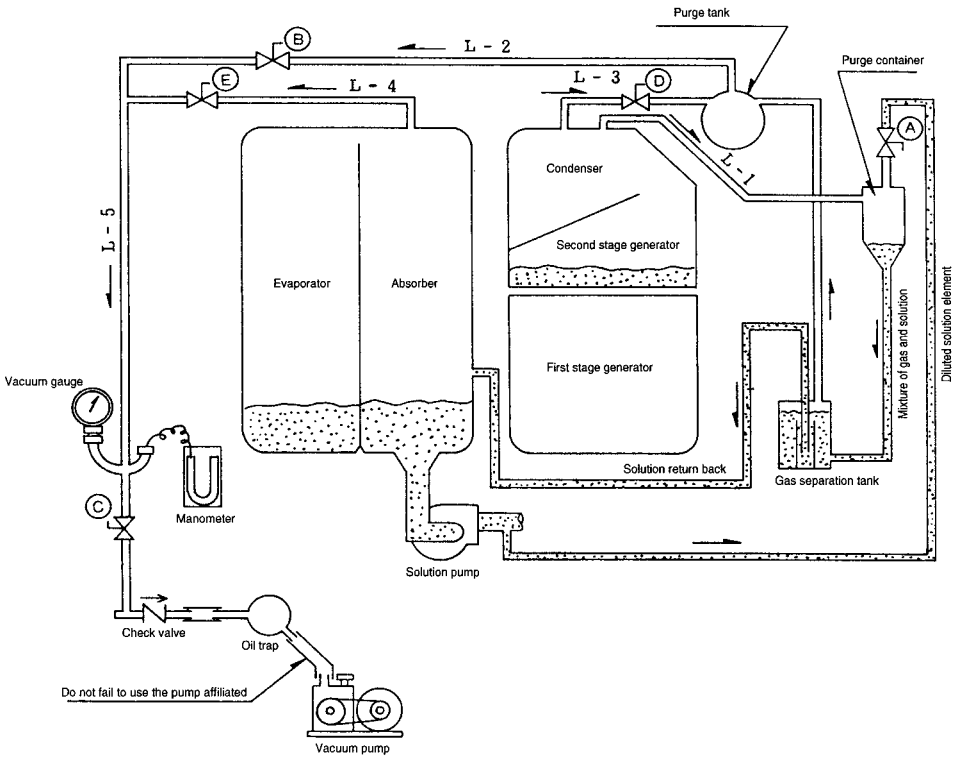


Figure 7.2.1 Purging facilities(AR-W70~200G2)

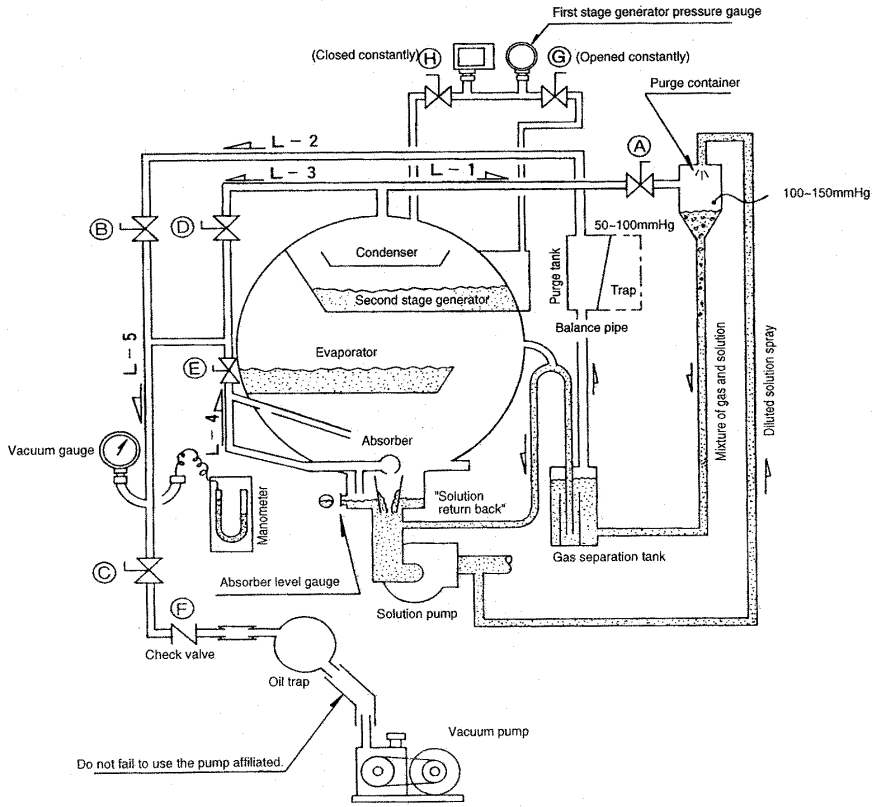


Figure 7.2.2 Purging facilities(AR-W220~1650G2)

(2) Checking performance of Purge Pump and Hermetic Condition of Check Valve

Before operating the purging facilities, be sure to check the performance of the purge pump and the hermetic condition of the check valve.

① On the oil gauge, check the oil level of the purge pump.

② After making sure that the manual valves A, B, D and E are fully closed, start the purge pump and open the manual valve C. See Figure 7.2.1~7.2.2.

③ Check that the manometer reads approximately 0~3 mmHg after five minutes operation. If the vacuum of 0~3 mmHg cannot be reached, the purge pump performance may be lowered due to such a state that too much water content in the oil of the purge pump or the piping/joint between the manual valves B and E and the purge pump may be leaked.

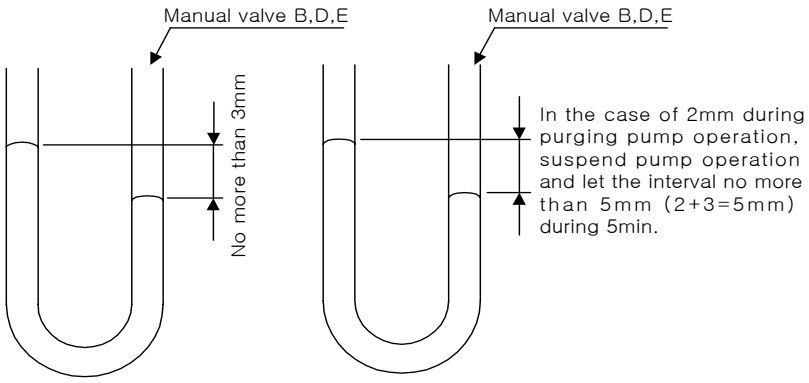


Figure 7.3 Manometer reading value after five minutes operation

If too much water is contained in the oil, it has yellow or white turbidity. Replace the turbid oil with new one. For the replacement of oil, refer to handling manual of vacuum pump. If a leak is found on the piping or joint, rebind the new sealing tape. If the hose joint is leaked, reattach the joint using vacuum grease, etc.

④ If the vacuum of 0 to 3 mmHg is reached, stop operating the purge pump and check the manometer for a decrease in vacuum degree. If a decrease in vacuum is 10 mmHg or below for 3 minutes, it is considered proper. If a decrease in vacuum exceeds 10mmHg, the closing of the check valve may not be perfect or a leak may occur on the piping/joint between the manual valves B and E and the check valve.

If the check valve is faulty, disassemble it for repair. If a leak is found on the piping/joint, repair it.

The above procedure ① to ③ should be taken for checking the purge performance.

The procedure ④ should be taken to prevent air from flowing back into the chiller due to incomplete closing of the check valve in the event of power suspension during the purge operation.

(3) Classification of Purge Operation

The purge operation is generally classified into the following.

① Purging operation for charging solution or refrigerant

② Purging operation after installation before trial running

③ Purge operation for cooling

(4) Operational Procedure of Purging Facilities

According to a particular purpose, perform the purge operation as mentioned below.

Referring to Figure 7.2.1~7.2.2, open or close the valves correctly. During the purge operation, attend the chiller to check the working condition of the purge pump etc. If a power suspension takes place or any part of the purge pump is damaged, which is checked by the exhausting sound of the purge pump stops, immediately close the manual valve C to prevent air from flowing back into the chiller.

① Purging Operation for Charging Solution and Refrigerant

In the chiller delivered, nitrogen gas is charged for corrosion proof. After installation, it is required to purge nitrogen and charge solution and refrigerant. For this charging perform the purging operation, which is not necessary in case that the chiller is delivered with solution and refrigerant pre-charged.

Operate the purge pump, and fully open the manual valves A, B, C, D, and E. The purging is completed when the manometer reads the saturated pressure value. During the purging operation, replace the purge pump oil once or twice.

② Purging Operation after Installation before Trial Running

After charging solution and refrigerant as mentioned above ①, it is required to remove the air introduced at the time of charging. Thus the complete purging can be achieved. During the purging operation, replace the purge pump oil once or twice. Operate the purge pump, and fully open the manual valves A, B, C, and D.

③ Purge Operation for Cooling

To maintain the performance of the chiller, operate the purge pump when the purge tank pressure reaches 50 mmHg or higher (50~100 mmHg). Thus the non-condensed gas collected in the purge tank is discharged.

1) Before starting the operation of the purge pump, check its performance.
2) After completion of the check, start the cooling operation. Then, press the purge operation switch "start" button for operating the purge pump. Checking that the purge pump is working and the refrigerant pump it turning at the same time, fully open the manual valves A, B and C. It is sufficient to purge for About 20 minutes. When turning off the power at the control panel in emergency, be sure to close the manual valves.
3) The purging through manual valve E should be performed in the above cases ① and ② and also in case of emergency. The manual valve E should not be manipulated in a normal operation.

