BROAD X GENERATION
NON – ELECTRIC CHILLER

233kW~11630kW (20~1000RT)

USER'S MANUAL

Aug, 2012 EN

⚠ Please read this manual carefully to ensure proper operation and maintenance of the chiller.

1. Only those who have been trained by BROAD and obtained operator qualifications can operate BROAD chillers.
2. This manual should be kept for the duration of the chiller's life.
3. If there are any technical improvements to this product, we will inform you in a timely manner so as to facilitate your upgrading the technology of the chiller.
4. It is prohibited to change the chiller's component, structure and wiring diagram without BROAD's approval.
5. Chiller operation environment requirements:

   Machine room temperature: 5~43 °C

   Relative humidity: < 85%

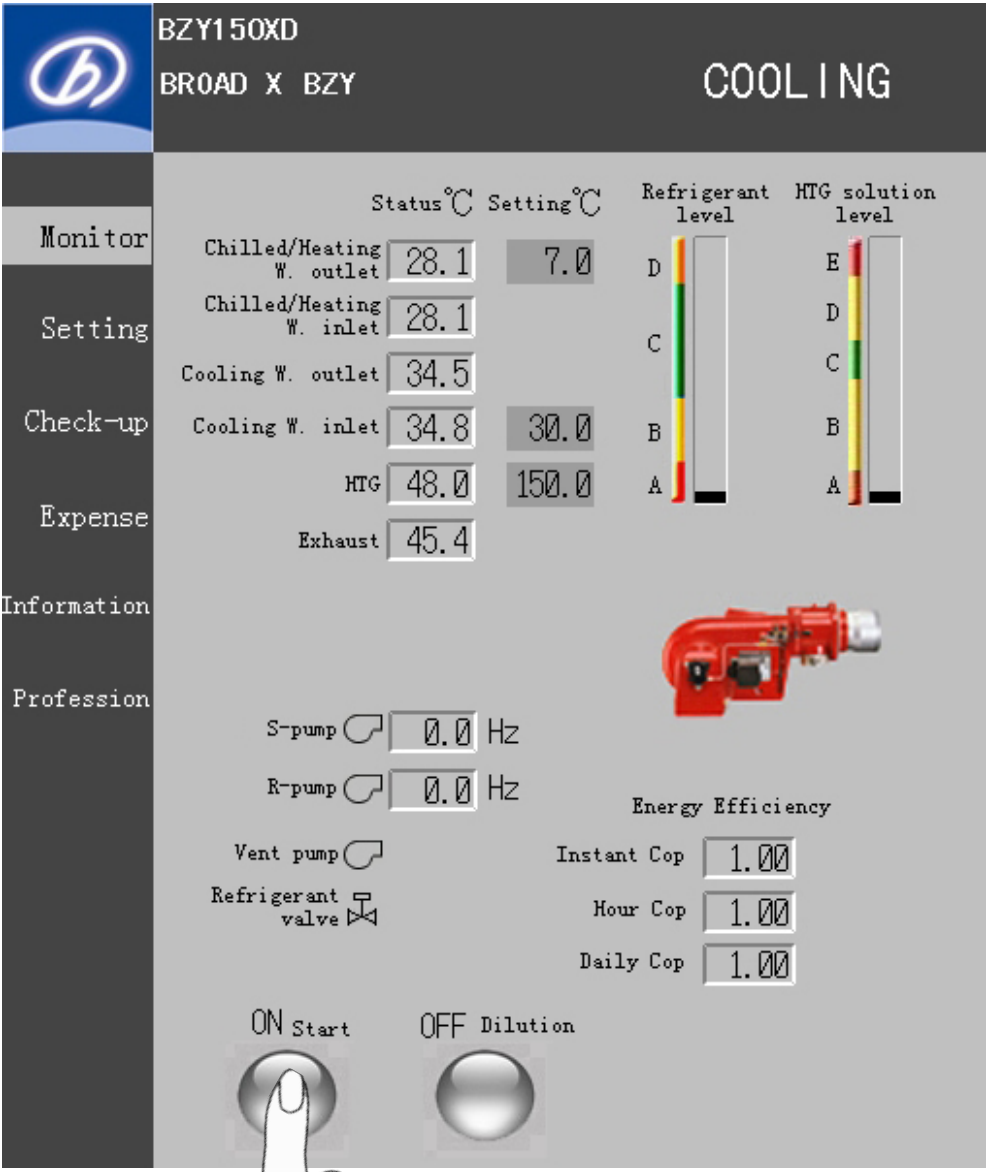
   Environment: The chiller should be kept away from dusts, corrosive gases, especially brines, and strong acid or alkaline environments. Vibration should also be avoided inside and around the machine room.
6. Do not install the touch screen in the place where temperature or humidity varies than the recommended ratings, so as to avoid condensation and freezing.

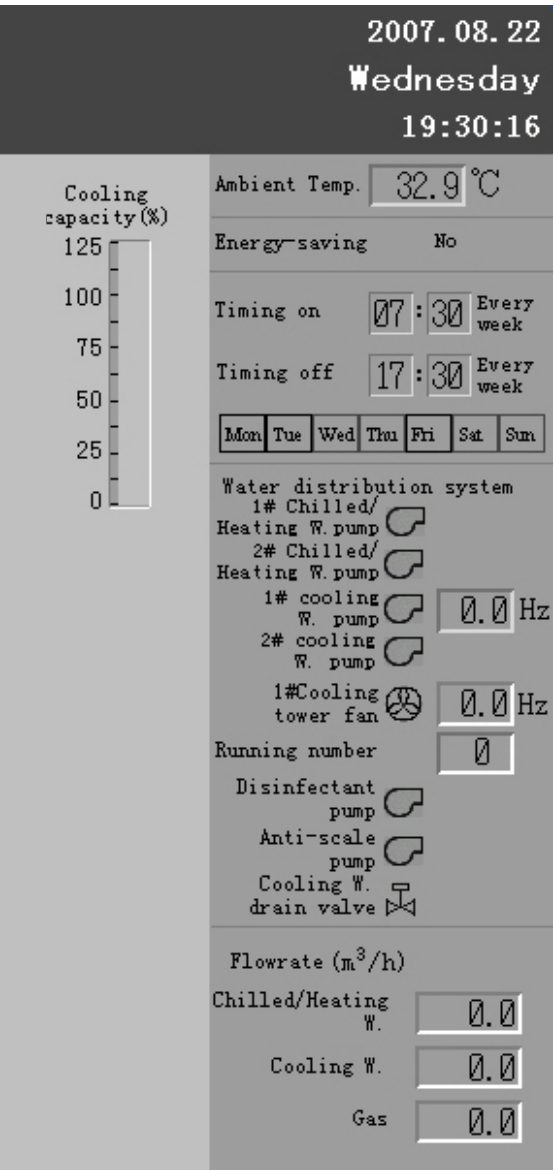
CONTENTS

Note: BROAD X Generation Non-electric Chiller includes DFA and IFA. The differences between DFA and IFA are listed in those sections marked with ▲. Since the main shell technology, operation, check, maintenance and troubleshooting are almost the same as DFA; all the contents in this manual non relevant to burners are applicable to both DFA and IFA.

Operation oriented information

Knowledge oriented information


BZY150XD
BROAD X BZY
COOLING
Monitor
Setting
Check-up
Expense
Information
Profession
Status℃
Setting℃
Chilled/Heating W. outlet
28.1
7.0
Chilled/Heating W. inlet
28.1
Cooling W. outlet
34.5
Cooling W. inlet
34.8
30.0
HTG
48.0
150.0
Exhaust
45.4
Refrigerant level
D
C
B
A
HTG solution level
E
D
C
B
A
S-pump
0.0
Hz
R-pump
0.0
Hz
Vent pump
Refrigerant valve
Energy Efficiency
Instant Cop
1.00
Hour Cop
1.00
Daily Cop
1.00
ON Start
OFF Dilution



TOUCH SCREEN

Turn on the main interface of the chiller. Directly enter "monitor" main interface.

START

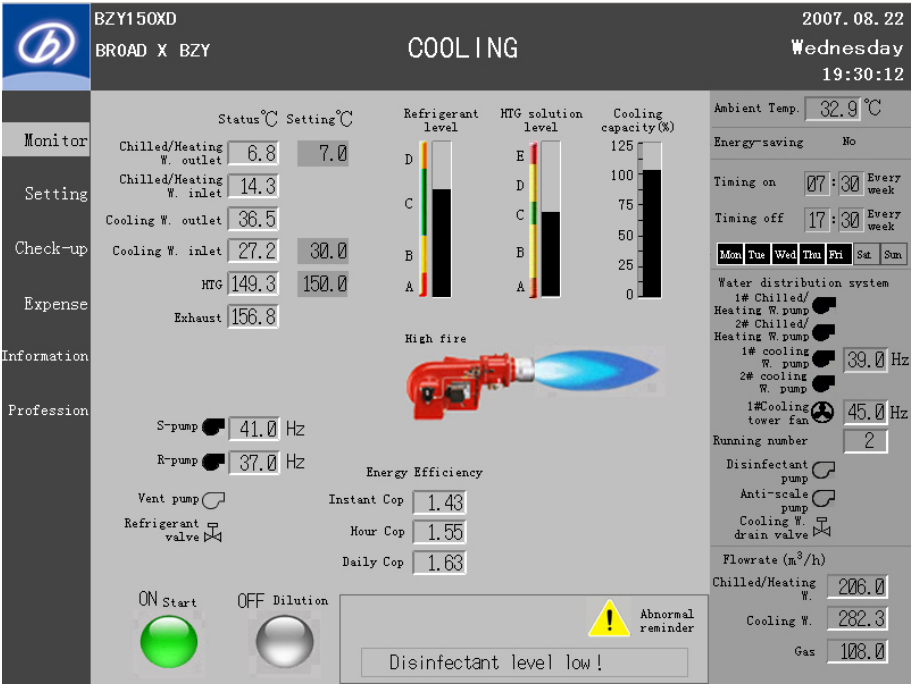
Press the "ON start", which will turn green after confirmation, the A/C water pump and cooling water pump will start automatically according to procedures. The chiller starts operation with automatic cooling load regulation and safety protection after chilled water and cooling water flow rate are acceptable.

SHUT-OFF

Press "OFF Dilution" , the burner steam valve will close and the chiller enters automatic dilution cycle. HTG temperature will drop gradually while the chilled water temperature rises. The dilution stops and chiller shuts off when shut-off requirement is met, the process normally lasts 30-60 minutes.

NOTE:
1. Nails or other sharp objects shall not touch the screen surface.
2. Clean the surface with a wet cloth. Alcohol or other organic solvent are not allowed.
3. The professional interface is only open to BROAD service engineers

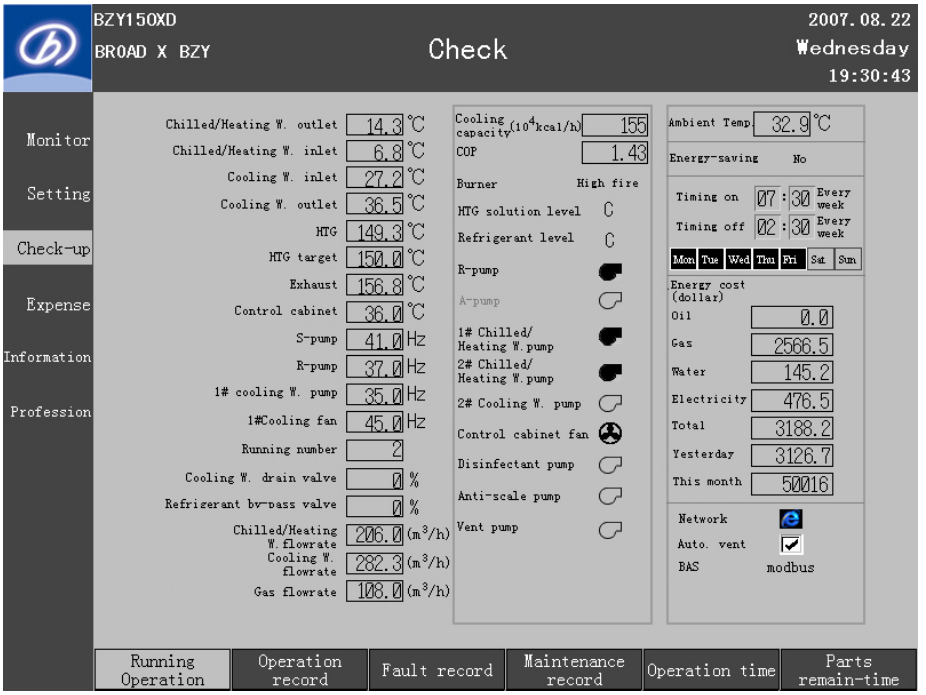
ALARM NOTICE



If fault notice or alarm notice showed on the main interface, press the blinking icon , and then enter the "Fault Record" interface. Then you can check the time of fault, reset time, the name of the fault, the fault alarm and abnormal reminders. Press the fault name and check the fault reasons and other informations. Then troubleshoot the fault according to the hints.

The Fault Record interface is also accessible by pressing "Fault Record" on the Check interface. Please refer to the next page.

CHECK



Press “Check-up" to enter.

Press “Running Operation" to check chiller's real time parameters, status, time, function, control mode, temperature, frequency, solution level, burner status etc.

Press “Operation Record" to check historical data, select “Today", “Yesterday" and “The Day Before Yesterday" to check three days records. Press “Print" to print out the records (a special printer is needed).

Press “Fault record" to check fault stop, fault alarm and abnormal reminders. Select the corresponding fault item to further checking the fault information. The fault can then be resolved by the hints.

Press “Maintenance Record" to check maintenance frequency and schedule (A reminder notice will appear on the main screen, 168 hrs before the deadline of the current maintenance).

Press “Operation Time" to check the accumulated running time, the auto-vent frequency of the chiller and main parts.

Press “Parts Remain – Time" to check the remaining life of each part.

AIR CONDITIONING MODE SELECTION

Press "Setting" to enter setting interface, then press "Mode" to enter.

COOLING (the corresponding circle turning black means the mode has been chosen, and the same for other modes)

a. Make sure the steam angle valve, concentrated solution angle valve and diluted solution angle valve are fully open.
b. Make sure the chilled water and cooling water drain valves are closed, and the heating water and hot water drain valve are fully open.
c. Make sure the system's cooling-heating switch valve is switched to cooling position and the system is full of water.

COOLING AND HOT WATER

Make sure the chiller is in cooling mode, the hot water drain valve is closed with the shut-off valve open and the hot water system is full of water.

HEATING

a. Make sure that, the steam angle valve, concentrated solution angle valve and diluted solution angle valve are fully closed, and the HTG solution level is in zone D.
b.Make sure that, the heating water drain valve is closed and hot water drain valve is fully open.
c. Make sure that, the system's cooling-heating switch valve is switched to heating and the system is full of water.