If air is mixed into the main unit to decrease the degree of vacuum, the desirable performance cannot be obtained and such an abnormal event as cavitation in the solution pump may take place. In this case, the purging operation must be performed. Open the manual valve E for the purging through L-4, and the prompt recovery will be made.

⚠ Note : the manual valves B and D should be closed for the purging through L-4 with manual valve E opened.

(5) Automatic Purging

So far the manual purge operation procedures have been described in (1) to (4). During the cooling operation, the continuous purging is automatically performed through L-1. In

this case, fully open the manual valve A and B and fully close the manual valves C, D, and E. The purge operation to be performed as mentioned in (4)-③ provides the same effect as the automatic purge operation in which the non-condensed gas collected in the purge tank is extracted through L-1.

7.6 Operation State

Figure 7.4.1~7.4.3 show the temperature and pressure value of each parts in steady state. Because the pressure and temperature of those state point is varying with chilled water temperature, cooling water temperature, steam pressure, water flow rate, steam consumption rate and etc., state points are hard to explained fixed value. Therefore the values in Figure 7.4.1~7.4.3 is only for reference.

⚠ Warning

① Though the surface is sealed by insulation material, Carefully do not touch hot surface to avoid a burn.

② Be careful to manipulate the steam system because steam pressure, 8kg/cm^{2}G at standard, is much higher than atmosphere's.

③ Inside pressure of the chiller is at the vacuum state.

④ The inlet/outlet pipes temperature of heat exchanger have a similar temperature with connected heat exchanger.

⑤ The working pressure of chilled water and cooling water is 8 kg/cm^{2}G at standard.

⑥ The discharging pressure of solution pump is 0.5kg/cm^{2}G.

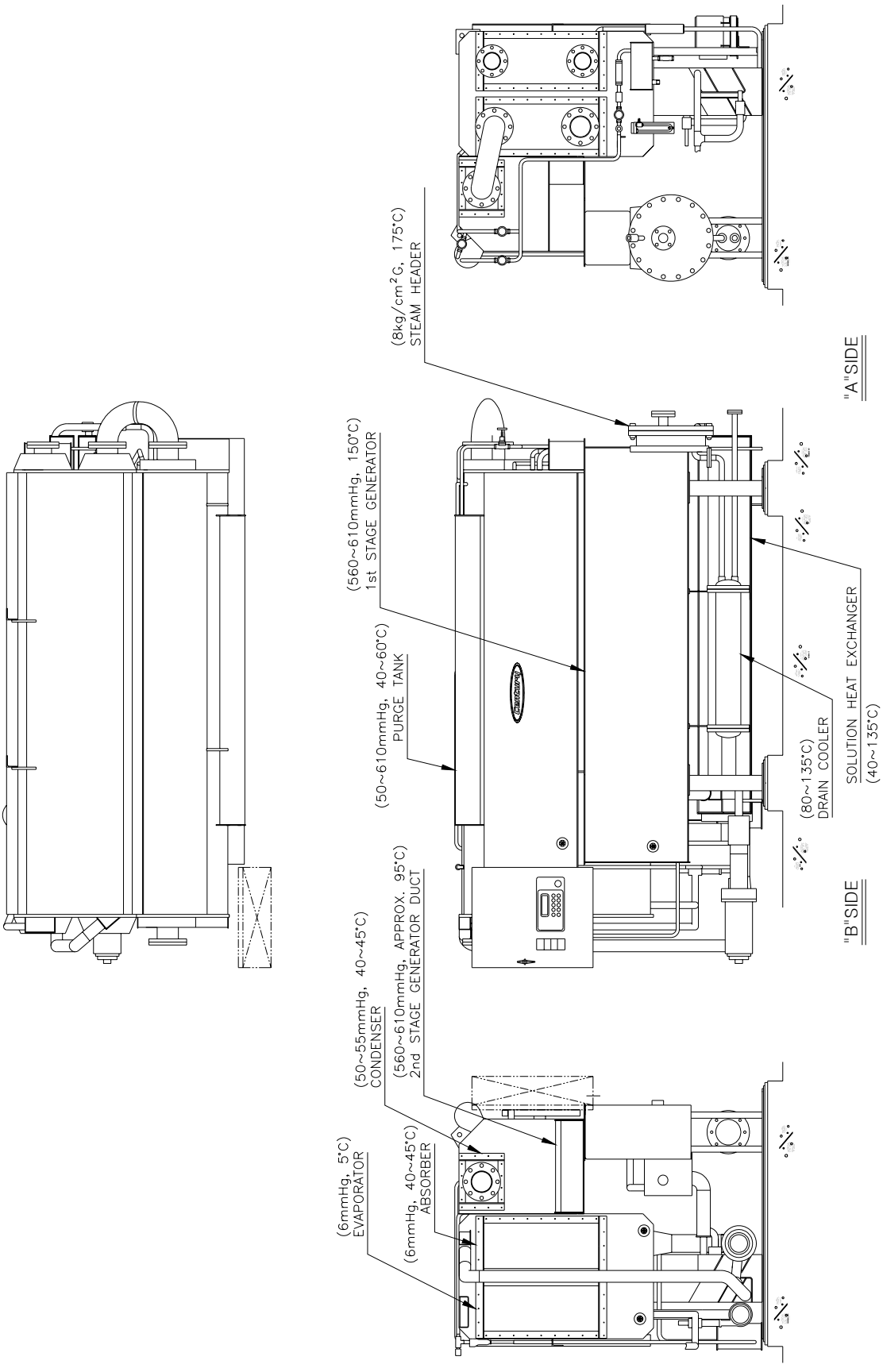


Figure 7.4.1 Operation state(AR-W70~200G2)

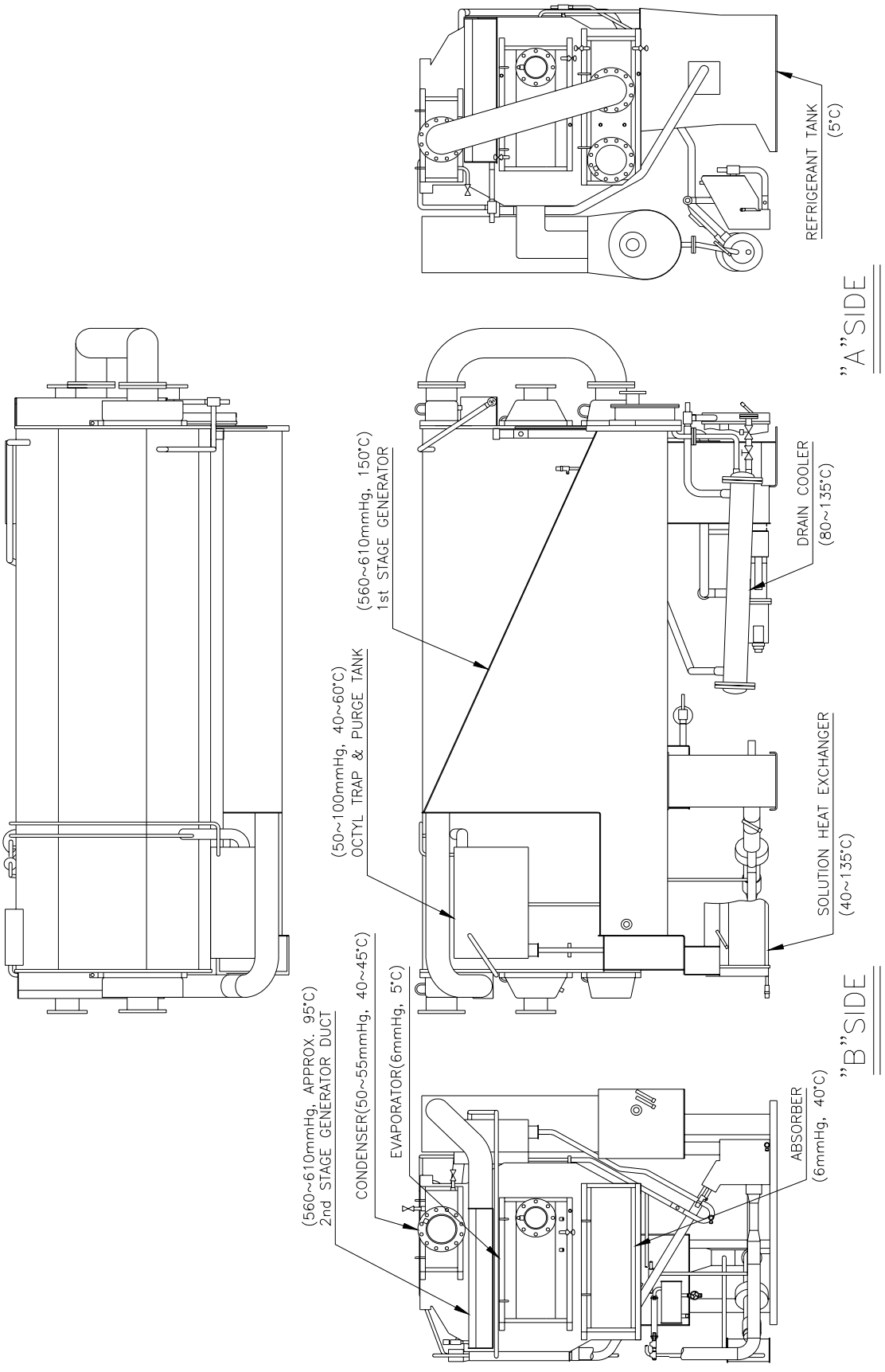


Figure 7.4.2 Operation state(AR-W220~800G2)

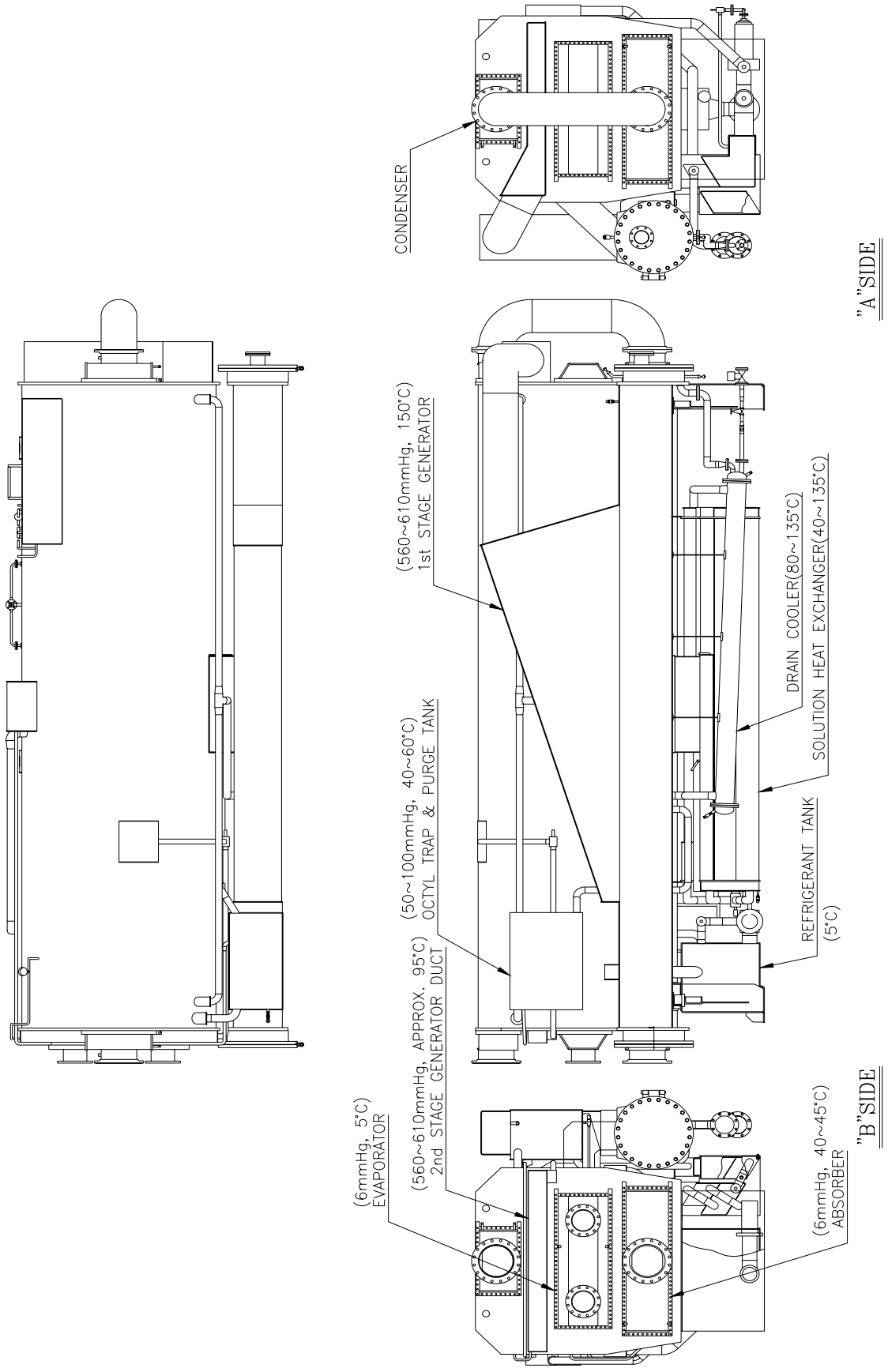


Figure 7.4.3 Operation state(AR-W900~1650G2)

8. Maintenance and Inspection

To keep the desirable performance of this absorption chiller for a long time and to use it at an economical running cost, it is required that the perfect maintenance and inspection be carried out.

※ Lithium bromide solution used for this chiller may develop vigorous corrosion in a co-existent state with oxygen contained in the air. To avoid this, check daily that the outside air is not introduced into the chiller. Even if a small amount of air is introduced, it will corrode iron, copper and copper alloy in combination with lithium bromide. To suppress this corrosion, the corrosion inhibitor is added in the lithium bromide solution. Since the corrosion inhibitor is consumed gradually, periodically analyze the solution and refill the corrosion inhibitor as needed(see section 8.8 "Maintenance for inhibitor"). Also, the purification of the solution must be carried out periodically.

※ The heat transfer tube may be contaminated heavily if the chilled water and cooling water have low qualities. Contamination deteriorates the thermal conductivity of the heat exchanger, and lowers the cooling performance. Also, impurities in the water cause the tube to corrode. To prevent corrosion of the tube, periodically conduct the water quality inspection and check the tube for corrosion using an eddy current flaw detector or an inside-tube viewing mirror(see section 1.3.(1).9).

※ Periodical inspection by user

It is recommended that the user should conduct the yearly inspection for the following items.

① Check if there is a flaw on the main unit
② Check if the lid fixing bolt it worn.
③ Check if the pipes and valves are damaged.

8.1 Periodical Maintenance

To extend the service life of the machine and keep the stable performance, conduct the periodical maintenance in the manner mentioned below.

(1) Daily Inspection

① Sample the operation data in actual operation according to table 10.1 "Operation record chart", and examine it referring to the test result report submitted with the chiller.

② In maintenance of the chiller, it is most important to prevent air leakage for keeping the specified vacuum degree. Before operation, check the purging facilities and perform the purge operation. For the inspection procedure, refer to 7.5-(2) "Checking Performance of Purge Pump and Hermetic Condition of Check Valve".

③ Frequently check that the chilled water, cooling water, steam, drain etc. are flowing smoothly.

(2) Weekly Inspection

① Regenerate the refrigerant.

After a long operation of the chiller, a small amount of the solution may be mixed into the refrigerant, causing a decrease in the cooling efficiency. To avoid this, take the following refrigerant regeneration procedure.

1) For the air-conditioning use, regenerate the refrigerant for about 30 minutes after

refrigerant blowing. Stop the operation. after refrigerant regeneration.

2) For the industrial use, regenerate the refrigerant during low load operation.
3) For refrigerant blowing, fully open the refrigerant blow valve(see figure 8.1.1~8.1.3 & figure 6.3.1~6.3.3 V15) and continue the blowing until the level in the refrigerant gauge disappears with taking care not to cause cavitation in the refrigerant pump. Then fully close the refrigerant blow valve and stop the refrigerant pump.
4) With stopping refrigerant, continue the cooling operation. Then regenerated refrigerant in generators is gathered in refrigerant tank and refrigerant level is gradually risen.
5) If refrigerant is risen to middle level of sight glass mounted in the refrigerant tank(see figure 8.1.1~8.1.3 & figure 6.3.1~6.3.3 G06), then operate the refrigerant pump to do normal cooling operation. After regeneration of refrigerant, it is necessary to switch the refrigerant pump to "On".

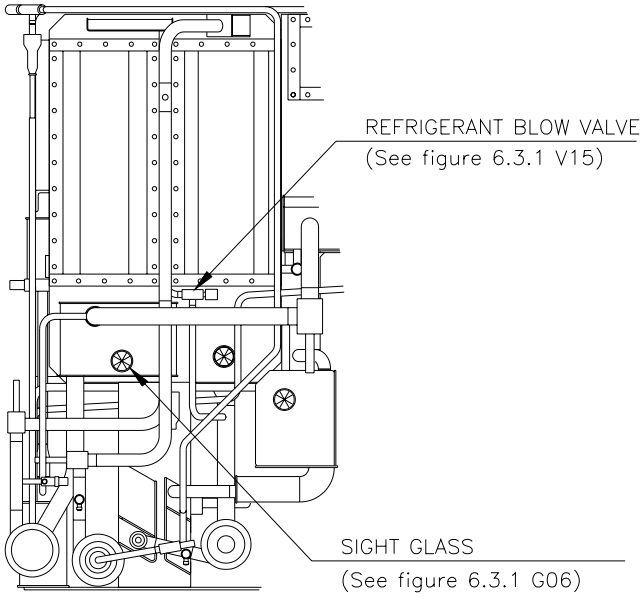


Figure 8.1.1 Facilities for refrigerant blowing(AR-W70~200G2)

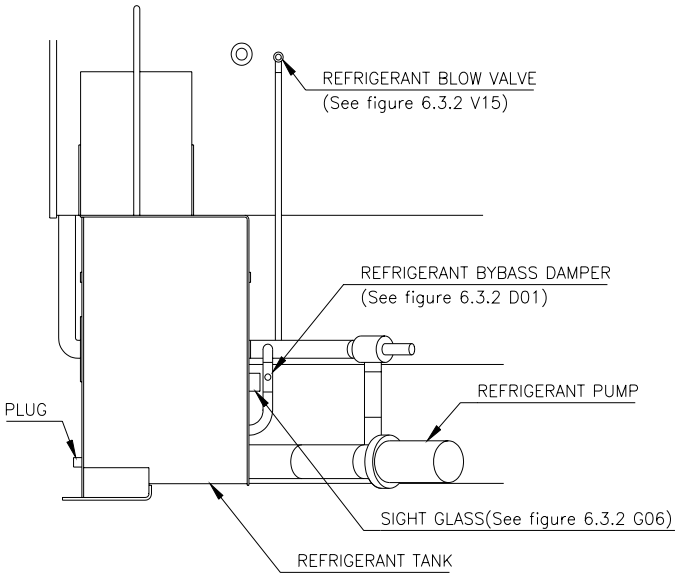


Figure 8.1.2 Facilities for refrigerant blowing(AR-W220~800G2)