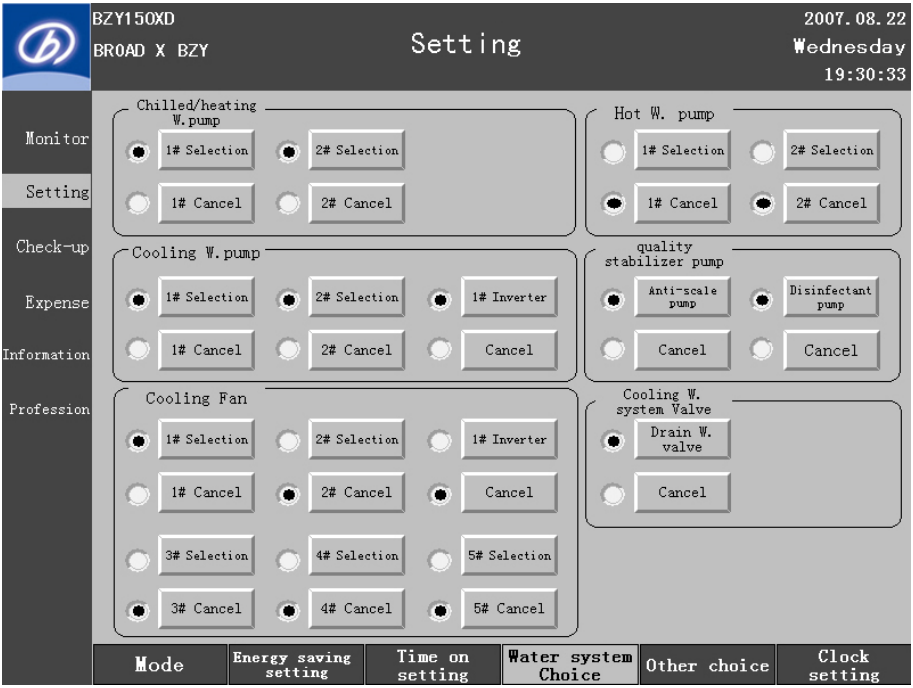
HEATING AND HOT WATER

Make sure the chiller is in heating mode, the hot water drain valve is closed with the shut-off valve open and the system is full of water.

HOT WATER ONLY

a. The same as"Heating a".
b. Make sure that, the hot water drain valve is closed and heating water drain valve is fully open.
c. Make sure that, the hot water shut-off valve is open and the system is full of water.

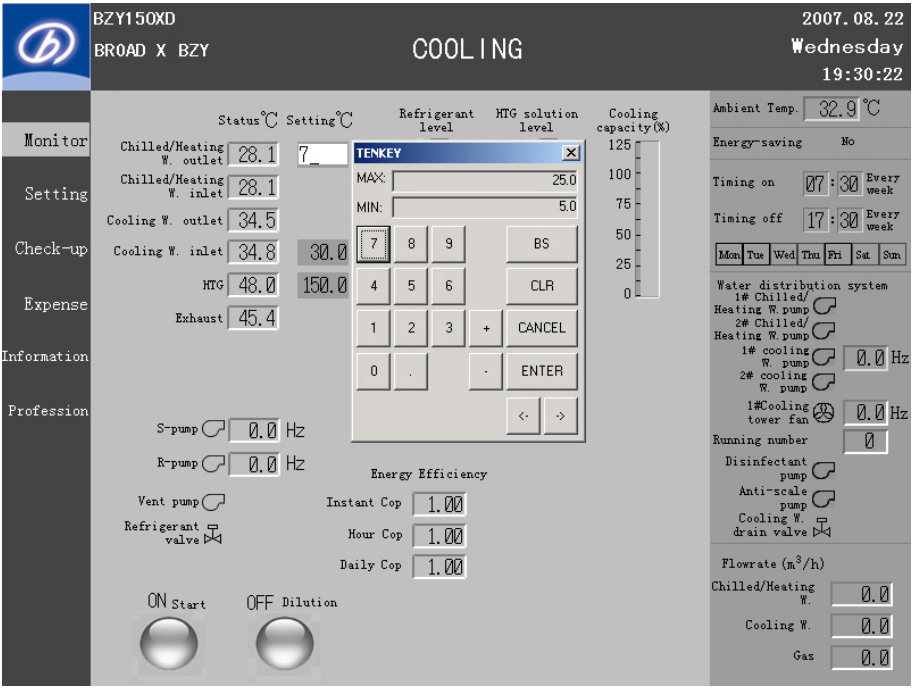
WATER SYSTEM SELECTION



Press “Water System Choice” on the “Setting” interface.

Choose the corresponding pump, fan, water quality stabilizer pump or valves, make single or multiple choices or cancel according to system demand.

TARGET TEMPERATURE SETTING



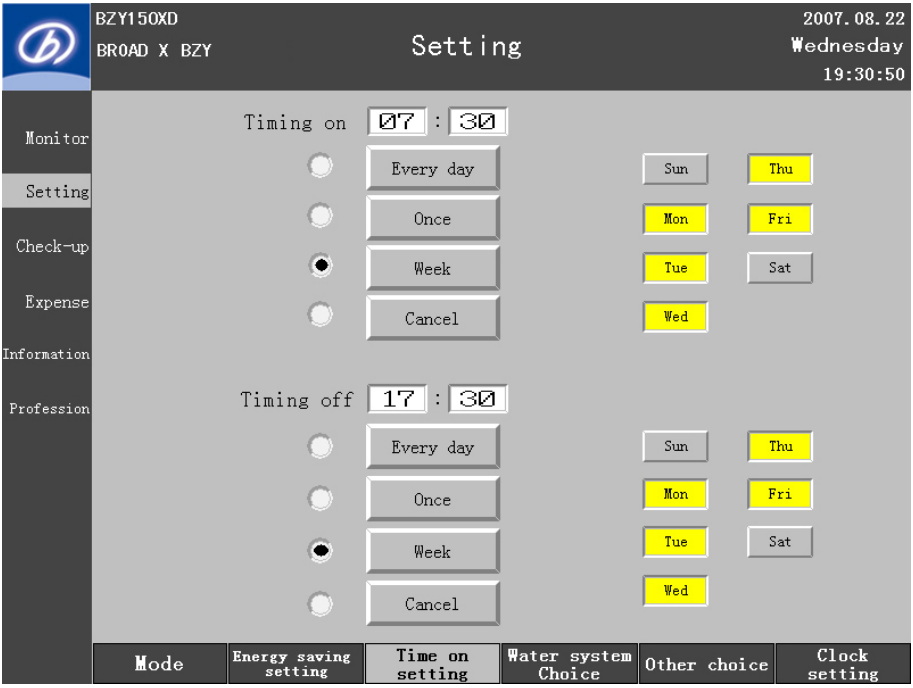
The setting target temperature of the chilled water outlet, cooling water inlet and HTG can be adjusted on the main screen. Input the target number and confirm in the "TENKEY" numerical keyboard (Appear while pressing the background part). The chiller will automatically adjust the load according to the target temperature setting. For example, if the chilled water target temperature is set at 7 °C, the chiller will automatically keep it around 7 °C.

Chilled/Heating W. Outlet temperature: Settings range is 5~25 °C, by default at 8 °C. By increasing the target temperature properly when the ambient temperature is low, the user can save energy. But increasing the target temperature too much will influence the effectiveness of the end air conditioning. At the same time, when the ambient temperature is high, it is suited to decrease the target temperature properly, but it will dramatically increase energy consumption if the target temperature is too low.

Cooling-water inlet temperature: Settings range is 22~34 °C, by default at 28 °C. Properly decreasing the setting helps to improve the chiller's performance.

HTG temperature: Settings range is 120~160 °C, by default at150 °C. The HTG temperature can be set at lower value when chiller load is low and vice versa. The condition where user's need is fulfilled, try to set the temperature low. The lower the temperature, chiller is more energy-efficient and safer for operation.

TIMING

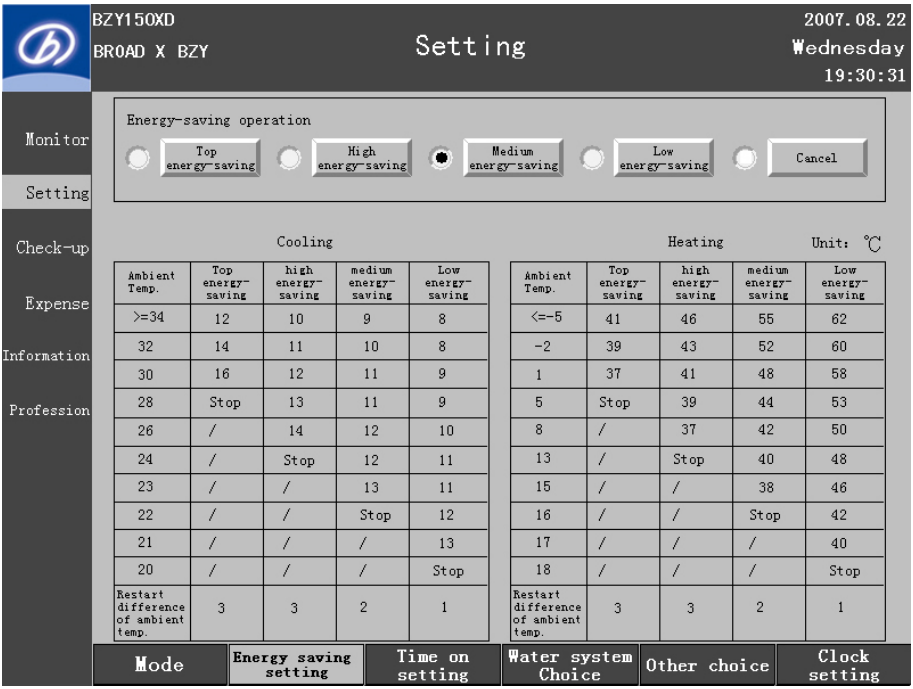


Press “Time On” on the “Setting” screen to enter.

“Timing On/Off” functions can be selected separately or together, according to need. “Every day”, “Once only” or “Every week” can be selected. The chiller will realize automatic On/Off by the setting.
Timing can be reset at anytime. Press “Cancel” to cancel the timing.

CLOCK SETTING
Press “Clock Setting” on “Setting” screen to enter, check and adjust the date and time.

ENERGY-SAVING SETTING



Ambient Temp.	Top energy-saving	high energy-saving	medium energy-saving	Low energy-saving
>=34	12	10	9	8
32	14	11	10	8
30	16	12	11	9
28	Stop	13	11	9
26	/	14	12	10
24	/	Stop	12	11
23	/	/	13	11
22	/	/	Stop	12
21	/	/	/	13
20	/	/	/	Stop
Restart difference of ambient temp.	3	3	2	1

Ambient Temp.	Top energy-saving	high energy-saving	medium energy-saving	Low energy-saving
<=-5	41	46	55	62
-2	39	43	52	60
1	37	41	48	58
5	Stop	39	44	53
8	/	37	42	50
13	/	Stop	40	48
15	/	/	38	46
16	/	/	Stop	42
17	/	/	/	40
18	/	/	/	Stop
Restart difference of ambient temp.	3	3	2	1

Press "Energy-saving setting" on the "Setting" screen to enter the "Energy" screen.

Select an energy-saving mode according to the ambient temperature and cooling load: top, high, medium or low energy-saving. The chiller will run automatically according to the ambient temperature and chosen energy-saving mode.

Note: After the chiller stops automatically at shutdown temperature, it can automatically restart when the ambient temperature increases (while cooling)/ reduces (while heating) by a certain temperature difference – this is called "restarting the temperature difference". For example, in medium energy-saving cooling operation, the chiller will stop when the ambient temperature is 22 °C and restart at 24 °C. In high energy-saving heating operation, the chiller will stop when ambient temperature is 16 °C and restart when it is 14 °C.

ENERGY-SAVING SELECTION GUIDANCE

(Please cancel this function when there is no need of air-conditioning)

NO.	Mode	Guidance
1	Top Energy-Saving	Avoids excessively heating or cooling the room when room is not in use.
2	High Energy-Saving	Dramatically saves energy. Recommended for users who do not have high demand for air conditioning. Not recommended in harsh climate seasons or for users who have small capacity indoor units.
3	Medium Energy-Saving	Energy saving and good air conditioning effect. Recommended for common use (except some special applications).
4	Low Energy-Saving	Avoids energy waste due to man-made imprecise temperature setting. Suitable for places with high standard requirements of air conditioning.

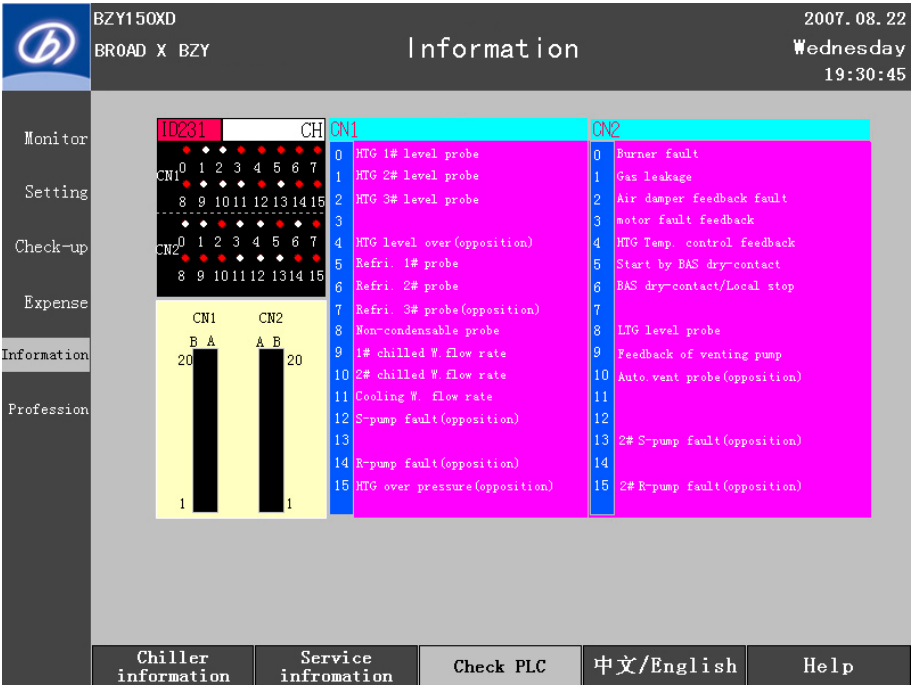
Press "Other Choice" on the "Setting" screen to enter.

BAS:
Choose "Local" if there is no BAS

AUTO-VENT:
Should be chosen under normal operating conditions, it can be canceled if the chiller is stopped for a long time with power on or under other special situations.

OIL/GAS SELECT:
An option for a dual fuel burner; to be chosen according to fuel type.

INFORMATION



Press “Information” to enter.

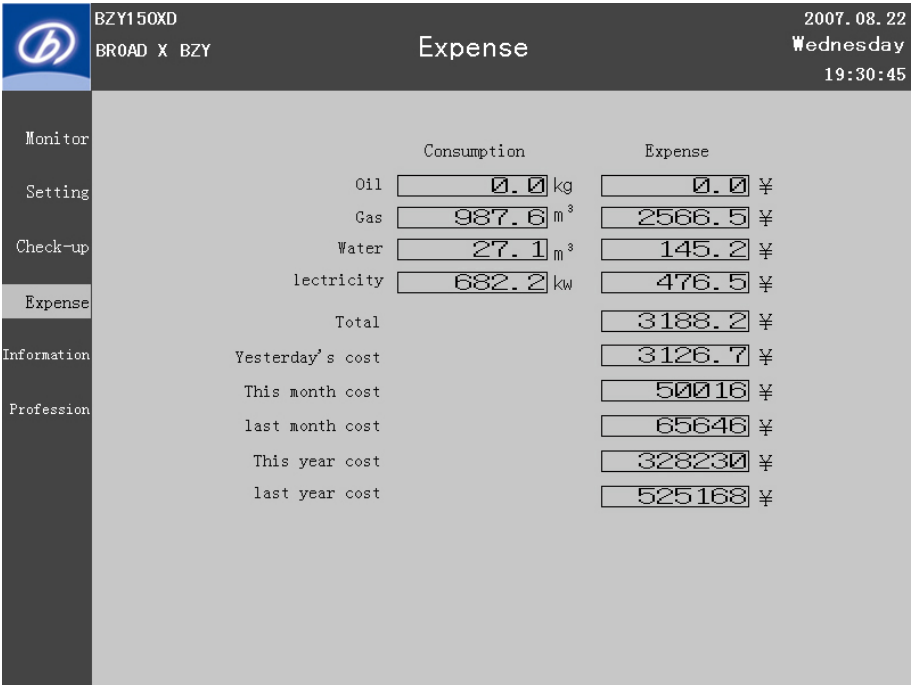
Press “Chiller Information” to check user code, chiller model, rated chilled water temperature, program version and other parameters.