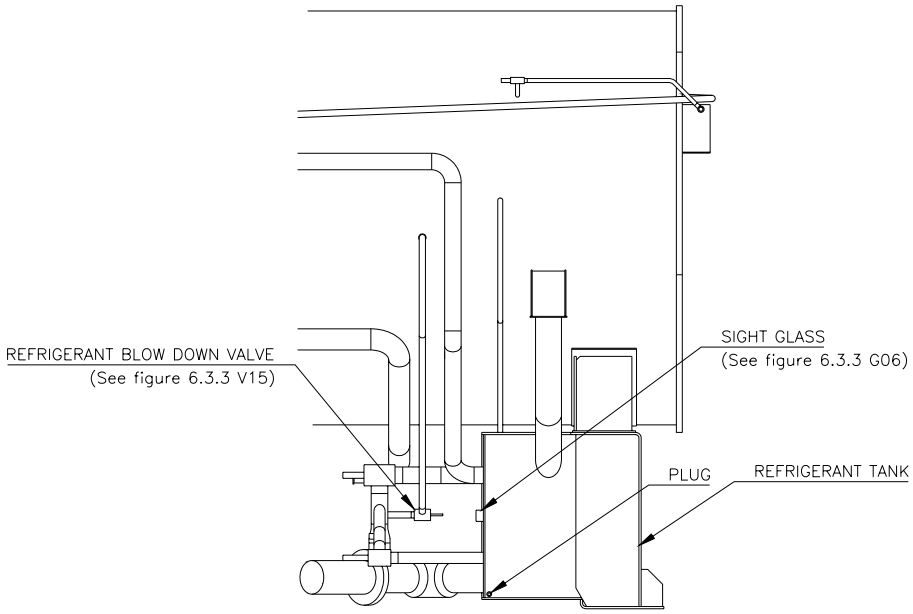


Figure 8.1.3 Facilities for refrigerant blowing(AR-W900~1650G2)

② Operate the vacuum pump

Operate the vacuum pump independently for about one hour for the purpose of maintenance.

③ Check the oil of the vacuum pump

After operation of the vacuum pump, be sure to check the oil. If the oil has yellow turbidity, replace the oil since it contains water. Use the vacuum pump oil IC-200 or equivalent. After replacement of the oil, be sure to perform the warming-up operation and check that the manometer pressure indicates 3 mmHg or less. After 4-hour operation, the oil replacement is required in most cases. For details, refer to attachment 2.

(3) Yearly Inspection

① Charge 2-ethyl hexyl alcohol about 200 cc/year on the normal condition. In the vacuum pump operation, the 2-ethyl hexyl alcohol is discharged outside together with the non-condensed gas. Therefore, charge the 2-ethyl hexyl alcohol in the chiller as required by the operating condition. The 2-ethyl hexyl alcohol is indispensable for maintaining the absorbing capacity.

② Charge $LiNO_3$ following the table 8.1. The standard portion of $LiNO_3$ is 500 mg/ℓ in the 53 wt% LiBr solution.

③ Check the steam control valve.

④ Check the operation of the control devices and the setting points.

⑤ Measure the lift of the steam control valve(see figure 5.7 V7). The lift to be measured is the spindle difference between 0% opening and 100% opening.

⑥ Check if scales or foreign matters are not accumulated in the cooling water tubes. Accumulation of scales or foreign matters causes a remarkable decrease in the heat transfer efficiency. By removing the accumulated matters, the service life of the tube can be extended. For cleaning the water tubes, discharge water in the tubes, open the front and rear water chambers and brush the inside of the tube carefully. By measuring the data on the chilled/cooling water pump discharge pressure, motor voltage, current,

etc., it becomes available when analyzing the water flow change in chilled/cooling water system, the scale accumulation, etc.

⑦ Check the refrigerant pump, solution pump and vacuum pump. For a long-time operation, conduct the check once in the first year. After then, it is recommended that the check be made every two years. The pump components such as bearing have considerably long service life, but it is desirable to check them for preventing a trouble.

⑧ Check refrigerant charged amount. The refrigerant vapor are slightly forced out of the machine during the purging, which result in the amount of refrigerant being decreased. The decrease of the refrigerant may cause such a serious trouble as crystallization. Carry out checkup/adjustment under the maximum load condition once a year, in the following manner. Prepare the refrigerant to be refilled, and seal the refrigerant in the machine under the maximum load condition. During the charging, check if an overflow of refrigerant takes place. Keep on supplying the refrigerant until occurrence of a slight overflow. Through the above procedure, the proper amount of refrigerant can be refilled.

(4) Other Inspection

Nitrogen gas should be charged to be positive pressure during the long out-of-service period. Seal nitrogen gas and keep the pressure of approximately 0.1 kg/㎠G for a long out-of-service period to prevent air from intruding. Otherwise, the inside of the chiller may corrode.

8.2 Maintenance for Cold Season

Take the necessary procedure to prevent the chilled water, cooling water, refrigerant, etc. from freezing.

(1) Drain the chilled water, cooling water and condensed steam by drain valve located in water chamber.

(2) Drain the water in the copper pipe for chilled water suspension switch.

(3) To prevent crystallization and freeze out solution pump and refrigerant pump, dilute the LiBr solution in accordance with following manner.

① Solution pump Auto/Manual change-over switch shall be "Manual" position to run solution pump and refrigerant pump.

② Open refrigerant blow valve(see figure 8.1.1~8.1.3 & figure 6.3.1~6.3.3 V15) to blow refrigerant to absorber. Please confirm refrigerant level in refrigerant tank through sight glass, and be careful refrigerant pump running tone during this work. When refrigerant pump begin cavitation, immediately shut refrigerant blow valve and stop refrigerant pump by refrigerant pump On-Off switch.

③ Please keep solution pump running for about 15~20 minutes to dilute the solution. If solution concentration of sampled solution from absorber is around 45 wt%, that mean enough dilute solution for long term stopping in winter season, so it is possible to finish dilution operation. Then stop solution pump.

④ Please be careful solution pump running tone during solution pump operation and when solution pump begin cavitation, please stop solution pump.

(4) The heater selection switch shall be "on" position to drive anti-freeze heater. That heater can prevent freeze out refrigerant return piping and refrigerant pump. This device is installed by option, if the ambient temperature is below 0℃.

(5) Please change vacuum pump oil to new one. And it is good way to prevent rust and

corrosion that vacuum pump shall be operated shortly once or twice a month.

(6) Charge the Nitrogen gas to have positive pressure, about 0.1 kg/cm^{2}G, in the shell.

8.3 Charging and extracting the LiBr solution and refrigerant

On the charging or extracting the LiBr solution and refrigerant, pay attention not to introduce the air into the chiller. The air introduction results in corrosion, cooling capacity decrease and crystallization.

(1) Charging

① Check the vacuum degree from the manometer.

② Prepare and connect the vessel, hose, copper tubes and etc. referring to figure 8.2.

③ Join the hose in figure 8.2 to the service valve of solution pump discharge(see figure 6.3.1~6.3.3 V08) or service valve of heat exchanger(see figure 6.3.1~6.3.3 V34).

④ Completely fill the vessel, tubes and hose with solution.

⑤ Open the service valve.

⑥ Because the chiller is at the vacuum state, the solution in the vessel flow into the chiller inside.

⑦ Pay attention to see the solution level of the vessel not to introduce the air into the chiller.

⑧ When the vessel is nearly empty, incline the vessel referring to figure 8.3 for complete charging.

⑨ Close the service valve after charging.

⑩ Remove the hose from the service valve.

⑪ Cover the service valve cap.

⑫ Clean the vessel, hose, copper tubes and etc. with water.

⑬ Start the purge operation because small amount air may be introduced into the chiller.

⑭ Check the vacuum degree.

⑮ After chiller operation, check the solution level of sight glasses at full load operation referring to table 6.3.1~6.3.3.

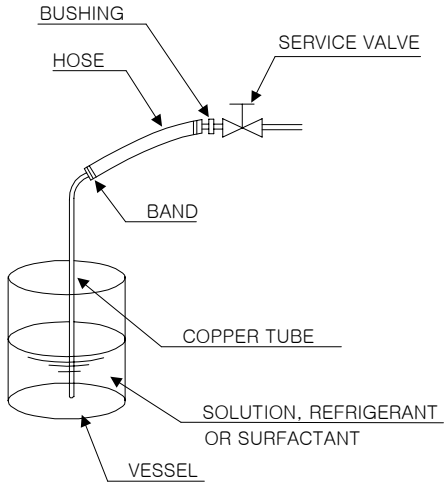


Figure 8.2 Charging & extracting the solution, refrigerant and surfactant

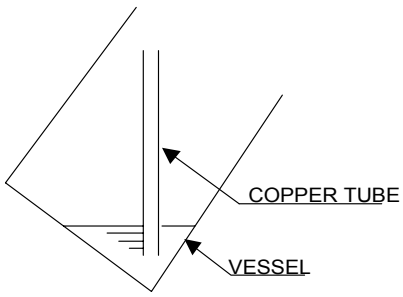


Figure 8.3 Method to incline the vessel

(2) Extracting(total amount)

① Pressurize the nitrogen gas into the chiller to be 0.2kg/cm^{2}G according to section 8.9.
② Prepare and connect the vessel, hose, copper tubes and etc referring to figure 8.2.
③ Join the hose in figure 8.2 to the service valve of heat exchanger(see figure 6.3.1~6.3.3 V34).
④ Open the service valve of heat exchanger.
⑤ Extract the solution into the vessel until the nitrogen gas is discharged.
⑥ Close the service valve of heat exchanger.
⑦ Extract the refrigerant through the service valve of refrigerant return pipe(see figure 6.3.1~6.3.3 V14) and the plug of refrigerant tank(see figure 8.1.1~8.1.3) according to ①~⑥.
⑧ Preserve the vessel not to be contaminated from foreign material.