Press “Service Information” to check BROAD head-quarters, branch offices and service engineer's hotline numbers.

Press “Check PLC” to check PLC's input signals (Please see the above chart).

Press “ 中文 / English” to change the language.

ENERGY COST



Press "Expense" to check the fuel, water, electricity consumption and operation cost (Fan coils excluded).

DFA SAFETY REGULATIONS

OPERATION

1. **When the chiller starts cooling operation, the chilled/heating water pump must be started before to the cooling water pump. When chiller shuts down, the cooling water pump must be stopped prior to the chilled/heating water pump; otherwise, copper tubes will get frozen.** Although the On/Off sequence of "Auto Control" mode is set out in the above mentioned requirements, a reconfirmation is needed once every 3 months in case of any accidents like incorrectt connection of cables or software viruses.
2. **In cooling operation, heating water drain valve must be opened and its handle be removed.** Otherwise the piping system for heating water will be heated and expanded, wasting a great deal of energy. The handle must be well kept for future use.
3. **Random adjustment of solution concentration regulating valves is prohibited.** Otherwise it will cause crystallization, reduce cooling capacity and waste energy.
4. **Angle valves must be 100% closed when the chiller is switched from cooling to heating operation.** Start the chiller and when the HTG temperature rises to 100 °C, check the temperature of the valve pipe on the main shell side to see if it rises. A loose shut-off of angle valves will result in high temperature and damage the HTG.

BURNING

1. **Ensure good ventilation conditions in machine room.** Otherwise chiller will be eroded, which will damage electrical insulation and affect combustion , even injure people due to oxygen shortage in machine room.
2. **Make sure there is no gas leakage.** Gas-fired chillers are not allowed to work if the gas leakage detection device and force fan linkage are not in reliable control.
3. **Make sure there is no exhaust leakage.** In case of exhaust leakage in machine room, the operator will suffer from CO posioning.
4. **The fuel filter should be cleaned or replaced regularly.** Otherwise it will stop burning, produce smoke to damage the solenoid valve or even cause deflagration. The oil pump will also be damaged for oil-fired type.
5. **Burner operating with black smoke is prohibited.** Excessive Air Coefficient should be within a range of 1.18~1.25 for gas-fired types and1.13~1.20 for oil-fired types. Otherwise, even a small amount of smoke will increase fuel consumption dramatically, pollute the environment and even cause fire. If the Excessive Air Coefficient is too large, it will cause deflagration and even stop the burner, and waste fuel.
6. **Gas pressure and fuel heating values must be stable and fuel quality must meet the local standards.** Otherwise it will cause soot in the fire tubes, increase energy consumption, affect cooling capacity. The burner might be damaged, even cause deflagration if it is serious.
7. **The exhaust damper must be full open before chiller start and full close when the chiller stopped for long time.**

VACUUM LIFE-SPAN

1. **Confirm the vacuum conditions and good condition of the auto purge and vent device.**
2. **Prevent others from handling the vacuum valve randomly.** The handle of the vacuum valve must be removed and well kept after operation to avoid unauthorized access.
3. **Conduct heating and chiller shut-off management with care.** The main shell should be maintained in vacuum condition during heating operation. If the expected shut-off period is over 8 months, it should be charged with 0.01 MPa~0.02 MPa high-purity nitrogen (purity>99.995%).
4. **Use only BROAD solution; it is forbidden to use solution regenerated by others.** It is required to sample the solution and test it once a year on the machine room site, and solution should be fully circulated and diluted before sampling. If result can't be confirmed or more details are needed, sample the solution with special bottle, and send it to BROAD lab with a label on the bottle correctly. BROAD will confirm the vacuum, rust condition of the copper tubes and steel to ensure 25-year life span. The solution needs not be taken out for regeneration. If it is too feculent, it can be filtered with the BROAD filter without stopping the unit. If the solution is regenerated by others, BROAD will not be responsible for the unit any more.
5. **It is forbidden to clean the copper tubes with chemicals without BROAD written permission.** If the chemicals are not property used, the cleaning is not strictly controlled or the chemicals are not drained completely, it will seriously corrode the copper tubes, which will reduce the life-span or even destroy the chiller.
6. **Strengthen water quality management.** Auto water quality stabilizer charging device should be installed (auto dosing of biocide and anti-sludging agent). The water should be tested at least once every 3 months and select the appropriate anti-sludging agent according to this result. Quality of make-up cooling water should meet the quality standard of city water. Poor water quality will cause more energy consumption, reduce cooling capacity and corrosion of copper tubes, or even destroy the chiller.

DFA SAFETY REGULATIONS

CONTROL

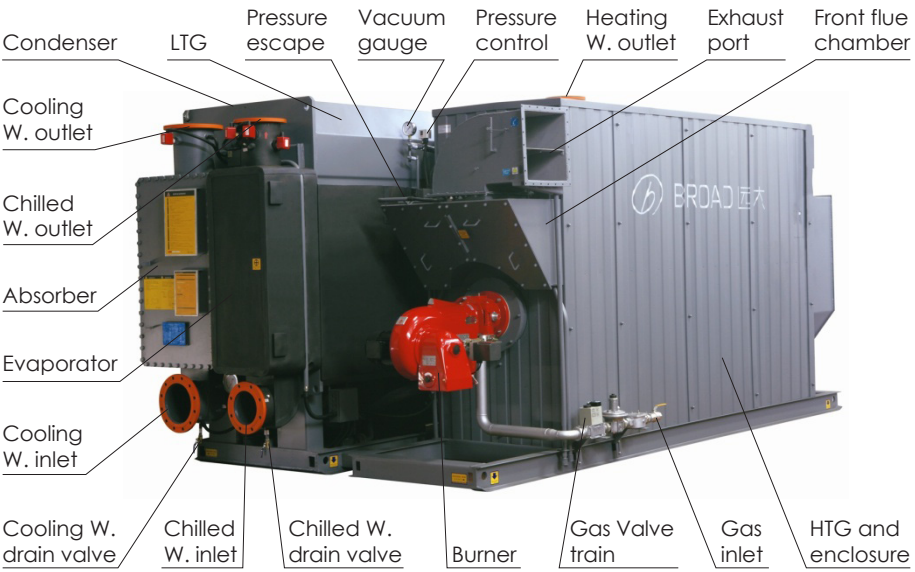
1. **Anti-freezing protection for the chilled water tubes must be strictly carried out.**
   BROAD's requirement of the 3-stage protection and interlock electrical diagram of the chilled/ heating water system must be followed to avoid poor operation, otherwise tubes will be frozen. The 3-stage protection should be checked every quarter.
2. **The chiller must be started in "Auto Control".**
   There are some protection procedures under "Commissioning Mode", but it can be used only under the supervision of professionals, otherwise serious failure will occur.
3. **The safety devices cannot be by passed nor can their settings be changed at will.**
   Before the cooling period begins, all the safely devices must be calibrated, especially the chilled water flow switch, temperature sensor and HTG pressure control. Otherwise the copper tubes may become frozen or serious personal injuries may occur.
4. **Power supply must be correct and voltage must be stable.**
   The fluctuation of the voltage must be within 10% of the rated value. A dedicated grounding wire must be available in the machine room. At least a 6.0 mm2 wire must be used as the grounding wire, and the grounding resistance should be ≤4Ω, otherwise it will damage the electrical components and control system or even cause personal injury.
5. **If the electric wire is damaged, it should be replaced only by manufacturer, service agent or qualified personnel.**
   Otherwise personnel and equipments will be in danger.
6. **The chiller must be on line 24/7/365.**
   To ensure collecting the data and monitoring the chiller, the chiller must be on line 24/7/365. Otherwise BROAD Monitoring Center will not know if the chiller is working normally or not. If the chiller is to be put into idle for more than 3 months, BROAD Monitoring Center must be informed before power-off.
7. **Computing data must be set correctly.**
   If the data are wrong, it will cause unexpected chiller shut-off and affect the user's energy management.

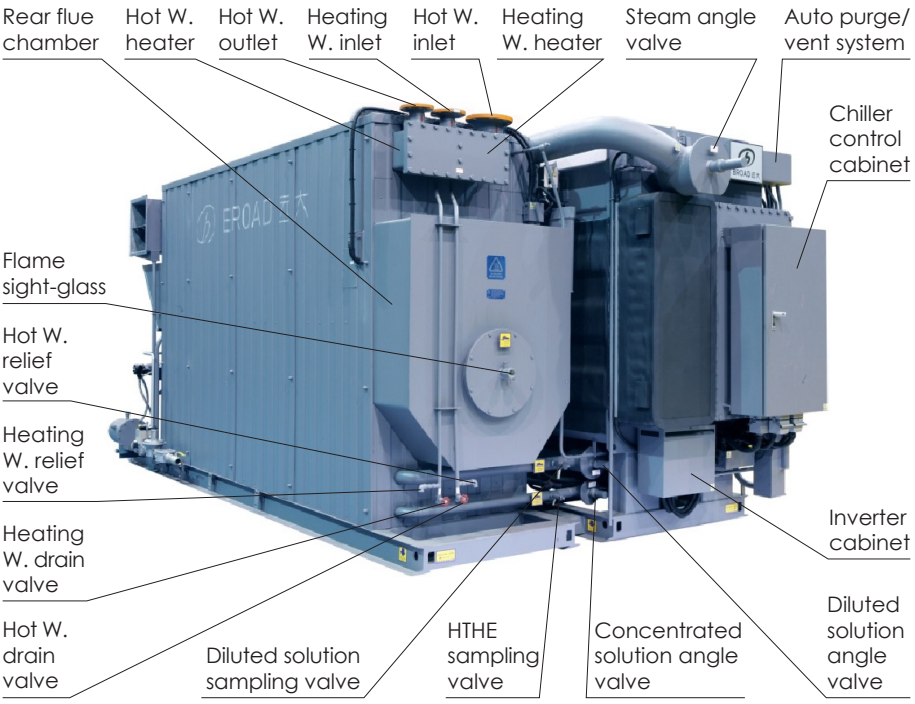
OTHERS

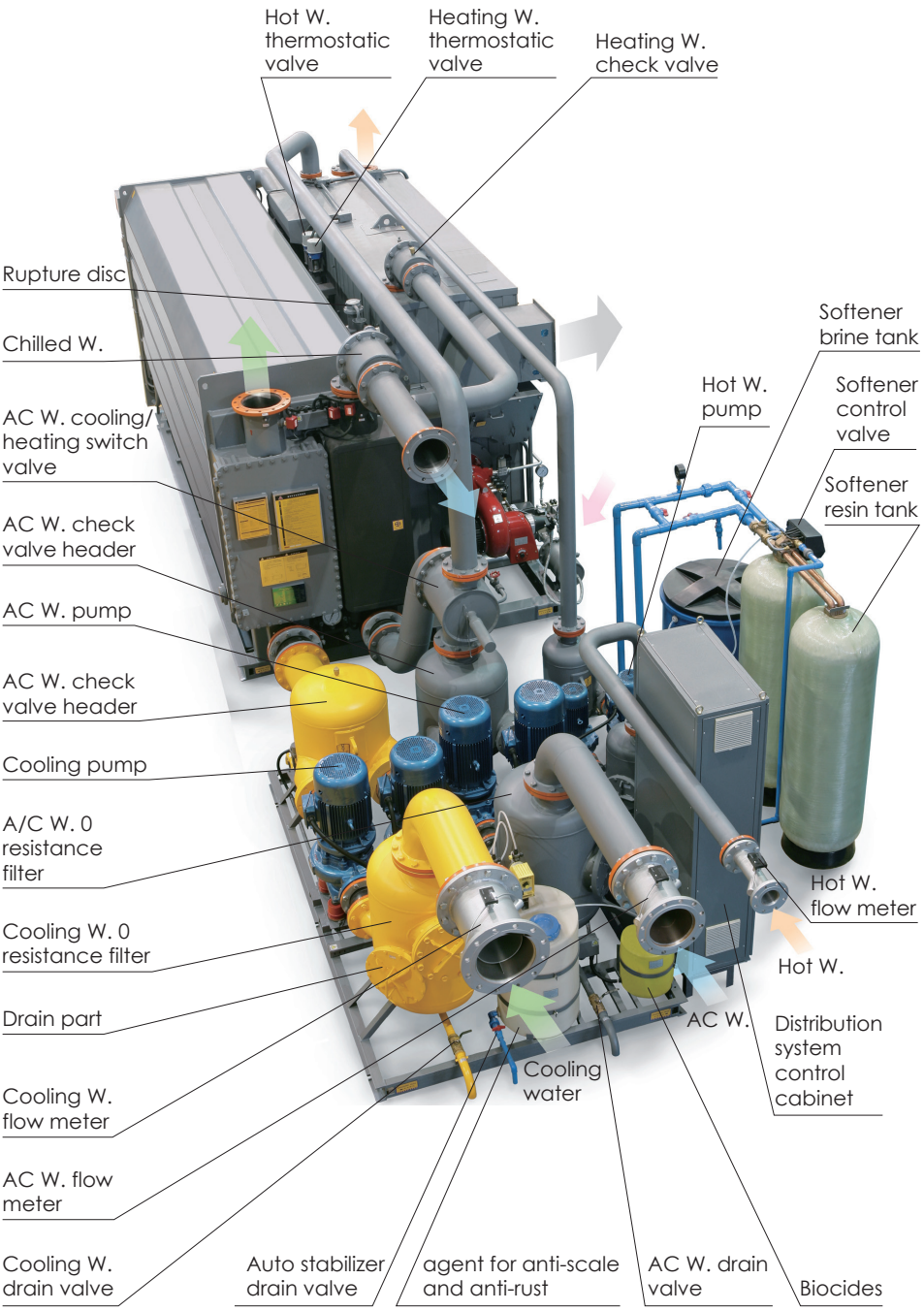
1. **Do not place heavy objects on or near the automatic pressure escape.**
   Otherwise, there is a danger of explosion.
2. **Piping system vibration is forbidden and external force is not allowed onto the chiller.**
   Otherwise it may affect the chiller's life-span, or even damage the chiller.
3. **The user should install a lightning proof device for the equipment.**
4. **The chiller must be well stored.**
   The doors and windows of the machine room must be installed with firm lock and baluster. No unauthorized persons have access the machine room. Spare parts and documents should be well kept.
5. **Humidity of machine room should be less than 85% with temperature ranging from 5 to 43 °C.**
   If the temperature in the machine room is lower than 0 °C, the inlets and outlets of chilled water and cooling water systems should be closed. The drain valve should be open (if conditions permit, it is better to add antifreeze instead of draining the water to avoid rust in the copper tube); otherwise the copper tube will be frozen. If the temperature in the machine room is over 32 °C, the machine room ventilation and control cabinet cooling must be increased. If the temperature is over 43 °C, electrical components will be destroyed in hours and serious damage will occur to the chiller.
6. **The chiller should be installed at an elevation less than 1000 meter. Transportation and storage temperature should be between -25-55 °C**
7. **Maintain, operate and commission the chiller strictly following the "User's Manual" and "Service File".**

NOTE: This regulation is applicable to BZY, BEY, BDEY, BZEY.

PRODUCT OVERVIEW






Hot W. thermostatic valve
Heating W. thermostatic valve
Heating W. check valve
Rupture disc
Chilled W.
AC W. cooling/ heating switch valve
AC W. check valve header
AC W. pump
AC W. check valve header
Cooling pump
A/C W. 0 resistance filter
Cooling W. 0 resistance filter
Drain part
Cooling W. flow meter
AC W. flow meter
Cooling W. drain valve
Softener brine tank
Hot W. pump
Softener control valve
Softener resin tank
Hot W. flow meter
Hot W.
AC W.
Distribution system control cabinet
Cooling water
Auto stabilizer drain valve
agent for anti-scale and anti-rust
AC W. drain valve
Biocides

PART LIST

MAIN PART LIST

NO.	Name	Function
1	H.T.G.	Use burner heat to concentrate H.T.G. diluted solution, generates water vapor and concentrated solution.
2	L.T.G.	Use H.T.G. steam to concentrate L.T.G. diluted solution, to generate steam and concentrated solution.
3	Condensor	Condensates the L.T.G. refrigerant steam, and cooling the refrigerant steam come from H.T.G.
4	Evaporator	Generates low temp. chilled water.
5	Absorber	Absorbs evaporator refrigerant vapor and pass the absorpor heat to cooling water.
6	High temp. heat exchange	Heat exchange of high temp. concentrate solution from H.T.G. and low temp. diluted solution from absorber.
7	Low temp. heat exchange	Heat exchange of high temp. concentrate solution from L.T.G. and low temp. diluted solution from absorber.
8	Heating water heater *	Generates heating water
9	Hot water heater **	Generates hot water
10	Solution pump(SP)	Pumps diluted solution to H.T.G. & L.T.G.
11	Refrigerant pump(RP)	Enable the refrigerant water spraying in endless cycles.
12	Burner(BM)	Provide heat to H.T.G.
13	Auto purge system	Automatically collect the non-condensable gases into inlet chamber and purge non-condensable gases out of machine insure the operation quality and chiller lifespan.

NOTE: parts with "**" are not for heating-cooling type;
parts with "**" and "*"are not for cooling-only type.

VALVE LIST

NO.	Type	Name	Function	Remark
1	Cooling/heating switch valve	Steam angle valve (F3)*	Separates main shell with HTG during heating and maintenance if necessary	Open in cooling, belongs to vacuum valve, heating mode should be closed (100% closed)
2		Concentrated solution angle valve (F4)*		
3		Diluted solution angle valve (F5)*		
4	Vacuum LIFE-SPAN	HTG concentration regulating valve (F6)	Regulates HTG solution concentration	Tighten the setscrews after regulation. No random regulation. Belongs to vacuum valve
5		LTG concentration regulating valve (F7)	Regulates LTG solution concentration	
6	low regulating valve	Refrigerant sampling valve (F9)	Take out refrigerant; concentrate solution; check pollution degree of refrigerant	Commissioning use
7		LTHE sampling valve (F10)	LTG concentrated solution sampling	
8		HTHE sampling valve (F11)	HTG concentrated solution sampling	
9		Diluted solution sampling valve (F12)	Solution charging/discharging or diluted solution sampling	
10		Main purge valve (F13)	Purge the chiller or oil interceptor	Purge only
11		Direct purge valve (F14)	Purge the chiller directly	
12		HTG purge valve (F15)	Purge the HTG directly through this valve	Open only while purging HTG
13		Sampling purge valve (F16)	Purge the sampling bottle or check the vacuum with the vacuum meter	Open only for sampling or checking vacuum with vacuum meter

cont.

NO.	Type	Name	Function	Remark
14	low regulating valve	Main shell pressure detecting valve (F18)	Checks main shell pressure	Closed in operation, open while checking HTG pressure
15		HTG pressure valve (F19)	Checks HTG pressure	Closed in operation, open while checking main shell pressure
16		Auto air vent valve & manual valve (F20)	Non-condensable gases are vented out of the chiller through this valve during auto purge. It can also prevent air into leaking in the chiller.	Manual valve is open in operation, closed while charging nitrogenor or in maintenance.
17		Nitrogen charging valve (F21)	Port used for charging nitrogen into the chiller or purging the collection chamber when necessary.	Open only for nitrogen charging
18		Auto purging valve (F22)	Switches the purge/venting of chiller	
19		Refrigerant motor valve (F24)	Bypasses refrigerant to absorber	Automatic, opens only during refrigerant bypass
20		Hot water thermostatic valve (F25)**	Stabilizes hot water temperature	Auto-trace and regulate hot water load
21		Heating water thermostatic valve (F26)**	Stabilizes heating water temperature	Auto-trace and regulate heating water load
22	Other vacuum valves	A/C W. switch valve (F1)*	Switches between chilled W. and Heating W. system	A/c W. goes through evaporator in cooling, and heater in heating.
23		A/C W. outlet check valve (F2)*	Prevents chilled W. going into the heater and hot W. into evaporator	
24		Chilled water drain valve (F27)	Drains water in evaporator copper tubes	Open when while necessary
25		Cooling water drain valve (F28)	Drains water in absorber and condenser copper tubes	Open when while necessary
26		Heating water drain valve (F29)*	Drains water in copper tubes of heating water heater	Open when while cooling
27		Hot water drain valve (F30))**	Drains water in hot water heater copper tubes	Open in cooling /heating while hot water inlet and outlet valves are closed
28		Chilled water pressure valve (F33)	Measures chilled water pressure	Open only while measuring pressure
29		Cooling water pressure valve (F34)	Measures cooling water pressure	Open only while measuring pressure
30		Auto vent valve(YA)	Vents air in system	
31		Manual drain valve(YC)	Drains water of cooling tower	
32		Drain valve (YD)	Drains dirt of cooling water filter	
33		Make up valve(YE)	Makes up water to water system	
34		Make up valve manually (YF)	Cooling water make up manually	
35		Water system shut off valve (F8)	Shut off cooling water system	
36		Balance valve (F17)	Balance water distribution quantity of cooling tower	

NOTE: This regulation is applicable to BZY, BEY, BDEY, BZEY.

SENSOR LIST

NO.	Name	Function
1	Chilled water inlet temperature sensor (T1)	Detect chilled water inlet temperature, for calculating cooling capacity and COP
2	Chilled water outlet temperature sensor (T2)	Detect chilled water outlet temperature to perform cooling load regulation to avoid frozen tubes in evaporator and calculate COP
3	Chilled water calibrating temperature sensor (T2A)	Calibrate chilled water outlet temperature to avoid frozen tubes in evaporator caused by chilled water outlet temperature deviation
4	Cooling water inlet temperature sensor (T3)	Detect cooling water inlet temperature and realize cooling tower fan frequency control to avoid excessively higher or lower than the setting
5	Cooling water outlet temperature sensor (T4)	Detect cooling water outlet temperature to control cooling water frequency control
6	HTG temperature sensor (T5)(connect PLC)	Detect HTG temperature and send signal to PLC to avoid HTG solution over-temperature and crystallization
7	HTG temperature control (T5A) (connect burner)	Perform HTG temperature limit protection by shutting off burner directly
8	Exhaust temperature sensor (T6)	Detect exhaust temperature to prevent over-temperature
9	Ambient temperature sensor (T9)	Detect ambient temperature to save energy; install outside
10	HTG crystallization temperature sensor (T10)	Detect HTG concentrated solution outlet temperature to judge HTHE (HTG) crystallization
11	LTHE inlet temperature sensor (T11)	Detect LTHE diluted solution inlet temperature to judge LTHE crystallization
12	LTG crystallization temperature sensor (T12)	Detect LTHE diluted solution outlet temperature to judge LTHE (LTG) crystallization
13	Control cabinet temperature sensor (T13)	Detect temperature inside control cabinet, auto start/stop the ventilation fan to avoid high temperature affecting the reliability, safety and life-span of electrical components
14	Heating water inlet temperature sensor(T14)**	Detect heating water inlet temperature and calculate heating water capacity
15	Heating water outlet temperature sensor (T15)*	Detect heating water outlet temperature. Adjust the heating load, and calculate heating capacity
16	Hot water inlet temperature sensor (T16)*	Detect hot water inlet temperature and calculate hot water capacity
17	Hot water outlet temperature sensor(T17)**	Detect hot water outlet temperature, adjust the hot water load, send an alarm if temperature is too high and calculate hot water capacity
18	Chilled water flow switch (B1,B1A) (Connected to PLC)	Detect chilled water flow rate to prevent frozen tubes in the evaporator
19	Cooling water flow switch (B2)	Detect cooling water flow rate to ensure chiller capacity
20	Chilled water flow switch (B3) (Directly connected to cooling water pump)	Detect chilled water flow rate to perform 3-stage protection
21	Pressure control (GY)	HTG overpressure protection. When overpressure occurs, a signal will be sent directly to PLC to the PLC to stop the burner
22	HTG solution level probe (YK1)	Detect HTG solution level, perform solution cycling regulation and HTG low solution level protection and detect the signal of tube cracks
23	Refrigerant level probe (YK2)	Detect refrigerant level and send signal to PLC to control the On/Off function of the of burner and refrigerant pump, perform load regulation and prevent refrigerant overflowing
24	Non-condensable probe (YK3)	Detect solution level in separation canister of auto-purge system and send signal to PLC. If no solution level is detected, the chiller will automatically vent out the non-condensable gases in from the chamber
25	Auto vent sensor(YK4)	When the solution level in chamber is detected, the auto vent process will stop
26	A/C water flow rate meter(V1)	Detect A/C water flow rate to calculate cooling/heating capacity and COP
27	Cooling water flow rate meter(V2)	Detect cooling water flow rate to calculate exhaust heating capacity
28	Gas flow rate meter(V3)	Detect gas flow rate to calculate gas consumption, energy cost and COP
29	Hot water flow rate meter(V4)**	Detect hot water flow rate to calculate hot water capacity
30	Conductance rate sensor(S)	Detect cooling water quality, control water draining time and add inhibitor
31	Different pressure detector(ΔP)	Detect A/C water pressure difference, control A/C water pump energy saving operation
32	Burner gas leakage detector (SG1)	Stop burner when gas leakage is detected to avoid safety accident
33	Gas leakage detector in machine room (SG2)	Equipped by the user, for detecting integrity of gas pipe in machine room. Draft fan will be started if gas leakage is detected to avoid accidents

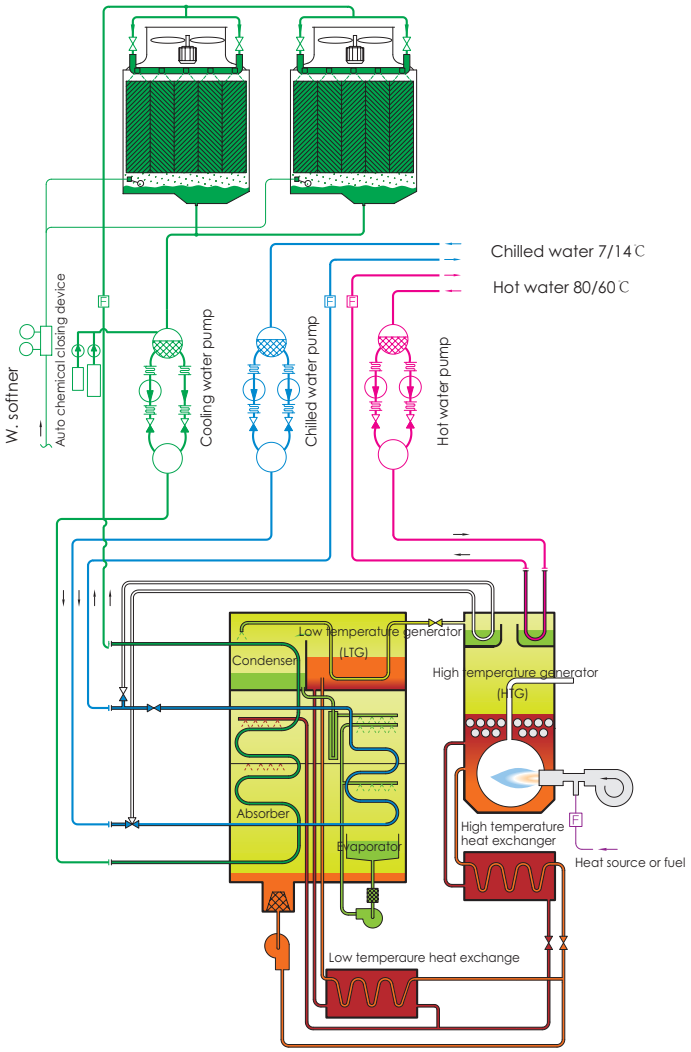
NOTE: parts with "**" are not for heating-cooling type; parts with "**" and "*"are not for cooling-only type.

SAFETY DEVICE LIST

NO.	Name	Function	Install position	Remark
1	Chilled water flow switch (B1,B1A)	Prevents frozen tubes in case of chilled water stoppage or low flow (lower than the lowest allowable flow rate)	Chilled water inlet pipe (Connected to PLC)	
2	Chilled water flow switch (B3)	Stops the cooling W. pump and prevents frozen tubes in case of chilled water stoppage or low flow (lower than the lowest allowable flow rate)	Chilled water outlet pipe (Connected directly to cooling W. pump)	
3	Pressure control (GY)	Prevents HTG overpressure in operation	HTG	
4	Chilled water outlet temperature sensor(T2)	Prevents frozen tubes in evaporator	Chilled water outlet pipe	
5	Chilled water calibrating temperature sensor (T2A)	Prevents frozen tubes in evaporator caused by deviation of chilled water temperature sensor	Chilled water outlet pipe	
6	HTG temperature sensor (T5)	Prevents HTG over-temperature and crystallization	HTG	
7	HTG temperature control (T5A)	Prevents HTG over-temperature	HTG	
8	Exhaust temperature sensor (T6)	Prevents fire caused by extra heat in flue duct	HTG exhaust outlet	
9	Hot water outlet temperature sensor (T7)	Prevents hot water temperature going above 95 °C	Hot water outlet pipe	
10	Heating water outlet temperature sensor (T8)	Prevents heating water temperature going above 95 °C	Heating water outlet pipe	
11	HTG crystallization sensor (T10)	Prevents chiller failure caused by HTG crystallization	HTG concentrated solution outlet pipe	
12	LTHE inlet temperature/ LTG crystallization temperature sensor(T11/T12)	Prevents chiller failure caused by LTG crystallization	Low temperature heat exchanger; diluted solution inlet/outlet	
13	Control cabinet temperature sensor (T13)	Prevents negative impact on operation reliability, safety and life span of electric components caused by super-high temperature of control cabinet	Control cabinet	
14	HTG solution level probes (YK1	Prevents HTG damage caused by HTG solution lacking	HTG	
15	Refrigerant level probes (YK2)	Prevents cavitation of refrigerant pump	Refrigerant chamber in evaporator	
16	Main switch	Powers off in case of chiller maintenance	Control cabinet	
17	Inverter	Pump, fan problem prevention	Control cabinet	
18	Circuit Breaker	Pump, fan and short circuit protection	Control cabinet	
19	Thermal relay	Pump, fan and wires over load, phase lack protection	Control cabinet	
20	Burner safety device	Prevents damage to equipment and personnel	Control cabinet, burner & gas train	
21	Automatic pressure escape	Releases pressure in case of burner deflagration or flue duct blockade	Front flue chamber	No weight on it
22	Rupture disc	Protects personnel and equipment in case of abnormally high pressure in HTG	HTG	
23	Heating water pressure release valve (YA1)	Prevents overpressure of heating water heater for safety protection of personnel or equipment	Heating water drain pipe	
24	Domestic hot water pressure release valve (YA2)	Prevents overpressure of hot water heater for safety protection of personnel or equipment	Hot water drain pipe	
25	Grounding wire	Protects personnel and equipment in case of electricity leakage	Control cabinet	Prepared by user
26	Gas leakage detector in machine room (SG2)	Prevents accidents caused by leakage of gas pipes	Machine room	Prepared by user
27	Fire-fighting detection device	Protects personnel and equipment in case of fire accident in machine room	Machine room	Prepared by user
28	Lightening rod	Protects personnel and equipment from lightening	Above the rain cover of chimney exhaust vent	Prepared by user

NOTE: 1.Short connection or adjustment of safety equipment beyond safety value is strictly prohibited.
2.Special attention should be paid to reliability of all safety devices by regular checking.