(3) Extracting for gravity measurement of refrigerant and solution

① Check the vacuum degree from the manometer.
② Close the V21, V22, V23 and V24 shown in figure 8.4.
③ Prepare and connect the vessel, hose, copper tubes and etc. referring to figure 8.4.
④ The transparent vessel has to endure the vacuum pressure.
⑤ Connect the flared tube with service valve to extract the desired solution or refrigerant referring to table 6.3.
⑥ Operate the vacuum pump.
⑦ Check the inside pressure of vessel. Inside pressure should be less than 5mmHg.
⑧ Open the service valve.
⑨ Open the stop valve in figure 8.4.
⑩ Check the extracted solution amount.
⑪ Close the stop valve.
⑫ Close the service valve.
⑬ Stop the vacuum pump.
⑭ Open the V30 shown in figure 8.4.
⑮ Release the vessel.

8.4 Charging 2-ethyl hexyl Alcohol

(1) Operate the solution pump.
(2) Attach the joint and vinyl tube to the manual service valve(see figure 6.3.1~6.3.3 V08) for solution discharge referring to figure 8.2. Stick the sealing tape on the screwed part of the joint.
(3) Enter the vinyl tube into the 2-ethyl hexyl alcohol container(vessel in figure 8.2) until the tube end reaches its bottom.
(4) By opening the valve, press out air from the vinyl tube with the solution. Then stop the solution pump.
(5) Close the manual service valve before the 2-ethyl hexyl alcohol container becomes empty.
(6) When charging 2-ethyl hexyl alcohol, take care not to introduce air in the chiller.

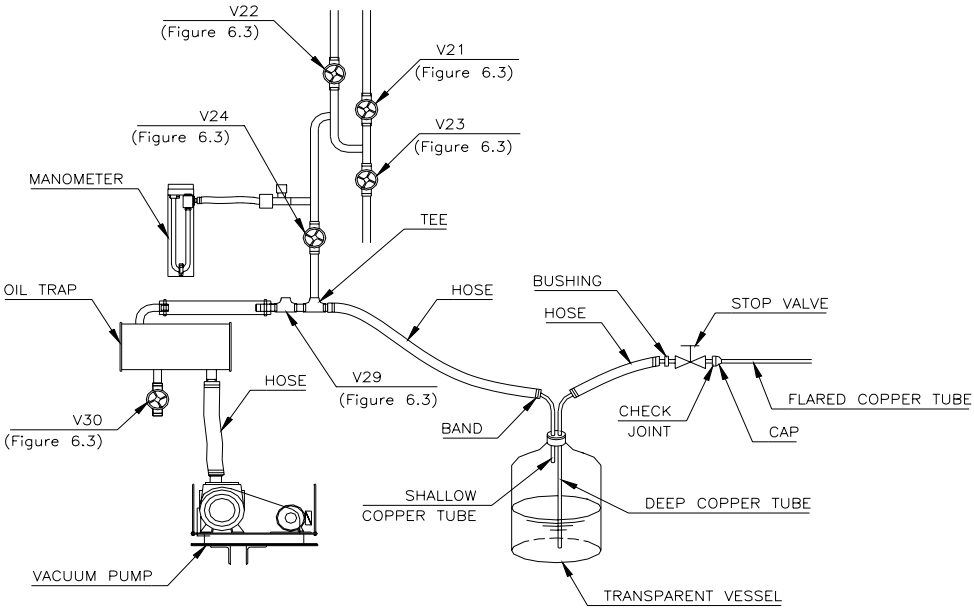


Figure 8.4 Extraction method

⚠ Caution

① Pay attention not to introduce the air into the chiller inside.
② Carefully manipulate the valves not to be destroyed.
③ Before the extraction work, clean the tools with water.
④ After the determination of solution or refrigerant, refill the solution into the chiller inside.

8.5 Maintenance for inhibitor

The inhibitor should be added to protect the corrosion. LiBr solution may greatly corrode metals which is common in inorganic salt series and cause quick corrosion by the mixture with air. Though the table 8.2 shows some kinds of inhibitor, use only $LiNO_3$ as inhibitor. After charging $LiNO_3$ as inhibitor, if another inhibitor is added, chemical reaction which is harmful to the chiller may be occurred. Indeed, it is not desired that you use Li_2CrO_4 as inhibitor because it has a harmful toxicity to human.

Table 8.1 Charging amount of $LiNO_3$

Model	Amount[cc/year]
AR-W70~200G2	500
AR-W220~400G2	1000
AR-W450~600G2	2000
AR-W700~800G2	3000
AR-W900~1000G2	4000
AR-W1250~1650G2	5000
※ at the normal condition (20% wt solution)	

Table 8.2 Kinds of inhibitor

Item	Li_2CrO_4	Li_2MoO_4	$LiNO_3$
Molecular weight	130	174	70
Color	Yellow	colorless	colorless
Toxicity	Very harmful	-	-

(1) Analysis

① Sampling method

After refrigerant blow down, join the hose in figure 8.2 to the service valve of solution pump discharge(see figure 6.3.1~6.3.3 V08) according to figure 8.2. It is possible to extract the solution from the service valve of solution pump discharge not only on the cooling operation but also on the stopping the chiller. With solution pump operation, open the service valve and extract the solution. Though the discharge pressure of solution pump is higher than atmosphere's, don't extract the solution on the cavitation.

② Sampling amount

The LiBr solution amount to be sampled should be 500cc or above. Completely fill a plastic vessel with the solution and cover up the vessel tightly. Keep in mind that the vessel have to be air-tight. Write the following item to the plastic vessel.

1) User name and chiller model
2) sampling date(year/month/day/time)
3) sampling state(operating or stopping the chiller)
4) temperature, gravity and concentration of sampled solution

③ Solution analysis

The reference of data analysis is shown in table 8.3.

Figure 8.3 Reference for data analysis

Item	New solution (initial charged)	Allowable range	Remarks
Concentration[%]	53	-	The allowable range column is transferred value to 53% solution.
Gravity	1.59	-	
$LiNO_3$[mg/ℓ]	500	350 ~ 800	
Alkali degree	0.12 N (LiOH 0.2%)	0.09 N (LiOH 0.15%)	
NH_4[ppm]	0.3 or below	1.0 or below	
SO_4	0.05 or below	-	
Cl	0.1 or below	-	
Ca+Mg	0.01 or below	-	
Heavy metals[mg/ℓ]	0.1 or below		

⚠ Caution : The above solution analysis is hard to be performed by user. Therefore, send the sampled solution to Finetec Century or our agents for solution analysis.

(2) Refilling of the inhibitor

① Example for the refilling amount calculation

1) Solution analysis result
- Concentration : 40%
- $LiNO_3$ amount : 58mg/ℓ

2) Determine the refilling amount

※Calculate the $LiNO_3$ amount transferred to 53% solution.
- Gravity of 40% solution : 1.39
- Gravity of 53% solution : 1.59

$$58mg/\ell \times \frac{53\%}{40\%} \times \frac{1.59}{1.39} = 76mg/\ell$$

※Determine the refilling amount

$$500mg/\ell\,(standard) - 76mg/\ell = 424mg/\ell$$

In case of 53% solution, the ratio of 100mg $LiNO_3$ per 1ℓ solution(100mg/ℓ) is able to be transferred to the ratio of 62.9mg $LiNO_3$ per 1kg solution(62.9mg/kg) according to gravity calculation, 100[mg/ℓ]×1.59[ℓ/kg]=62.9mg/kg.

If 4,000kg solution is charged in the chiller, $LiNO_3$ amount to be refilled is 1,067g as following equation.

$$Amount = 62.9[mg/kg] \times \frac{424[mg/\ell]}{100[mg/\ell]} \times 4,000kg = 1,067g$$

Because $LiNO_3$ is generally 40% water solution and its gravity is 1.285. Refill 2ℓ $LiNO_3$ solution in this case according to following equations.

$$1,067g \times \frac{1}{0.4} = 2,667g$$

$$\frac{2,667[g]}{1.285[kg/\ell]} = 2.075[\ell] \fallingdotseq 2[\ell]$$

② Refilling method

After preparing tools in figure 8.2, join the tube with the service valve of 1st stage generator(see figure 6.3.1~6.3.3 V35) and fill out the tube with $LiNO_3$ solution. By opening the service valve, $LiNO_3$ solution flow into the chiller inside through the tube. Close the service valve before the container becomes empty. When charging inhibitor, take care not to introduce air in the chiller.

8.6 Decrystallization

(1) perform the refrigerant blowing in the same manner as for the refrigerant regeneration.

(2) Operate the chilled water pump and Stop the cooling water pump. Turn off the NFB, disconnect the chilled water suspension cutout switch and the pump starting relay and attach the short-circuit bar on the external interlock terminal, and then turn on the NFB.

(3) Set the steam control valve to the lower limit (approx. 35%). Turn the refrigerant pump switch to the "stop" position.

(4) Press the "start" button to perform the independent operation of the solution pump and heat the solution.

(5) After heating the solution, press the "stop" button, turn K1M to the "auto" and keep the stopped state for about 10 minutes with maintaining 80℃ solution in the first stage generators. Repeat this operation. Slight crystallization can be dissolved by the heated solution. In decrystallization operation, take care not to induce cavitation in the solution pump. If it occurs, immediately stop the solution pump.

(6) For successful decrystallization, the solution level in the absorber is raised. Decrystallization is completed if the absorber solution level is not lowered with the solution pump operated. Check the solution level through sight glass.

(7) If decrystallization is unsuccessful even with the procedure (5), contact Finetec Century or our agents. Before decrystallization, be sure to remove the thermometer and automatic start/stop switch from the water chamber for preventing damage due to the temperature rise of the water in the tube.

⚠ Caution : If it is desired to start the operation immediately after decrystallization, drain the cooling water out of the tube. Otherwise, the cooling tower, thermometer, relay, etc. may be damaged.

After the decrystallization operation, turn off the NFB, return the chilled water suspension cutout switch(69WC) and pump starting relay(63SH2) to normal status, remove the short-circuit from the external interlock terminal, and then turn on the NFB.

8.7 Maintenance for heat transfer tubes

When low grade water is supplied to the chiller, the scale may be formed inside of tubes. If the scale is adhered to tube, the cooling efficiency is decreased by heat resistance increasing and crack is generated by corrosion. Crack of tube may introduce the water into inside of the chiller through the crack, which is severely cause to shorten the chiller life.

(1) Cleaning by tube brush

After open the water chamber, Remove the scale with using brush. Use nylon or bronze brush according to scale condition. Figure 8.5 shows the method.

① Drain the water of water chamber with opening drain valve and air purge valve, after close the stop valves(see figure 5.7 V1~V4).

② After open the water chamber, clean the water chamber inside, tube inside and tube plate.

③ Close the water chamber.

(2) Chemical cleaning

When it is impossible to remove the scale by the stainless steel brushing or brushing work is hard by space or installation state, Chemical cleaning is recommended. The general method is performed by the circulation of cleaning water with the pump and tank such as Figure 8.6. It is possible to clean the water system with rust(scale) remover for a short time. The rust remover for heat exchanger cleaning contains acid, inhibitor and surfactant. But, their components and mixed ratio may be different as makers. Anti-acidity work should be done to neutralize the surface of tubes. Follow the below steps.

① Install the blind plate on the cooling/chilled water inlet/outlet flange.

② Install the cleaning piping.

③ Leak test with circulating the cleaning liquid.

④ Mix rust remover to be 10~15% of total water amount

⑤ Control the concentration and temperature of cleaning water according to rust remover.

⑥ Circulate the cleaning water for 4~6 hours.

⑦ Drain the cleaning water.

⑧ Dilute the cleaning water in the chiller with circulating the supplied water

⑨ Drain the supplied water.

⑩ Mix anti-acidity to be 5~7% of total water amount.

⑪ Circulate the anti-acid water for 2~3 hours.

⑫ Drain the anti-acid water.

⑬ After cleaning with supplied water again, disassemble the cleaning piping.

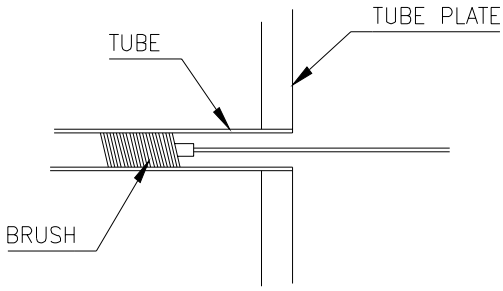


Figure 8.5 Tube brushing

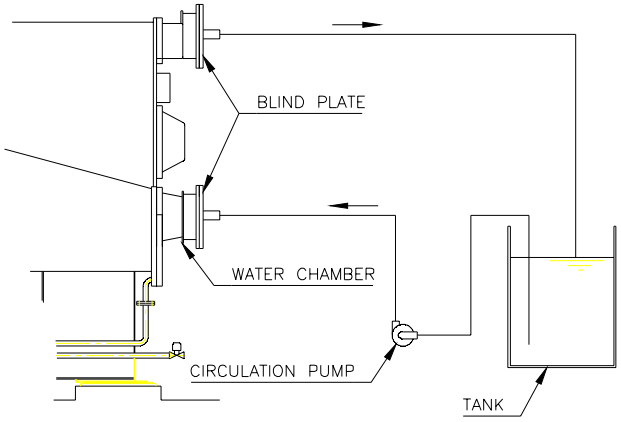


Figure 8.6 Chemical cleaning schematics

Non-activity acid may be used according to scale type. In particular case that rust remover has a anti-acidity character, it is not necessary to do anti-acidity work from ⑩ to ⑫. It is indispensable to discuss with rust remover maker about above comments.

⚠ Caution

① After chemical cleaning, remove the remained cleaning liquid to protect the chiller from corrosion by chemical cleaning liquid.

② Keep in mind that you should select the rust remover for general heat exchanger with copper tube.

8.8 Maintenance for Solution Pump and Refrigerant Pump

In this section, you can find out the ways on the disassembly, check time, work order, check criteria and action etc.

(1) Check time

Check according to the following standard.

⚠ Note : The below values are based on approximate safety standard so that you have to determine properly depending on operation method, usage situation and operating time etc.

Table 8.4 Maintenance interval

No.	Item	Operating time [hr/year]	Maintenance interval			Application
			one year	2 years	3~4 years	
1	Annual & Consecutive operation	7,000~8,000	○			-
2	For cooling	1,400~2,000		○		Machinery room etc.
3	For cooling	700~1,000			○	For building air-conditioning
4	For cooling	700~1,000		○		In severe load changing area like intermittent operation

(2) How to check

① Discharge the solution or refrigerant inside the pump.

② Remove the pump from main body.

If you keep the pump for a long time under being removed, you have to wrap pump casing with vinyl material etc. to prevent the chiller from air being introduced from

outside. When removing it from wiring and terminal box, you have to classify their numbers or colors for the preparation of terminal connection.

③ Disassemble and check the pump.

The defective pumps must be exchanged with spare product depending on the disassembling and check result.

④ Assemble again after checking.

Make each parts clean and assemble again. Do not allow main body to touch water at that time. Wipe it simply. Never use sealing materials of oil and fat series such as grease for gasket surface. Wash it with water and then wipe foreign material carefully to assemble it.

⑤ Put pump into the main body.

You have to exchange packing of both absorption side of the flange and discharge side with new one to connect carefully.

⑥ Purge the pump.

⑦ Leakage test

⑧ Confirm the pump rotation direction.

⑨ Compare discharge pressure and operation current of pump with those prior to checking.

⚠ Note : You may complete disassembling and checking operation in the above way.

8.9 Nitrogen gas charging method

(1) Prepare the Nitrogen gas tank, regulator, pressure gauge, hose and stop valve referring to figure 8.7.

(2) Join the hose of figure 8.7 to service valve of solution pump discharge(see figure 6.3.1~6.3.3 V08).

(3) With the regulator, adjust the outlet pressure of nitrogen gas tank.

(4) Open the service valve.

(5) Pressurize the chiller until inside pressure reaches 0.1~0.2kg/cm^{2}G.

(6) Close the service valve.

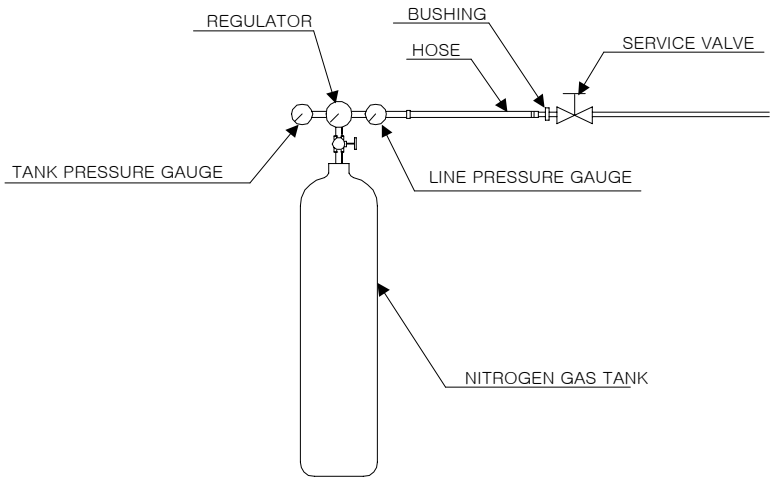


Figure 8.7 Nitrogen gas charging method

8.10 Concentration measurement method

(1) Tools

① Mass cylinder

② Gravimeter(measurement range : 1.0~1.8)

③ Thermometer

(2) Procedure

Figure 8.8 shows following procedure.

① Fill the mass cylinder to 80% with the solution extracted according to section 8.3.(2).

② Insert the gravimeter into mass cylinder.

③ After stop of gravimeter fluctuation, read the value of gravimeter.

④ After remove the gravimeter from the cylinder, insert the thermometer into the mass cylinder and stir the solution.

⑤ After the temperature reading, remove the thermometer.

⑥ Move the solution from the mass cylinder to empty vessel.

⑦ Find the concentration referring to figure 4.2 "Graph for specific gravity varying with temperature and concentration".

⑧ After determination, clean the tools with water.