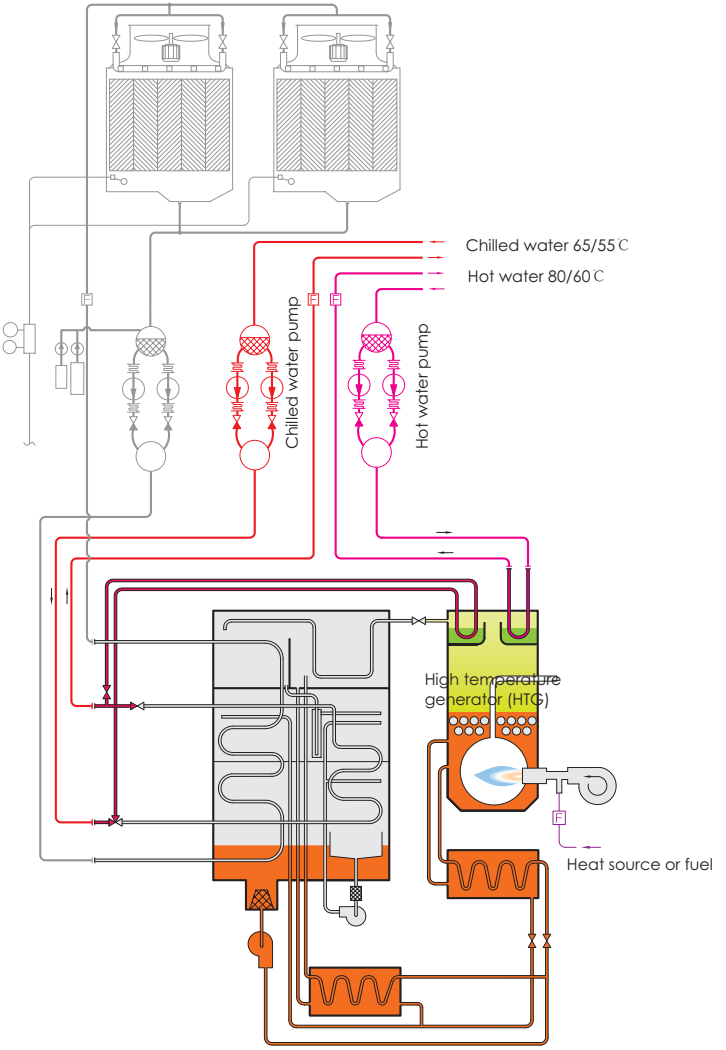
WORKING PRINCIPLE



THE COOLING PRINCIPLE

The input heat energy heats the LiBr solution to 140 °C to generate steam, which is then condensed into water by the cooling water…When the condensed water enters the evaporator (in high vacuum condition), it evaporates immediately and its temperature goes down to 5 °C. It is then sprayed over the copper tubes, decreasing the temperature of water in tubes from 14 °C to 7 °C, and then producing chilled water. The water absorbs heat from air conditioning system, evaporates and is then absorbed by the concentrated LiBr solution from the generators. The cooling water takes away the heat and releases it into the air. Diluted solution is pumped into generator to be heated to repeat the process all over again.

NOTE: LiBr is a kind of brine with strong water-absorption capability, with no poison and harm.



THE HEATING PRINCIPLE

The input heat energy heats the LiBr solution. The steam produced by the solution heats the heating water and hot water in the respective tubes, while condensate returns to the solution to be heated and the cycle repeats.
As "separate heating" is adopted, whereby the chiller does not run during the heating cycle, the heating cycle becomes very simple, just like the mechanism used in a vacuum boiler.
Therefore, the life span of the chiller can be doubled.
A separate heat exchanger can provide dedicated hot water while cooling or heating operation is stopped.
Only BROAD has the unique technology that can realize "three functions in one unit".

PERIODIC CHECK ITEMS AND INTERVALS

NO.	Items		Interval
1	Capacity and COP		1 week
2	HTG solution level		1 month
3	Flow meter		1 week
4	Chilled W. 3-stage protection	Protection while water flow rate lower than the minimum	3 months
5		Water pump chain control	3 months
6	Com-bustion	Burner operation check	1 week
		Flame detector check & clean	1 month
		Combustion chamber and fire tube check & clean	1 year
7	Monitoring center	Normally connected to BROAD monitoring center	1 week
8	Solution		1 year
9	Package pumps	Softener check	1 month
		Auto water-treatment plant check	1 month
		Pump check	1 month
10	Cooling tower check	Water level check & adjust	1 week
		Fan check & adjust	1 year
		Distributor check and adjust	1 year
11	AC and hot water quality and scale	Check by scale detector or soft connector	6 months
		Check by opening water box cover	1 year
12	Cooling water quality and scale	Water quality analysis	1 month
		Cooling water and circulation system cleaning	1 year
		Water system filter cleaning	1 year
		Check by scale detector	1 year
		Check by opening water box cover	2 years
13	Inverter		3 months
14	Electrical system and components		3 months

COOLING CAPACITY AND COP

Every BROAD packaged chiller is equipped with a flow meter for fuel, AC water, cooling water and hot water. By detecting the real time flow rate and using control software, the BROAD packaged chiller is able to calculate cooling capacity and COP automatically. Under normal operation and maintenance chillers can maintain cooling and energy efficiency and load capacity, as well. However in regular operation cooling capacity and COP might decrease temporarily for various reasons, such as scaling of the water system. Therefore regular checks on the chiller's cooling capacity and COP display on the touch screen should be performed.

HTG SOLUTION LEVEL

HTG solution level should be stabilized at zone C in cooling operation. The stability of the HTG solution level relates directly to the stability of operation and even the life span of the chiller. So during cooling operation, regular examinations for 3 hours for the complete start up to shut down cycle of the chiller need to be performed 3 times per month. No matter how the external load varies, the HTG solution level should be stabilized at zone C.

FLOW METER

Check that the value of chilled water, cooling water and hot water flow rate on display is normal. If it is not within the normal range, check that the flow meter is installed according to specification, the battery is normal, the pipes are clean, there is no air inside the pipes, etc.

CHILLED W. 3-STAGE PROTECTION

Check whether 3-stage chilled water flow controller is in protection status when chilled water flow is below 60% of the rated , whether the operation is flexible; and whether it retrieves when the flow is above 70% of the rated.

When the chilled W. 3-stage flow controller is in protection status, check whether it stops cooling W. pump after PLC or not. Check whether water pump starts cooling W. pump after starting A.C W. pump, and whether it can only stop A/C W. pump after stopping cooling W. pump.

COMBUSTION

a. Burner operation check

Whether the burner operation is stable or not directly determines the chiller's operational stability. Therefore a weekly check up on burner operation is necessary. The check up method is as follows:

1. Observe the flame through flame sight glass on the rear flue chamber. The flame should be stable with normal color. For gas the flame color should be light blue with red in the middle. For oil, the color should be white-red color.
2. Observe the burner ignition and fire stage change. The flame should be stable without deflagration.

b. Flame Detector Check & Cleaning

The Flame detector is a component which is used to detect whether the flame is normal or not when the burner is running, and it is therefore one of the most important safety protection devices of the burner. Excessive resistance caused by the flue duct, poor oil quality, large fluctuations in gas pressure, blocked oil filter or improper djustment of the burner damper will all result in insufficient combustion in the burner. Under such conditions, the flame detector will be smoked black by the exhaust, and thus unable to detect the flame signal, which might cause burner failure. Therefore, the flame detector must be checked and cleaned once a month.

1. Procedures for oil burner flame detector cleaning
   · Pull out the flame detector.
   · Clean the glass cover with soft cloth or quality tissue.
   · Insert the flame detector back into the holder.
2. Procedures for gas burner flame detector cleaning.
   · Power off the chiller.
   · Open the combustion head to check if there is soot on the flame detecting probe, and if the distance between the probe and the diffuser or ignition electrode meets the requirements stipulated in "Burner manual". Clean if needed.

c. Checking and soot cleaning of the Combustion chamber and fire tubes

should be checked every year (when the cooling season or heating season ends).

1. The harm of soot in fire tubes and combustion chamber
   Soot in the combustion chamber and fire tubes might greatly decrease the HTG heat transfer efficiency and it will waste energy, resulting in air pollution or even causing fire accident when the exhaust temperature increases to a certain degree.
2. Soot detection
   · Inspect if the exhaust temperature rises abnormally.
   · Open the automatic pressure escape when the combustion stops to inspect if there is soot on fire tubes.
   · Inspect from sight-glass on the rear flue chamber to see if there is soot within combustion chamber when the burner is in operation.
3. Soot cleaning procedures
   · Shut off the chiller power. Start cleaning when the temperatures in the combustion chamber and fire tubes are close to room temperature.
   · Disconnect the burner control wire if necessary. If the marks on the wire are not clear, re-mark properly to avoid any false wiring the next time.
   · Close the fuel inlet valve, diffuse gas or drain residual oil.
   · Take off the oil pipe or straight connecting pipe to the butterfly valve.
   · Remove the burner and keep it safe.
   · Remove HTG front flue chamber cover, rear flue chamber manhole (no manhole for small models) cover and insulation head.
   · Take out the turbulators in the fire tubes from the front flue chamber and clean with rags (non-corrosive detergent can be used).
   · Clean the combustion chamber and fire tubes with steel brushes or other tube cleaning equipment.
   · Clean the soot with a vacuum cleaner.
   · Reinstall the turbulators, covers of front and rear flue chamber, insulation head, burner and its control wire and oil pipe or straight connecting pipe in turn.

   CAUTION:
   Do not damage the insulation materials!

4. Remarks
   · The setscrews of the front and rear flue chamber cover should be replaced. A mixture of graphite powder and engine oil should be applied on screws before installation.
   · After the burner is reinstalled, vent air (oil burner) or diffuse gas to the outside (gas burner) before burner operation.
   · The sealing gaskets (silicate fiber) for the front flue chamber flange must be replaced to avoid exhaust leakage.
   · Recheck and adjust burner's excessive air coefficient after de-scaling.

MONITORING CENTER

When there is downtime or downtime occurring after the chiller is connected to the monitoring center, BROAD "Expert system" will send alarming message to service engineer and A/C administrator who have been registered in BROAD monitoring center. Unstable network and electromagnetic interference, etc. can interrupt monitoring center, then will cause alarm failure. So indicator light of monitoring center inside control chamber should be checked every week to assure whether monitoring center is working normally.

Indicator light	Functions
STATUS light	Glints at a constant speed when the chiller is connected to BROAD monitoring center successfully
TXD light	Glints at a constant speed when sending data to PLC successfully
RXD light	Glints at a constant speed when receiving data from PLC successfully
ACT light	Glints at a constant speed when exchanging data through users' LAN successfully
LNK light	The light is on when LAN is connected to internet successfully
POWER light	The light is on when the chiller is powered on successfully
PPP light	/

SOLUTION

a. LiBr solution quality index

Lithium chromate type solution:

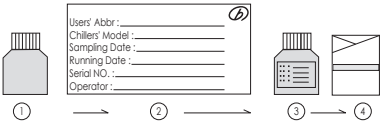
Item	Standard
LiBr%	40/50/52/53/55±0.5
Li2CrO4%	0.15~0.25
PH Value	9.0~10.5
BrO3-	No reaction
Cl- %	< 0.05
NH4+ %	< 0.0001
SO42- %	< 0.02
Ca2+ %	< 0.001
Mg2+ %	< 0.001
Ba2+ %	< 0.001
Fe3+ %	< 0.0001
Cu2+ %	< 0.0001
(K+Na)%	< 0.06
Organic	None
Transparency	Clear, transparent (visual)

Lithium molybdate type solution:

Item	Standard
LiBr%	40/50/52/53/55±0.5
Li2MoO4 ppm	170±20
Alkalinity (N)	0.05~0.2
BrO3-	No reaction
Cl- %	< 0.05
NH4+ %	< 0.0001
SO42- %	< 0.02
Ca2+ %	< 0.001
Mg2+ %	< 0.001
Ba2+ %	< 0.001
Fe3+ %	< 0.0001
Cu2+ %	< 0.0001
(K+Na)%	< 0.06
Organic	None
Transparency	Clear, transparent (visual)

b. Annual analysis

1. Purpose of annual analysis
   Poor vacuum within the chiller will result in metal corrosion and change the solution composition. The vacuum condition in the chiller can be judged by analyzing the Fe and Cu contents in the LiBr solution.
2. In line with our "customer - centered" principle, BROAD service engineers will conduct annual solution analysis on the site for Li2CrO4 solution users, and provide an onsite test report of LiBr solution. Li2MoO4 solution users can sample 50ml of LiBr solution and send (post) it to BROAD for testing. The testing is free during warranty period.
3. Requirements for sampling solution
   Start the solution pump and let it run for 10 minutes when the chiller is off or in a total diluted off state. Wait until the solution is completely blended. Sample according to the procedures described in C.
4. If the testing result of Li2CrO4 solution can't be determined immediately on the site, or the user requires a more detailed and professional testing report, the user can sample 50ml LiBr solution and send(post) it to BROAD, BROAD headquarter will provide a more detailed and professional testing report.
5. Procedures for sending the solution
   Sample as per the above requirements. Use a 50ml hard plastic bottle to hold the solution(with cover, which can be purchased locally).Fill the bottle with3mm~ 5mm of empty space left to the top of the bottle. Wax the bottle if the sample can't be delivered within one week .



- Write detailed information on the label, such as user abbreviation, chiller model, serial NO., sampling date, chiller operation time, operator, service engineer and local service office, and paste the label tightly on the solution bottle.
- Pack under the guidance of the post office or express mail service and post to: BROAD Service Center BROAD Town, Changsha, 410138 China.
- If it is convenient for the customer, our service engineer can bring the sample to BROAD town.

c. Solution Sampling and Concentration Analysis

1. Sampling under positive pressure:
   Applicable to sampling locations with positive pressure (This is suitable for a 2 stage chiller when the solution pump is running with a frequency over 40Hz but not for other chillers).
   - Prepare a clean glass or plastic container.
   - Remove the cork on the sampling valve.
   - Put the container under the valve nozzle and open the valve to discharge the solution.
   - Close the valve, clean the valve nozzle with water and dry it, then put back the cork.
2. Negative pressure sampling: Applicable to sampling locations with negative pressure or unknown pressure status.
   - Take a sampling bottle and 2 rubber vacuum hoses. Connect one end of one rubber hose to the purge nozzle of the sampling bottle and the other end to the sampling purge valve. Use the other rubber hose by connecting one end to a sampling nozzle of the bottle and the other end to the nozzle of the sampling valve.

   NOTE: Make sure the connection hose is reliable and has no leakage.

   - Start the vacuum pump, open the main purge valve and the sampling purge valve in turn to purge the sampling bottle for 1 minute, and use the bubble comparison method to make sure there is no air in the bottle.
   - Open the sampling valve to sample the solution.
   - Close the sampling valve, sampling purge valve, main purge valve and vacuum pump in turn after finishing sampling.
   - Pull off the hose connected with the sampling valve first (the hose must disconnected from the valve port slowly to allow the solution inside the hose to be transferred into the bottle as well). Then pull off the hose (make sure the solution is transferred into the bottle). Finally pour the solution from the sampling bottle to a clean glass or a plastic container (e.g. a measuring cylinder).
   - Clean the sampling valve nozzle with water and dry it, then put the cork back.

d. Solution Concentration and Refrigerant Specific Gravity Check

1. Close the hot water and heating water thermostatic valve (skip this step if no heating and hot water function).
2. Under cooling mode, the chiller should be running more than 2 hours under high fire.
3. Run the refrigerant pump continuously; The solution level inside the refrigerant water box should remain at the 1/3 of the sight glass and become stable.
4. Swiftly sample the LTG and HTG concentrated solution from the LTHE and HTHE sampling valves with sampling bottle by employing the negative pressure method.
5. Open the diluted solution sampling valve (In rated operation with inverter frequency above 40Hz, this valve is under positive pressure. However because of constant change of frequency, it is possible for air leakage due to temporary low frequency. Therefore the negative pressure sampling method is suggested) to discharge the solution directly.
6. Measure the solution concentration and temperature with the density meter and thermometer, then check the actual concentration against the "LiBr Temperature, Specific Gravity and Concentration" curve.
7. Sample the refrigerant water from the refrigerant sampling valve with the negative pressure sampling method. Get the specific weight value with a hydrometer.
8. The designed maximum concentration is: LTG: 61%; HTG: 61%; diluted solution: 56% and specific weight for refrigerant is <1.04.
9. Use water to clean the sampling valve nozzle to remove the residual solution and dry the nozzle. Replace the cork.