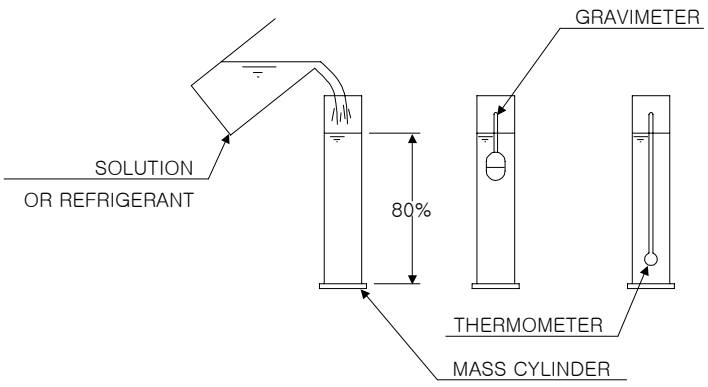


Figure 8.8 Concentration measurement method

⚠ Caution

① Carefully manipulate the gravimeter and thermometer not to be destroyed.

② Don't fill the mass cylinder to 80% or above.

③ After gravity determination, immediately measure the temperature to decrease the measurement error.

8.11 Solution purification

(1) Phenomena of solution contamination

Even though the inhibitor is added in LiBr solution to protect the chiller from the corrosion by introducing air, a little contaminants may cause to following problems.

① Clogging and contamination of heat exchanger tubes

② Clogging of spray nozzle

③ Difficulty of pumps

④ Cooling capacity decrease

⑤ Fouling increase

(2) Purification method

① External purification

1) Method

After extraction of total LiBr solution, sediment the contaminants and pass the solution through the filter(1μm).

2) Advantages

- It have no need to prepare an additional device.

3) Disadvantages

- It is impossible to remove the ferrous and copper ion.
- It is impossible to purify the non-extractable solution in heat exchanger lower side and pipings.
- It is necessary to destroy the vacuum state of chiller inside.
- It is hard to work.

② Internal purification

1) Method

The solution purification device has the particular membrane(0.1μm) that filter the solution from solution pump outlet on the cooling operation and this device is not mounted on Finetec Century standard chiller. Figure 8.9 shows the solution purification device.

2) Advantages

- It is possible to purify the solution on the cooling operation without solution extraction.
- It is able to remove the smaller size particle such as ferrous and copper ion.
- It is not necessary to stop the chiller on the purification.

3) Disadvantages

- It is very expensive.
- It has needed to prepare the system for cleaning the membrane using pressurized air or N_2 gas.
- It is hard to install this device.

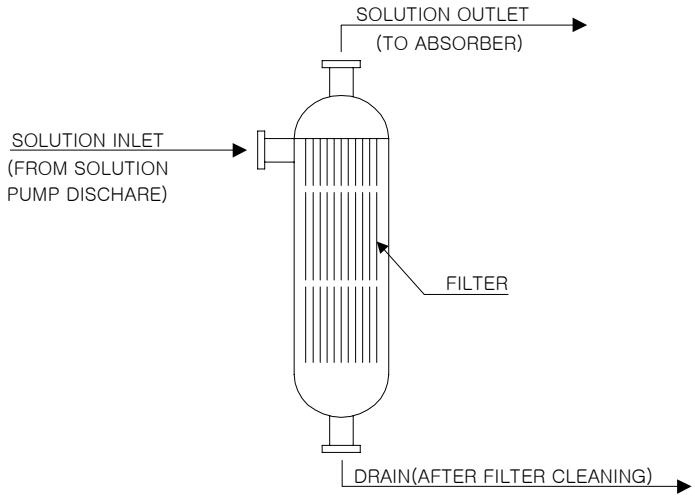


Figure 8.9 Solution purification device

8.12 Water chamber removal-rejoining work

The water chamber may be removed when overhaul or tube cleaning work. The table 9.5 shows the weight of water chamber for each model.

Table 8.5 Weight of water chamber[kg]

		W70,80G2	W90,100G2	W115,125G2	W140,150G2	W170,200G2	AR-F220~1500G3
Evaporator	A	43	45	44	43	45	need not lift(supported by hinge)
	B	35	35	33	32	32	need not lift(supported by hinge)
Absorber	A	34	35	43	35	35	need not lift(supported by hinge)
	B	49	50	43	50	52	need not lift(supported by hinge)
Condenser	A	27	28	23	23	24	need not lift(supported by hinge)
	B	16	16	23	23	24	need not lift(supported by hinge)

(1) AR-W70~200G2

① Remove the water piping.

② Remove the bolts to join water chamber to tube plate.

③ Connect the wire rope to the water chamber holes(∅25) as shown figure 8.10.1

④ Take away the nuts of stud bolts. Don't remove the stud bolts.

⑤ Remove the water chamber from the chiller-heater.

⑥ Assemble the water chamber in reverse after tube cleaning or overhaul. The joining torque of wrench is 2,000 kg·cm when join bolts.

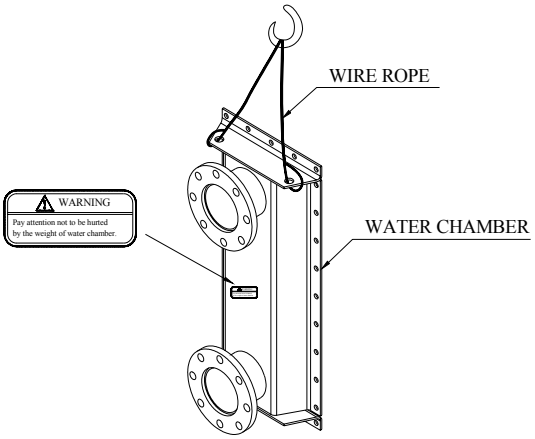


Figure 8.10.1 Opening of water chamber(AR-W70~200G2)

(2) AR-W220~16500G2

① Remove the water piping.

② Take away the bolts to join water chamber to tube plate.

③ Open the water chamber.

④ Assemble the water chamber in reverse after tube cleaning or overhaul. The joining torque of wrench is 2,000 kg·cm when join bolts.

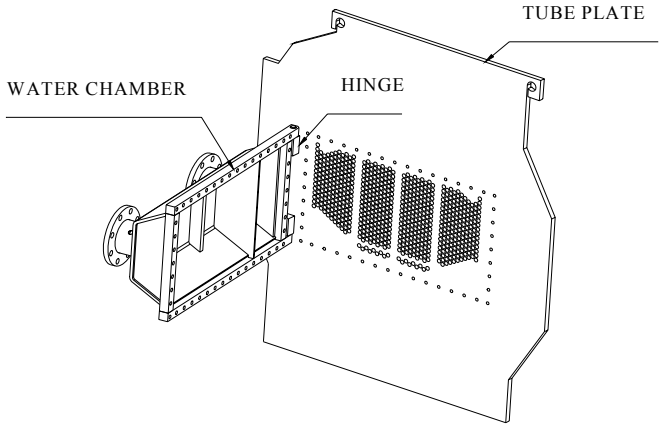


Figure 8.10.2 Opening of water chamber(AR-W220~1650G2)

⚠ Warning

① Pay attention not to be hurted by the weight of water chamber.

② Carefully manipulate the valves not to be destroyed by weight of water chamber.

③ Save the bolts or nuts not to be lost during the work.

8.13 Use limits

If the components of chiller is faulty, buy and exchange the components referring to table 8.5. 53 weight % LiBr solution is used as absorbent for standard. If you cannot find out the LiBr solution manufacturer in your country, contact with Finetec Century or our agents. The distilled water is used as refrigerant to gain easily at any country. Solution pump and refrigerant pump are manufactured according to our operating condition such as flow rate and head. Therefore it is recommended that the pumps are included in spare parts. Also because surfactant and inhibitor are consumed by purging operation, it should be contained in spare parts by option. Packing for water chamber is desired to be contained in spare parts to overhaul the chiller. Even if others are easily gained in your country, you should prepare and preserve the parts to countermeasure immediately against a trouble.

Table 8.6 Use Limits

Item	Specification	Remark
Absorbent	LiBr solution(53%)	Hanchang, fixed concentration
Refrigerant	Distilled water	-
Inhibitor	$LiNO_3$	Hanchang
Surfactant	2-ethyl hexyl alcohol	Hayashi pure chemical
Solution pump	Canned motor type	Fixed at our operating condition.
Refrigerant pump	Canned motor type	Fixed at our operating condition
Vacuum pump	5×10^{-2} Torr	Reachable pressure
Check valve	CV-11(3/4", 1/2")	Tokyo Danle
Ball valve for water chamber	10K-N610	O.N. Industry
Needle valve	US-125PE	FUJIKIN
Solenoid valve	PVS-**A-210	CKD
Safety valve	SD-11(3/4"×1/2")	Tokyo Danle
Compound gauge	-76cmHg~2kg/cm^2G	PT 3/8"
Manometer	-60~0~60mmHg	-
63SH1 & 63SH2	VM-150S-S(-720~-50mm Hg)	UEDA MFG
69WC	YPS-C104Q(0.2~2kg/cm^2)	Saginomiya
26SH1	INS-C115M1L7Q(155±3℃)	Saginomiya
Temperature controller	ASIC-2/7040	ASI co. ltd.
Aux. relay	MY-2(AC24V)	OMRON
Thermistor	ST-W22	PRECON
Fuse	10A, 3A	-
Sight Glass	KP-360	Nihon Klingage or Youlim
Vacuum pump oil	IC-200 or MR-200	Matsumura co., ltd. refer to Attachment 2 "vacuum pump"
Packing for water chamber	-	Spare parts

8.14 Check list

Table 8.7 Check list (1)

Item	Check	Cycle						Working scope
		Daily	Weekly	Every 2 to 3 months	Every Season	Yearly	Others	
Safety devices	1. Operation check				○			O
	2. Setting point check				○			M
Control panel	1. Insulation check				○			M
	2. Sequence operation check				○			M
	3. Protection circuit trip check				○			M
	4. Power supply grounding check					○		M
	5. Wire connection and terminal check (for loosening)				○			M
Automatic control condition	1. Operation check				○			O
	2. Setting point check			○				M
Vacuum condition	1. Leakage check (Examine if non-condensed gas is exhausted from the purge pump.)			○				M
	2. Pre-operation vacuum check	○						M
	3. Freon leakage test					*○		S
Purging equipment	1. Leakage check for check valve	○						O
	2. Disassembling check for check valve			○				M
	3. Replacement of oil		○					M
	4. Motor check					○		S
	5. Disassembling check for purge pump					*○		M
Solution	1. Chemical analysis					*○		S
	2. Replenishment of 2-ethyl hexyl alcohol and $LiNO_3$				○			S
	3. Discharge and purification						○	S

Note : ① An asterisk "*" in the "Yearly" column signifies that the check should be made yearly or every two years.
② For a circle in the "Others" column, the check cycle should be determined according to the relevant condition.
③ Before insulation check, be sure to remove the wiring for the temperature controller consisting of transistor circuits.
④ Working scope : O(operator), M(maintenance engineer), S(service engineer)

Table 8.8 Check list (2)

Item	Check	Cycle					Working scope
		Daily	Weekly	Monthly	Every Season	Yearly	
Refrigerant	1. Regeneration of refrigerant 2. Amount of refrigerant		*◉			 ◉	O S
Solution pump Refrigerant pump	1. Abnormal sound and vibration 2. Disassembling check 3. Motor insulation check 4. Cleaning of strainer	◉		◉		 *◉ *◉ *◉	M S S M
Tube	1. Cleaning of tubes 2. Tube crack and flaw check				*◉	 ◉	M S
Water chamber tube plate	1. Opening check 2. Replacement of water case packing					◉ *◉	M M
Water	1. Water quality analysis			*◉		◉	S

Note : ① An asterisk "*" in the "Yearly" column signifies that the check should be made yearly or every two yearly.
② An asterisk "*" in the "Weekly" column signifies that the check should be made every 2 to 3 weeks.
③ For water quality analysis, be Sure to carry out within one month after the start of trial operation
④ The crack and flaw check of tubes is required to at the beginning of the season.
⑤ Working scope : O(operator), M(maintenance engineer), S(service engineer)

8.15 Life time of sub parts

Table 8.8 Life time of sub parts

Item	Part	Operating life[year]	Remark
Absorbent	LiBr	Permanent	Necessary to regular maintenance
Solution pump & Refrigerant pump	Body, Impeller	7~10	
	Shaft	3 years or 8000 hours	
	Coil	5	
Purge pump	Body	approximately 5	
	Motor	5~7	
Safety device	Pressure switch	3~5	Check two times for one year
	Temperature switch	5~7	
	Pressure gauge	3~5	
	Temperature gauge	3~5	
	Vacuum gauge	approximately 2	
	Solution level relay cathode	approximately 2	
Control device	Relay	3~5	
	Magnetic contactor	3~5	
	Indicating lamp	3~5	
	Electronic temperature controller	3~5	
etc.	Sight glass	2~3	
	Diaphragm valve rubber	2~3	
	Packing	2~3	

9. Troubleshooting

Described below are the possible causes of troubles to be encountered with the chiller in service and the relevant countermeasures to be taken. In the event of a trouble, conduct the check and take the proper countermeasure. If necessary, contact Finetec Century or our agents.

9.1 Lighting of Trouble Indicator Lamp

(1) High pressure of 1st stage generator
- ① Insufficient purging of non-condensed gas
- ② Insufficient amount or suspension of cooling water
- ③ Failure in the cooling water temperature control
- ④ Contamination inside the tube of cooling water system

(2) Water suspension
- ① Failure of the chilled water pump
- ② Strainer clogged

(3) Excessive refrigeration
- ① Overload for refrigeration
- ② Chilled water outlet temperature too low
- ③ Refrigerant mixed with solution

9.2 Recovery Procedure

(1) Faulty stop due to water suspension or excessive cooling

If the operation is stopped due to water suspension or excessive cooling, the refrigerant and chilled water may freeze. To avoid this, immediately stop the solution pump and the refrigerant pump. Since the dilution operation is not performed, the solution may be crystallized if the chiller is left in the failed state for an extended period. The recovery procedure should therefore be taken as promptly as possible.

(2) Faulty stop due to other causes

Take the recovery procedure as promptly as possible. press the stop button and release the hold state the trouble indication and the protection circuit. press the start button to restart the operation.

9.3 Cooling capacity decrease

Table 9.1 Troubleshooting for cooling water decrease

Cause	Countermeasure
Too high cooling water temperature	Check the cooling water system or cooling tower.
Insufficient cooling water flow rate	Check the cooling water pump and if the cooling water pipings are not clogged with foreign matters.
Low steam pressure	Check the operation of steam control valve, pressure reducing valve and strainers.
Purging trouble	After the operation of purge pump, check if its performance is lowered and lubrication oil is sufficient.

Table 9.1 Troubleshooting for cooling water decrease(continue)

Cause	Countermeasure
Air intruded	Retighten the packing parts. If the air intrusion cannot be stopped still, remove the solution and refrigerant from the chiller, charge nitrogen gas approximately 0.2 kg/cm^{2}G and conduct the bubble test using soapy water. If a leak point cannot be known after above steps, contact Finetec Century or our agents.
Tube contamination of cooling water side	Clean the tubes after cooling water drain.
Refrigerant pollution by solution mixing	Blow the refrigerant from the refrigerant tank into the absorber through refrigerant blow valve referring to section 8.1.
Improper amount of refrigerant/solution charged	Adjust the refrigerant/solution to a proper amount. If the charged amount is insufficient, the pump generates the noise.
Improper solution flow rate	Check the valve opening degree according to test report. Check the pump if necessary.
Counter rotating pump	Check the rotating direction with discharge pressure.
Refrigerant overflow	Extract the refrigerant by performing the purge pump.
Clogged steam strainer	Clean the steam strainer.

9.4 Crystallization

(1) Symptom

① The refrigeration capacity is remarkably insufficient.

② The solution level is at least 20mm lower than that of full load.

③ Although the steam is let to flow, the temperature of the diluted solution returned from absorber decreases gradually.

④ Although the pump is rotating, the solution cannot flow through the pipings.

⑤ The pump overload relay is actuated to prevent the pump from rotating.

(2) Cause

① Because the steam pressure is too high, the concentration of the solution in the first stage generator become too high.

② The circulating amount of the solution is insufficient to cause excessive concentration of the concentrated solution.

③ Excessive steam is supplied with not proportion to cooling capacity decrease due to air intrusion.

④ The cooling water temperature is too high, or it becomes too low suddenly.

⑤ In the event of power failure, the solution flow is stopped suddenly and the proper countermeasure is not taken in time.

⑥ The safety relay is failed.

⑦ Dilution operation is insufficient after operation.

(3) Countermeasure

① Examine the cause of crystallization, and remove it.

② Dissolve crystallization referring to section 8.5.

9.5 Refrigerant overflow

Table 9.2 Troubleshooting for refrigerant overflow

Cause	Countermeasure
Too high cooling water temperature	Check the cooling water system or cooling tower.
Refrigerant overcharging	If the overflow takes place at the full load, the refrigerant may be overcharged. Extract the proper amount according to this manual.
Too high steam pressure	Adjust the steam pressure to the specified value.

9.6 Poor Performance of Vacuum Pump

Table 9.3 Troubleshooting for vacuum pump

Cause	Countermeasure
Oil contaminated	Replace the oil.
Rust formed on such components as the valve	Clean off the rust using trichloroethylene.

9.7 Other Items to be Checked

Check if the specific gravity of the solution is proper. Check the solution extracted pump discharge port at the beginning of the cooling season and once during cooling season.

10. Operation Record

Table 10.1 Operation record chart – An asterisk"*" denote the routine data sampling item.

Name	Two stage steam absorption chiller		Equipment number					
Date		Weather		Operator				

Item		Unit	Record number				
			1	2	3	4	5
Measured time		hr.:min.					
Ambient temperature		℃					
Steam	Opening degree of control valve	%					
	Inlet pressure	kg/cm^{2}G					
	Inlet temperature	℃					
	Consumption rate	kg/h					
	Drain outlet temperature	℃					
Chilled water	Pressure of evaporator	mmHg					
	Inlet temperature	℃					
	*Outlet temperature	℃					
	*Chilled water flow rate	m^3/h					
	Chilled water inlet pressure	kg/cm^{2}G					
	Chilled water outlet pressure	kg/cm^{2}G					
Cooling water	Pressure of condenser	mmHg					
	*Inlet temperature	℃					
	Outlet temperature	℃					
	*Cooling water flow rate	m^3/h					
	Cooling water inlet pressure	kg/cm^{2}G					
	Cooling water outlet pressure	kg/cm^{2}G					
Solution	*1st stage generator pressure	kg/cm^{2}G					
	*1st stage generator temperature	℃					
	1st stage generator inlet temperature	℃					
	1st stage generator outlet temperature	℃					
	2nd stage generator inlet temperature	℃					
	*2nd stage generator outlet temperature	℃					
	Absorber spray temperature	℃					
	*Absorber outlet temperature	℃					
	High temperature heat exchanger outlet temperature	℃					
	Diluted solution concentration	%					
	*Refrigerant outlet temperature	℃					
Level	Absorber	–	○/○	○/○	○/○	○/○	○/○
	1st stage generator	–	○	○	○	○	○
	2nd stage generator	–	○	○	○	○	○
	refrigerant tank	–	○/○	○/○	○/○	○/○	○/○
Electric power voltage		V					
Pump	Solution pump current	A					
	Refrigerant pump current	A					
	Spray pump current	A					
Vacuum pump achieved		mmHg					