PUMP SET SYSTEM

Check every part of distribution system once a month.

a. Softener Checking

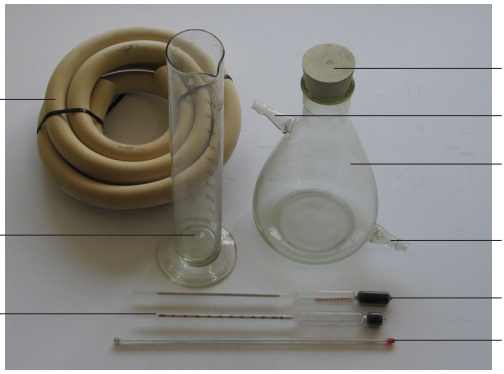
Check the softener once a week. The water pressure should not exceed 0.6MPa. Keep the brine tank at least 1/3 by adding industrial salt. Strengthen water quality monitoring and adjust the regeneration program, period, flow rate or softener settings according to inlet/outlet water quality and variation, so as to keep the system performing best. The period of adding salt is referred to in the chapter under "Add salt and resin manually".

b. Auto Dosing Device Check

If the cooling water system is running for a long period of time, the scale will get accumulated, also mud and algae in the pipes, and all of these materials are thermal resistant. They will reduce the heat transfer, causung energy wastage and shorten the chiller's life. Check whether the chiller can realize auto dosing or not, the stabilizer has run out and the stabilizer pump has been set properly.

c. Pump Check

Check the pump's running noise and vibration to see whether the base is steady or not. Make sure the motor's current does not exceed the rated value and its temperature increases normally. Check whether the frequency driver of the cooling water pump and cooling fan are normal.



COOLING TOWER

a. Check and Adjust Cooling Tower Water Level

Check whether the cooling water system is full of water, the level of the water collector ("sump") should be 25mm lower than its upper edge or (and)20mm lower than the overflow pipe. No matter what the load is, the water collector should never be empty while the cooling water pump is running, no overflow should occur in water collector while the cooling water pump is powered off. Otherwise the float ball valve's acting position for the water pool level should be adjusted.

b. Check and Adjust Cooling Tower Fan

Check the cooling tower's air volume and adjust the cooling fan's blade angle if necessary. The smaller the fan's blades angle to the horizontal direction, the smaller the air volume, and vice versa. The adjusting angle should be within the calibrated scope on the fan axis, and every blade should be at the same angle. Start the fan after adjustment and use the ampere meter to detect the running current to make sure it is within the rated current on the nameplate. Otherwise, adjust it again.

c. Check and Adjust Cooling Tower's Water Distribution

Check whether water distribution is asymmetric. The cooling tower's water distribution device is very important. Insufficient water flow and unsteady valve adjustment always cause asymmetric water distribution. The smaller the cooling water pump frequency and cooling water flow rate, the more asymmetric the water distribution is. Hence the cooling water pump frequency should not be too low.

A.C. /HOT WATER QUALITY AND FOULING

a. Check Water Quality and Fouling

Distilled water, de-ionized water or soft water should be used for the chilled/heating water system and the primary side of the secondary heat exchanging hot water system to avoid fouling and chemical corrosion to the chiller, piping system and terminals. The direct hot water system can be treated by Siliphos. Although water treatment is applied, fouling can still form on the water side of the chilled/heating and hot water copper tubes after operating for a long time. So it is necessary to regularly check the water side of the chilled/heating and hot water pipes. The checking methods are as follows:

1. Every 6 months, check the fouling detector to see if fouling has formed in the copper tubes, or open the soft connecter to be inspected by you. Take a sample using a small bottle and send it to an authoritative lab for analysis.
2. Every year, open the water box cover of the chilled/heating and hot water system to check for fouling in the copper tubes and rust on the tube sheet or water box interior.

b. Tube cleaning

If analysis shows that fouling exists inside the copper tubes, cleaning is needed. Chemical cleaning is subject to BROAD written approval and BROAD service engineer's on-site confirmation.

COOLING WATER QUALITY AND FOULING

a. Cooling Water Quality Requirement

Since the cooling water is exposed to the atmosphere for a long time, evaporation loss can be significant and water quality is subject to deterioration due to corrosion. Cooling water quality must meet the requirement of the GB/T18362-2008, "Cooling Water, Makeup Water Quality Standard" as stipulated in the following C. The high concentration of Chlorine ions and acidic materials in the water might corrode the metal badly; too high a concentration of mineral and alkaline substances might also cause serious fouling. In general, city water (not including sea water for flushing sewage) can be used as cooling water, but industrial water, underground water, lake water and desalinized sea water must be analyzed by a related technical authority before being used. Even if it can be used as per the following standard table, regular analysis is required. Drain water, sea water and waste water are prohibited to be used directly.
If the cooling tower is affected by outside pollution such as waste gas, drain water or exhaust, regular analysis of the cooling water is required to maintain the water quality. Based upon the water analysis result, it may be required to add proper amounts of qualified water quality stabilizers for anti-corrosion, anti-scaling & bacteria killing; all of which will prolong the chiller's life-span. BROAD package chillers employ auto water-treatment equipment and soft water equipment (please refer to "Water-treatment equipment" part) designed to scientifically manage water quality to prevent serious damage to the chiller, breed bacteria and endanger personal health.

b. Management of Cooling Water System

Item	Inspection & Maintenance	Period
Water Analysis	The ordinary water source is analyzed by a specialized technical department according to international standards to determine the water refreshing interval. PH value can be self analyzed	Once 1 month
Circulation System	Clean fan motor, fillings, water pool and filter. Cycle with weak organic acid for 4 hours if the water is hard	Before each cooling season. Every 6 months for chillers in full time service
Water System Filter	Clean the filter of cooling water and make-up water (must be cleaned one week after operation for newly installed chillers)	Once a year
Chiller Water System Inspection	Check the scale in copper tubes with a fouling detector	Once half a year
	Open the water box cover to check if there is fouling in the copper tubes or rust in the tube sheet and water box interior	Once a year

Excessively hard water will cause serious fouling in the cooling water system and result in a decrease in cooling capacity. Service engineers must be informed to confirm and take steps for safe cleaning.

WARNING: To ensure the chiller's full life-span, no chemical cleaning procedure can be adopted without BROAD written confirmation! Cleaning of the chiller copper tubes or water system fouling by an unqualified company will seriously damage the chiller copper tubes or even cause chiller scrapped!

c. Cooling water and make-up water quality standards(GB/T18362-2008)

	Cooling water standard	Make-up water standard	Possible hazard with non-compliance	
			Corrosion	Scale
pH (25 °C)	6.5~8.0	6.0~8.0	○ (too low)	○ (too high)
Conductivity(25 °C)(us/cm)	<800	<200	○	-
Cl- (mg Cl-/l)	<200	<50	○	-
SO42- (mg Ca SO42- / l)	<200	<50	○	-
pH4.8 (mg CaCO3/ l)	<100	<50	-	○
Hardness (mg CaCO3 / l)	<200	<50	-	○
Fe (mg Fe / l)	<1.0	<0.3	○	○
S2- (mg S2- / l)	No	No	○	-
NH4+ (mg NH4+ / l)	<1.0	<0.2	○	-
SiO2 (mg SiO2 / l)	<50	<30	-	○

Notes:
1. "○" represents possible hazard with non-compliance; " - " represents no hazard with non-compliance
2. Water quality stabilizer can be added accordingly to prevent corrosion, scaling and viscosity in cooling water system.
3. Cooling water can be partly discharged or totally changed to avoid impurities concentration
4. The quality of chilled water, heating water and hot water quality can referred to in the above table.

PERIODIC CHECK

INVERTER(Be checked once every 3 months)

Item	Content	Tools or method
Surroundings	Make sure the inverter cabinet temperature is within -10 to 40 °C, Humidity is below 85% and no dust, oil fog or water droplets in the air	Visual Inspection, Thermometer, Humidity Meter
Voltage	Main circuit and control circuit voltage should be normal	Multi-meter
Display	Displays characters clearly with full letters; no omission of characters or strokes	Visual Inspection
Installation Support	No loose bolts and no abnormal sound or vibration	Visual Inspection Hearing
Front Panel	No deformation, no color change, no dust and no damage	Visual Inspection
Wiring Connection	There is no damage, breakage, color change or deformation on cable's coated wire with firm connection	Visual Inspection
Cooling Tower Fan	No abnormal sound or vibration. No aging or color change owning to overheat on fan blades.	Listening and Visual Inspection
Air duct	No blockage.	Visual Inspection

ELECTRIC SYSTEM AND PARTS

Electrical system and parts shall be checked once every 3 months. Electrical system checking general requirements: parts and wiring are fixed firmly; the temperature rise of parts in operation is normal; labels are clear, complete and pasted firmly; and, no dusts or objects on each part. Electrical parts checklist:

Item	Content	Tools or method
Transformer	Deviation of each output voltage shall be within 5% of the rated value. Surface temperature is below 60 °C.	Multi-meter, Infrared Thermometer
Temperature Control, Pressure Control, Flow switch	Temperature and pressure control set point activates and resets normally. Cooling W. flow switch shall disconnect (connect) when the water pump is off (on). No rust on bellow pipe of pressure control and flow switch.	Visual Inspection
All Temperature Sensors	Calibration. Measure temperature at all places with precision thermometer and compare with the value on touch screen: compensate if deviation <2 °C; check the wiring and sensors if deviation ≥2 °C	Thermometer
AC Contactor, Circuit Breaker	Touch the testing point of the AC contactor and circuit breaker with a small screw driver, and check if it functions normally and all switches respond swiftly and reliably.	Visual Inspection, Small Screw driver
Canned Pump	No abnormal sound when the pump is running and the rotary direction is correct. The current should stay within the nominal range. Insulation resistance ≥0.5 MΩ. Surface temperature rise is ≤60 °C when the motor is in operation.	Multi-meter, Infrared Thermometer
PLC module	Check if PLC signals are consistent with touch screen display.	Visual Inspection

FAULT TYPE

There are four different types of faults: fault stop, fault alarm, abnormal reminding and abnormal record. The touch screen will indicate when the first three types occurred.

a. Fault stop

Emergency repair is needed when "fault stop" occurs during chiller operation. The chiller will enter dilution shut off cycle immediately, and this type of fault must be dealt with in a timely manner otherwise it will lead to chiller stoppage and possibly cause a safety accident. The chiller can only be started only by manual reset after all faults are cleared.

b. Fault alarm

The alarm is sent out and the chiller remains in operation, but the fault should be solved and reset within 24 hours or the chiller will upgrade to fault stop. When such faults appear, the chiller will remain in operation and continuously alarming. Some fault alarms (such as burner, chilled w. Pump, cooling w. Pump and so on) will reset automatically at intervals, then upgrade to fault stop if reset fails. All fault alarms will upgrade to fault stop if faults are not solved within 24 hours.

c. Abnormal Reminding

A reminder prompt appears and the chiller remains in operation. These types of faults have to be repaired within 10 days, otherwise the chiller will upgrade to fault stop. Although the chiller will remain in operation and continue reminding under such a fault, some functions will be disenabled when something abnormal appears. Some other abnormalities will upgrade the chiller to fault alarm if several attempted automatic resets fail. All abnormal reminding will upgrade to fault stop if they are not solved in 10 days.

d. Abnormal record

It will not affect chiller operation. The chiller will record the fault, but not remind the user on the touch screen to correct the fault. The PLC will store the record for the service engineer's review and reference for maintenance.

Any fault should be solved in a timely manner, even though some faults or abnormalities will not immediately cause the chiller to stop.

If not solved in time, a fault will cause the chiller to stop. In addition, if the chiller running with fault will waste energy, shorten life span and increase the complexity and difficulty of repair. For these reasons every fault should be solved immediately.

FAULT AND TROUBLESHOOTING

CHILLER

a. Fault stop

NO.	Fault	Cause	Keys
1	Chilled water flow switch fault	a. Wrong wiring or short circuit b. Flow switch(es) damaged or improperly adjusted c. Before starting the chiller, there is water passing by the chilled water side	a. Check and connect the wires correctly b. Readjust or replace the switch(es) c. Check to verify whywaterflow is taking place through the chilled water circuit of the chiller and rectify situation *
2	Copper tube cracks	a. Abnormally low /insufficient chilled water flow rate, when the chilled water 3-stage protection failed or improperly adjusted simultaneously,which can cause evaporator copper tube(s)to crack Possible reasons: 1. Some valves in chilled water system damaged 2. Chilled water pump fault 3. Filters on chilled water system are seriously chocked 4. Air is not totally vented out of the chilled water system b. Chilled water outlet temperature too low, while the chilled water 3-stage protection failed or improperly adjusted, which can cause evaporator copper tube to crack c. Possible reasons: 1. Too much deviationof chilled water outlet temperature 2. Chilled water outlet Temperature set too low c. Improper cleaning within the water system results in copper tube erosion d. Bad water quality causes pitting; scaling can cause under deposit corrosion and penetration of tube e. Corrosive gas gets in to the cooling water system causing erosion on absorber and condenser copper tubes f. Chiller vibration causes copper tubes to crack g. Improper maintenance in winter. (Anti-freeze was not added in the water system or water was not drained out in the copper tubes when the temperature in machine room was less than 0 °C)	a. Stop the pumps and cut off power supply immediately* b. Close water system inlet valves * c. Close the 3 angle valves (for vapor, diluted solution and concentrated solution) * d. Inform service engineer immediately * e. Take sample from the drain valve and check the specific gravity. If the gravity is over 1.1, water between the inlet and outlet valves of the chiller should be collected for regeneration in the future f. Drain the LiBr solution into a clean vessel g. Open the water box cover, plug one end of the copper tubes tightly with a cone rubber plug, spot the leaking tubes with the positive pressure bubble detection method h. Leaking tubes can be clogged with cone copper blocks when less than 3% of tubes are leaking. Replacement is required when the quantity is more than 3% i. Check the chilled water flow switches to see if they work. Recalibrate or replace them j. Replace the chilled water temperature sensor if its deviation is ≥2 °C k. Solution regeneration required l. Chiller re-commissioning m. Thoroughly analyze the reasons for the fault, and take steps to make sure the fault does not happen again. NOTES: 1. The chemical cleaning method of the water side copper tubes is subject to BROAD approval. It is forbidden to use a metal brush for cleaning * 2. The cooling tower should be away from the chimney so as to avoid exhaust entering into cooling tower. Chimney should be down-wind side from of the cooling tower * 3. Improve the machine room anti-freezing condition. If the temperature is lower than 0 °C, antifreeze must be added or the water in the copper tubes be completely drained*

NOTE: "*" Indicates work which can be performed by the user.

cont.

NO.	Fault	Cause	Keys
3	Chilled water off	a. Chilled water pumps stop b. Chilled water system lacks water or filter severely clogged c. Chilled water outlet/inlet valves closed or damaged d. Flow switch(s) improperly adjusted or damaged	a. Check chilled w. pumps power supply and reset it * b. Add water (vent air from pipes) or clear the filters * c. Check and open valves or replace them * d. Readjust or replace switch(es)
4	Insufficient chilled water flow	a. Actuating value of flow switch is improperly adjusted b. Flow switch damaged c. Open circuit or loose contact with flow switch(es) d. Insufficient water flow 1. Chilled water valve damaged 2. Chilled water pump fault 3. Chilled water system filters seriously blocked 4. Air is not totally vented out of the chilled water system	a. Readjust b. Replace c. Check the wiring d. Regain the chilled water flow by following methods * 1. Repair or replace 2. Repair 3. Clean filter 4. Refill the water and vent air out
5	Chilled w. outlet, HTG temperature sensor fault	a. Incorrect temperature sensor wiring; open/short circuit b. Temperature module(s) damaged c. Temperature sensor(s) damaged	a. Check and connect the wires correctly b. Replace temperature module(s) c. Replace temperature sensor(s)
6	Temperature Detecting Module fault	a. Incorrect communication lines wiring; open/short circuit b. Temperature detecting module damaged	a. Check and connect the wires correctly b. Replace temperature module(s)
7	S-pump Inverter fault	a. Inverter damaged b. Incorrect fault feedback wiring; open circuit c. Communication circuit fault or strong electromagnetic interference	a. Refer to the inverter manual b. Check and connect the wires correctly c. Check communication circuit and eliminate source of electromagnetic interference
8	No solution level in HTG (during cooling)	a. Solution pump filter clogged, wrong rotation, not started or stopped by fault b. S-pump's setting of maximum frequency is too low c. Concentration regulating valve is improperly adjusted d. Incorrect level probe wiring or open/short circuit e. Level control damaged	a. Clean filter, repair or replace solution pump b. Reset s-pump frequency. c. Tune down concentration regulating valve d. Check and connect the wires correctly e. Replace solution level control

b. Fault alarm

NO.	Fault	Cause	Keys
1	Chilled/heating/hot w. outlet, cooling w. Inlet, temperature sensor fault	a. Incorrect temperature sensor wiring or open/short circuit b. Temperature module damaged c. Temperature sensor damaged	a. Check and connect the wires correctly b. Replace temperature module c. Replace temperature sensor(s)
2	HTG super high temperature	a. PLC control failure. b. Excessive deviation in HTG temperature sensor c. Temperature control abnormal. d. Inadequate vacuum	a. Check PLC control system b. Replace c. Check or replace d. Check and recover the vacuum
3	HTG solution level control fault	a. Aging of upper and lower coating of solution level probe leads to short circuit b. Incorrect solution level control or level probe wiring	a. Replace solution probe's upper and lower cover b. Check and connect the wires correctly

cont.

NO.	Fault	Cause	Keys
4	Cooling water off	a. Cooling water pumps stop b. Cooling water system lacks water or filter severely clogged c. Cooling water outlet/inlet closed or damaged d. Flow switch(es) improperly set or damaged	a. Check cooling water pumps' power supply and reset * b. Add water (vent air from pipes) or clear the filters * c. Check and open valves or replace them * d. Readjust or replace flow(es)
5	Burner fault	a. Incorrect fault feedback wiring or open/ short circuit b. Burner fault	a. Check and connect the wires correctly b. Refer to burner manual
6	Ignition fault	a. Incorrect fault feedback wiring or open/ short circuit b. Burner fault	a. Check and connect the wires correctly b. Refer to burner manual
7	Gas leakage	a. Incorrect fault feedback wiring or open/ short circuit b. Interior leakage of the solenoid valve.	a. Check and connect the wires correctly b. Repair or replace
8	Refrigerant pump inverter fault	a. Inverter fault b. Incorrect fault feedback wiring or open circuit c. Communication circuit fault or strong electromagnetic interference d. Refrigerant pump get stuck or electrical fault	a. Refer to inverter manual b. Check and connect the wires correctly c. Check communication circuit and eliminate source of electromagnetic interference d. Restore flexibility or replace the pump.
9	Absorption pump, vent pump fault	a. Incorrect pump wiring or short circuit/ loose contact b. Pump overload, lack of phase, short circuit or damaged	a. Check and connect the wires correctly b. Check or replace pump
10	Auto air vent abnormal operation	a. Auto purge valve is not switched to vent b. Actuating value setting too large (no venting for long time may cause valve plate's sealing elements to stick) c. Vent interval short d. Solution level control or vent probe wiring fault e. Auto-vent manual valve closed	a. Check auto purge valve b. Check vent valve c. Reset vent interval d. Check solution level control and vent probe wiring e. Open auto-vent manual check valve (normally open in operation)
11	AC pump fault	a. Incorrect pump wiring or short circuit/ loose contact b. Pump overload, lack of phase or short circuit c. Soft starter fault	a. Check and connect the wires correctly b. Check or replace pump c. Check or replace soft starter
12	Cooling water pump fault	a. Chilled water 3-stage protection act or is wrong wired b. Incorrect pump wiring or short circuit, loose contact c. Pump overload, lack of phase or short circuit d. Inverter or soft starter fault	a. Check chilled water 3-stage protection b. Check and connect the wires correctly c. Check or replace pump d. Check or replace inverter, soft starter
13	Cooling fan fault	a. Incorrect fan wiring or with short circuit, loose contact b. Fan overload, lack of phase or short circuit c. Inverter (if exists) fault	a. Check and connect the wires correctly b. Check or replace fan* c. Check or replace inverter
14	Hot water pump fault	a. Incorrect wiring, short circuit or loose contact b. Pump overload, lack of phase or short circuit	a. Check and connect the wires correctly b. Check or replace pump

c. Abnormal reminding

NO.	Fault	Cause	Keys
1	Chilled w. inlet /cooling w. outlet /HTG crystallization /LTG crystallization /LTHE diluted solution inlet/vent/ambient /control cabinet temperature sensor abnormal	a. Incorrect temperature sensor wiring or open/short circuit b. Temperature module damaged c. Temperature sensor damaged	a. Check and connect the wires correctly b. Replace temperature module c. Replace temperature sensor(s)
2	Large deviation with chilled water outlet temperature sensor	a. Temperature sensor resistance value drifts b. Incorrect temperature sensor wiring c. Temperature module drifting or damaged	a. Check and connect the wires correctly or replace b. Replace temperature module c. Calibrate or replace temperature sensor
3	Chilled water outlet temperature lower than 4 °C	a. Chilled water flow rate is too low b. Chilled water outlet temperature setting is too low c. Cooling water temperature is too low	a. Increase chilled water flow rate * b. Increase chilled water outlet temperature setting * c. Increase cooling water temperature
4	Heating/hot water outlet temperature over 95 °C	a. Thermostatic valve works abnormally b. Water flow is too low c. Large deviation in temperature sensor(s) d. Temperature sensor installation location is too close to water heater	a. Check thermostatic valve wiring or actuation device b. Increase water flow rate * c. Replace temperature sensor d. Move the temperature sensor to 10m away from the water heater
5	Exhaust over temperature	a. Soot in fire tubes b. Excessive combustion c. Exhaust temperature sensor deviation too large	a. Clear soot * b. Adjust combustion amount c. Replace temperature sensor
6	High temperature in control cabinet	a. Machine room overheated b. Control cabinet fan damaged c. Improper temperature sensor installation location	a. Strengthen ventilation to reduce machine room temperature * b. Repair or replace c. Check and reinstall in proper position
7	HTG over-pressure	a. Poor vacuum condition b. Cooling water flow rate is too low or temperature is too high c. Steam angle valve opening is too small d. Scaling with cooling water copper tubes. e. Too small LTG solution circulation f. Pressure control actuating value is too low g. Pressure control damaged h. Low or no flow in heating model	a. Refer to item 13 of "Abnormal Reminding" b. Increase cooling water flow rate or reduce cooling water temperature * c. Check the opening of steam angle valve * d. De-scale. Plan is subject to BROAD written confirmation e. Readjust the solution circulation f. Reset g. Replace h. Check the heating water loop
8	Cooling water flow switch abnormal	a. Improper flow switch wiring b. Flow switch damaged or improper setting c. Water flow in cooling water side before chiller started	a. Check and connect the wires correctly b. Readjust or replace flow switch c. Check the reason for the water flow
9	Refrigerant level control fault	a. Incorrect refrigerant level probe wiring or short circuit b. Refrigerant level control damaged c. Refrigerant box gets frozen d. Refrigerant level probe upper and lower covers are aging	a. Check and connect the wires correctly b. Replace solution level control c. Refer to "refrigerant freezing keys " d. Replace solution level probe upper and lower cover

FAULT AND TROUBLESHOOTING

cont.

NO.	Fault	Cause	Keys
10	Refrigerant overflow	a. Poor vacuum b. Refrigerant water polluted c. Cooling water flow too low or temperature too high d. Comprehensive solution concentration is too low e. Heating capacity is too high f. Scaling in absorber copper tubes	a. Refer to poor vacuum eliminating method b. Refer to polluted refrigerant eliminating method c. Increase cooling water flow or improve cooling tower performance d. Increase solution concentration e. Decrease heat input f. Remove scaling in absorber copper tubes
11	Refrigerant freezing	a. Cooling water temperature and user's load are both low b. Chilled water outlet target temperature setting is too low c. Chilled water flow is too low	a. Increase cooling water temperature and select energy saving operation mode * b. Increase chilled water outlet target temperature * c. Check the chilled water system and increase chilled water flow *
12	Crystallization	a. Cooling water inlet temperature is too low b. Excessive combustion c. Poor vacuum d. Circulation is improperly adjusted e. Excessive corrosion inhibitors	a. Check cooling water temperature setting value; keep normal or add inverter to control b. Readjust burner and reduce combustion c. Refer to "poor vacuum" d. Readjust circulation amount e. Add corrosion inhibitors strictly according to the standard
13	Poor vacuum	a. Sealing element aging b. External vacuum valve is not closed tightly c. Leakage caused during transportation, whereas leakage detection not performed at initial start, or new leakage occurred during operation d. Leakage at welding seam caused by serious outside corrosion e. Auto purge and air vent device defective f. The chiller keeps running at high HTG temperature which generates non-condensable gases	a. Replace b. Check and close tightly * c. Conduct thorough leakage checking and repair to the chiller d. Remove the rust and eliminate the leakage, then repaint the leaking point or the whole chiller (the chiller shall be in vacuum when paint is applied) e. Troubleshoot f. Readjust the setting of HTG target temperature to avoid HTG operating at high temperature *
14	Auto-vent frequently	a. Poor vacuum b. Incorrect or broken non-condensable probe wiring c. Vent valve stuck	a. Refer to poor vacuum eliminating method b. Check and wire correctly c. Replace sealing elements
15	Lack of anti-scale agency	a. Anti-scale agent runs out b. Level probe fault	a. Add anti-scale agent * b. Check or replace level probe
16	Lack of disinfectant	a. Disinfectant runs out b. Level probe fault	a. Add disinfectant * b. Check or replace level probe
17	AC/cooling/ hot water flow meter abnormal	a. Incorrect flow meter wiring or open/short circuit b. Flow meter damaged or fault c. Electromagnetic interference	a. Check and wire correctly b. Check or replace flow meter c. Eliminate source of electromagnetic interference
18	AC water pressure drop/ cooling water conductivity sensor fault	a. Incorrect sensor wiring or open/ short circuit b. Sensor damaged or fault c. Electromagnetic interference	a. Check and wire correctly b. Check or replace Sensor c. Eliminate source of electromagnetic interference
19	Internet monitoring abnormal	a. Incorrect wiring or internet cable not connected b. Communication port failed c. Network gateway abnormal d. Internet is abnormal e. Internet parameter setting is wrong	a. Check and wire correctly b. Repair or replace c. Repair or replace d. Fix the network problem * e. Reset networking parameters
20	PLC/touch screen low battery	a. Fail to replace on time b. Poor battery quality	a. Replace battery and the replacement should be done in 2 minutes b. Purchase battery from BROAD *

d. Abnormal record

NO.	Fault	Cause	Keys
1	Cooling water inlet temperature over upper limit	a. Poor performance of cooling tower b. Lack of water leads to air in the water c. Cooling water target temperature setting is too high. d. Fan blade angle improperly adjusted causes motor strap too loosen	a. Refer to cooling tower fault and eliminating method b. Add water (and continuously add water) * c. Reset target temperature value * d. Adjust fan blade angle or strap
2	Cooling water inlet temperature below the lower limit	a. Low outdoor temperature b. Fan actuation temperature is low c. Cooling tower fan linkage fails	a. Chiller stops, no cooling * b. Readjust the setting value * c. Find the cause and recover the linkage control
3	HTG over-Temperature	a. Poor vacuum b. Excessive combustion c. Excessive deviation of HTG temperature sensor	a. Refer to poor vacuum and eliminating method b. Readjust burner c. Replace temperature sensor
4	Vent alarm	The same as "Vent over temperature"	The same as "Vent over temperature"
5	Burner on-off frequently	a. Load change is dramatic and the chiller's load regulation is abnormal. b. Burner is abnormal c. Gas lower limit pressure switch frequently turns on and off	a. Conduct load regulation function commissioning accurately b. Refer to 5.4 "Burner fault and troubleshooting" c. Improve gas pressure and stabilize or adjust pressure switch setting value
6	Inverter communication abnormal	a. Inverter communication port damaged b. Communication cable abnormal. c. Communication converter damaged d. Electromagnetic interference	a. Replace inverter b. Redo the wiring c. Replace d. Eliminating source of electromagnetic interference
7	Instantly power off	Voltage unstable	Negotiate with utility company *
8	Sudden power failure	a. Power failure b. Main switch is open c. PLC control circuit fuse is burnt out d. Machine room gas leakage or fire alarm is activated	a. Negotiate with utility company * b. Check the main switch and restart the chiller * c. Find the cause and replace the fuse d. Eliminate the gas leakage or fire alarm *

e. others

NO.	Fault	Phenomenon	Causes	Keys
1	Cooling capacity lower than the rated value	Chilled water outlet/inlet temperature both increase and temperature difference decreases; cooling water radiation decreases	a. Poor vacuum b. Insufficient cooling water flow c. Cooling water inlet temperature is higher than the rated value. d. HTG fire off temperature setting value is too low e. Chilled water flow or temperature measurement is inaccurate f. Amount of added Octanol is insufficient g. Chiller heating/cooling switch valves are not fully opened h. Refrigerant water gets polluted i. Refrigerant water spray gets clogged or refrigerant inverter goes out of control j. Refrigerant loss k. Comprehensive solution concentration is too low l. Fouling in copper tubes m. Combustion volume is too small n. Soot in combustion chamber and fire tubes o. Hot water is overloaded	a. Refer to poor vacuum and eliminating method b. Vent air out of water system and fulfill the tank with water. Check if valves of water system are fully opened and filters are clogged. Check the pump model selection and rectify * c. Cooling tower has poor heat dispersion effect. Check if cooling fan belt is loose or has fallen off. Adjust cooling fan blades' angle. Check distribution angle and speed of cooling tower water distributor. Check if the tower selection is correct * d. Reset HTG fire off temperature e. Calibrate the flow meter and thermometer. Calculate accurately chilled water flow and temperature difference. f. Increase by 0.3% g. Check respectively the 3 heating/cooling switch valves;, the steam angle valve must be fully open * h. Refer to item 4 of this chapter i. Backwash or flush R-pump filter, Wash spray device when necessary. Conduct accurate commission to R-pump inverter j. Check and fully close the refrigerant bypass valve. Make sure the refrigerant anti-overflow control is reliable k. Drain part of the refrigerant water to increase comprehensive concentration l. Clean the copper tube fouling. Detailed plan is subject to BROAD written approval m. Readjust burner and increase combustion volume n. Clean the exhaust soot and readjust the burner using exhaust analyzer o. Adjust according to specific condition
2	Heating capacity lower than the rated	Heating water (hot water) temperature cannot be increased. Outlet/inlet temperature difference becomes small	a. Combustion volume is too small b. Scaling in water heater copper tubes. c. Soot in combustion chamber or fire tube d. Poor vacuum e. Level in HTG is too high f. Too much octanol injected in HTG.	a. Check for clogged fuel system filters. Readjust burner to increase combustion rate b. Clean the copper tube fouling, Detailed plan is subject to BROAD written approval c. Clean soot. Find the root cause and readjust the burner d. Check and repair leakage, Purge vacuum e. Lower the solution level f. Switch to cooling, heat the solution for 2 hours, regenerate after bypassing the refrigerant water.

cont.

NO.	Fault	Phenomenon	Causes	Keys
3	Plate heat exchanger mixed flow	a. Rated cooling capacity drops noticeably b. HTG temperature is obviously high and HTG pressure is low. S-pump frequency becomes low and refrigerant level increases noticeably c. HTG low on solution or solution level rises frequently d. "HTHE crystallization" is reported all the time e. The concentration of HTG concentrated solution drops noticeably during operation. Take the measurement after the S-pump stops for 1 minute, the result is 3% higher than normal f. When in operation, S-pump frequency changes from operational to maximum, the HTG concentrated solution outlet temperature may drop by 30 °C in a short time	Caused by frequent power failure or unstable solution level in HTG	a. Replace heat exchanger b. Redo the commissioning of the chiller. Make sure the HTG solution level stays long time at zone C or solution level fluctuates within an allowable range c. Contact utility company or prepare backup generator to tackle the frequent power failure problem *
4	Refrigerant water polluted	Refrigerant water level is increasing. Specific gravity >1.04. Cooling capacity decreases	a. Cooling water inlet temperature too low b. Too much solution circulation causes HTG/LTG solution level to become too high and concentration too weak c. Comprehensive solution concentration too weak d. Excessive combustion e. Hot water flow increases suddenly	a. Increase the cooling water inlet temperature properly * b. Readjust the solution circulation amount c. Take out some refrigerant water. d. Readjust the burner to reduce the combustion e. Avoid sudden increase of hot water flow. By-pass refrigerant completely to regenerate in addition to above measures
5	Unstable HTG solution level	HTG solution level is not in zone C, or jumps between 2 zones frequently to zone E or zone A, and stays too long in zone D or zone B. S-pump frequency drops over 30% in 120 seconds	a. Improper adjustment of frequency b. Solution volume is insufficient c. S-pump fault d. HTG solution level control fault e. Poor vacuum	Observe 3 times the whole process from start to stop for 3 consecutive hours, then: a. Reset S-pump frequency and redo the chiller commissioning if necessary b. Add solution and redo the chiller commissioning c. Repair or replace d. Refer to HTG solution control fault keys e. Refer to Poor Vacuum and Solutions

cont.

NO.	Fault	Phenomenon	Causes	Keys
6	Rupture disk broken	Solution flows out from flow duct of the rupture disk	a. Incorrect operation during nitrogen charging. Nitrogen overcharged b. Copper tubes broken c. HTG pressure increases abnormally due to other reasons	Stop the chiller immediately, cut off power, stop water pumps, close valves and notify local BROAD service organization *
7	Chilled water outlet temperature higher than the target value	Chilled water outlet temperature is higher than the target setting value and can not be decreased	a. Overload b. Chiller cooling capacity is below the rated one c. Deviation of the temperature sensor(s) d. Wrong parameter setting	a. Add new chiller or reduce the load * b. Refer to item 1 of this chapter. c. Calibrate with accurate thermometer. If deviation ≥ 2 °C, replace the temperature sensor; deviation < 2 °C, readjust the compensation value d. Modify the parameter setting
8	Touch screen out of order	No normal display on touch screen	a. Touch screen's power off b. PLC communication failure c. Touch screen fault d. Problem with the connection cable between PLC and touch screen e. 24V DC supply failure f. Wrong configuration on communication port g. Wrong operation leads to touch screen program being lost	a. Power on * b. Repair or replace c. Replace d. Repair or replace e. Replace f. Check by programmer and modify g. Re-input the program
9	Big fluctuation with touch screen data display	Touch screen chiller parameters display unstable	a. Poor grounding of communication cable b. Temperature sensor poor wiring c. PLC Power module fails d. Shielded wires are poorly grounded e. Interference from inverter or high frequency from system power	a. Re-ground (to a dedicated grounding electrode) b. Overhaul and replace c. Overhaul and replace d. Shielded wires well grounded e. Eliminate interference and ground chiller properly
10	Canned pump fault	Canned pump can not be started after chiller startup	a. Pump motor overload protection b. Control circuit fails c. Pump fails d. Chiller in auto protection e. Pump is obstructed by solution crystallization f. Power phase absence	a. Find the cause and reset b. Check the control circuit c. Repair or replace d. Troubleshooting e. Try to notate solution pump in both directions, if it still cannot be started then de-crystallization is needed f. Adjust power supply to normal requirement

FAULT AND TROUBLESHOOTING

PUMP SET & PIPING

NO.	Fault	Phenomenon	Causes	Keys
1	Water pump or cooling fan abnormal	Does not start or stops abnormally after start-up	a. Control output relay of water system damaged b. PLC output module damaged c. Water system is not set in "linkage" control position d. Motor control contactor damaged e. Thermal relay protection activated f. Parameters setting problem	a. Replace b. Replace c. Switch to linkage position * d. Replace e. Find reason and recover * f. Reset
2	Cooling (or heating) capacity cannot be achieved	Chilled water outlet/inlet temperatures are both low(or high) and poor air conditioning effect	a. Air or dust clogged in pipes of air conditioning system b. Filter of air pipes blocked c. Some valve closed or screen clogged d. Hydraulic equilibrium improperly adjusted e. Terminal volume too small	a. Vent air or drain and clean the filter * b. Remove and clean filter * c. Replace or check * d. Increase the opening to those pipes without enough cooling capacity, decrease to the sufficient ones * e. Add more terminals *
3	Pump outlet pressure abnormal	Pump outlet pressure is much higher or lower than normal	a. Filter clogged b. There is leakage or lack of water in the system c. Copper tubes clogged or scaled d. Pump outlet/inlet valve or check valve is not completely open or screen clogged e. Air locked in pipes	a. Remove and clean filter * b. Make up water or check the leakage * c. Open water cover quickly to eliminate hidden troubles. Will cause frozen copper tubes if problem is not solved in time d. Open fully or check valves * e. Vent air *
4	Severe vibration to pressure gauge in pipes	Pressure gauge index wiggles with large range and high frequency	a. Lack of water causes pump cavitation b. Pipe support is not firmly fixed c. Pump foot bolt is loose d. Power supply phases are severely imbalanced or there is even lack of phase e. Pipes blocked by air or valve clogged	a. Make up water * b. Refix or make new support after chiller is off * c. Tighten immediately * d. Stop the chiller immediately and recover 3-phase power supply * e. Vent air and make up water or check valve *
5	Abnormal sound when water pump is running	Pump runs with much higher sound than common or noise	a. Fan blade or pump blade rubs the shell b. Axis damaged c. System lacks water and pump cavitation d. Something abnormal in pump cavity e. Running parts such as axis connector are loose f. Pump axis is not in the same plane with motor axis	a. Check * b. Replace * c. Make up and vent air * d. Check and take out the foreign bodies * e. Check or replace * f. Check static balance carefully *
6	Water pressure unstable	Pressure gauge display changes frequently	a. There is a lack of water or leakage in system b. Expansion tank loses effect c. Water pump inverter is running at low frequency	a. Make up water * b. Check the expansion box and make sure auto make up is running normally * c. Normal phenomenon *
7	Flow Meter abnormal	No display, no flow or abnormal flow in flow meter	a. Installation does not meet the requirements b. Air stacking or too many impurities in pipes after installation c. Water flow speed is lower than 0.05m/s d. Calculator fault e. Low battery	a. Reinstall * b. Vent air and clean * c. Raise flow rate or clean filter * d. Replace e. Replace battery

FAULT AND TROUBLESHOOTING

COOLING TOWER

NO.	Fault	Phenomenon	Causes
1	Abnormal noise and vibration	a. Fan improperly balanced b. Blade end touches the tower body c. Loose bolts d. Motor axis abnormal e. Pipe vibration f. Strap is too loose	a. Check balance b. Adjust the space between blade and tower body c. Tighten the loose bolt * d. Add grease and replace axis * e. Install pipe support frame * f. Adjust strap
2	Current too large	a. Fan blades are not at the same angle b. Motor fault c. Bearing fault d. Too large air output causes overload e. Power supply voltage too low f. Lose phase	a. Adjust to the same angle b. Repair or replace c. Replace bearing d. Adjust blade angle e. Recover normal voltage * f. Check power supply phase and recover *
3	Cooling water temperature rising	a. Insufficient air flow b. Vented hot air enters tower c. Absorb less air d. Dirty filling causes asymmetric distribution e. Distribution system abnormal f. Strap is too loose or broken	a. Check and adjust strap, adjust fan blade angle b. Improve ventilation condition * c. Improve ventilation condition * d. Clean * e. Clean sundries * f. Adjust or replace strap
4	Cooling water amount decreasing	a. Water collector level too low b. Filter screen clogged c. Insufficient water pump flow rate	a. Check, adjust auto make up and fast make up system* b. Clean* c. Repair or replace*
5	Asymmetric distribution	a. Sprayer or distribution pipe broken or clogged b. Water supply volume too large or small	a. Check damaged parts, clear out sundries and clean up water filter screen * b. Adjust water supply volume *
6	Water floating	a. Cooling water amount too large b. Air flow too great c. Asymmetric water distribution d. Incorrect installation direction of filling material e. Filling blocked f. Incorrect installation of baffle plates	a. Adjust water rate * b. Adjust fan blade angle, reduce air rate c. Clean up distributing basin and nozzle * d. Readjust installation direction e. Clean up filling material * f. Reinstall as required

OTHER PARTS

Faults and troubleshooting about burner, inverter, heat source valve, softener, auto water treatment and other automation equipment, please refer to manuals provided with the products accordingly.

MAINTENANCE

MAINTENANCE OBJECTIVES

· Zero fault stop.
· Minimize the occurrence of fault alarm and abnormalities.
· Reduce energy consumption.
· Zero repair cost (excluding the expense of regularly scheduled maintenance).
· 25 year life span.

MAINTENANCE METHOD

The traditional maintenance model for central air conditioning system adopts only "Regular maintenance" without considering the relationship between the maintenance period and the operation load - a chiller running at high operation load for a long period of time will experience faults and a decrease in energy efficiency.

Hence, BROAD classifies its maintenance model as "Load Maintenance" and "Routine Maintenance".

a. Load maintenance

"Load Maintenance" can be classified into three categories: high load, medium load and low load.

1. High load users: HTG temperature is always above 150 °C; typically district cooling, process cooling, luxury hotels, hypermarkets, etc.
2. Medium load users: HTG temperature is always within the range of 140 °C to 150 °C; typically shopping malls, ordinary hotels, theatres, clubs, hospitals, etc.
3. Low load users: HTG temperature is always below 140 °C; typically office buildings, government buildings, schools, gyms, etc.

Maintenance should be completed on the following items once every 2 months for high load, 3 months for medium load and 6 months for low load:

NO.	Items	Method
1	Check the record and feel the air conditioning effect	a. Check the running, fault and energy consumption records of the chiller b. Inquire/analyze the user's energy consumption and give energy saving suggestions to the user c. Check the running status of the chiller and terminals, and feel the air conditioning effect in different areas
2	Observe the operation and check parameter setting	a. Whether or not the burner starts and stops frequently b. Observe for at least 30 minutes to check if the HTG solution level fluctuates abnormally and noisily c. Whether or not the refrigerant level goes up abnormally d. Whether or not the cooling capacity of the chiller decreases and the energy consumption increases e. Check whether noise and vibration of the distribution system is normal or not, the foundation becomes flexible or not.
3	Burner	a. Clean off the dust and water on the steel strip to prevent rusting b. Clean burner fan blades and oil pump filter; check the fan motor bearing c. Wash the atomization tray, nozzle (oil type), ignition electrode and the residual carbon on the ion flame detector; make sure they are not damaged and are in the right position d. Clean the flame detector and confirm that the photosensitive part is transparent and not damaged e. Check the excess air coefficient: gas type 1.18~1.25, oil type 1.13~1.20
4	Solution and rust	a. When the solution pump is running, the solution should be clear and transparent as observed from the sight glass b. Observe the rust status of the copper tubes and steel plates. The vacuum must be confirmed when something abnormal is found
5	Vacuum detection	a. Confirm the vacuum of the chiller by bubble comparison method b. Check whether or not the vacuum valve cover, valve cork and the valve before compound gauge is closed c. Check the reliability of auto purge/ air vent device
6	Control cabinet	a. Check heating and aging status of each component in the control cabinet b. Check whether or not the touch screen displays the right PLC signal c. Check whether or not the control cabinet fan runs well; clean rust on the fan filter
7	Canned pump and inverter	Check the temperature rise, cavitation and abnormal noise of the motor. Check whether the inverter works normally

NO.	Items	Method
8	Temperature sensor	Calibration: To detect the temperature of chilled water, HTG and crystallization, check with precision thermometer, and compare readings with the displayed values on the touch screen. Make adjustment if the difference is less than 2 °C. If the difference is ≥2 °C, check whether the wiring is reliable or not
9	Cooling water quality	Check the water analysis results and ask to make improvement if the water quality is below the standard
10	Machine room ventilation	Check the machine room ventilation is good and whether the temperature is too high or too low (the range should be 5~43 °C)

Following maintenance items: For high load every 4 months, medium load every 6 months and low load every 12 months.

NO.	Items	Method
1	Water side of copper tubes	a. Take out the fouling detector for the cooling/chilled water, open the soft connector for heating/hot water to check the fouling with the copper tubes. If fouling occurs, clean according to a method officially approved by BROAD b. Check the reliability of water quality stabilizer charging, water drain, water makeup devices and their control
2	Fuel filter	Clean
3	Action test for flow switches	a. Adjust the water pump inverter or the outlet valve after the pump starts. Check whether the flow switch closes when the flow rate is above 70% of the rated value and whether it disconnects when the flow rate is below 60% of the rated value (40% for cooling water) b. Confirm the start/stop sequence of the cooling and chilled water pumps
4	HTG temperature and pressure control	a. Make sure the pressure control actuating value is set correctly (factory setting) b. Check if protection is actuated during Nitrogen charging for repair or during maintenance c. Make sure when HTG temperature >170 °C, HTG temperature control actuates to shut off the burner
5	Gas train air tightness & upper/lower limit pressure switch	a. Check valve train joints leakage by soap solution. Charge Nitrogen to maintain pressure at valve train per burner manual instructions b. Check performance of gas valve leakage detecting system c. Ensure that two stages of gas solenoid valves can both open/close reliably d. Test whether the burner is stopped when gas supply pressure is beyond upper/lower limit
6	Protection test	Check the possibility of accidents which may lead to stop fault
7	Rupture disc and sealing elements	Replace

Following maintenance items: For high load every 2 years, medium load every 3 years and low load every 5 years.

NO.	Items	Essentials of the method
1	HTG solution level probe and UDK upper/lower jacket	Filter the solution with a precision filter
2	Vacuum sealing elements in high temperature area	Replace
3	Sealing materials in front/rear flue chamber	Replace
4	Sealing gasket for heating/hot water box cover	Replace
5	Burner	Replace the nozzle, ion flame detector and motor bearing

Following maintenance items: For high load every 5 years, medium load every 7 years and low load every 10 years.

NO.	Items	Essentials of the method
1	Burner	Replace the oil pump, ignition electrode and solenoid valve coil
2	Inverter	Replace
3	Turbulator	Replace
4	Cold/heat insulation materials	Replace

b. Routine maintenance

The maintenance interval of some items has nothing to do with the running load of the chiller. This maintenance model is called routine maintenance.

Annual maintenance

NO.	Items	Method
1	Solution analysis	Fully dilute the solution inside the chiller, then BROAD service engineer test the solution at site, and issue a report of Site Testing of LiBr Solution. If the test cannot be finished at site or the user needs a more detailed and professional report, sample around 50 ml and send it to BROAD lab for testing by post or express. The lithium molybdate solution cannot be tested at site, sampling the solution around 50 ml and sending it to BROAD lab is required
2	Control cabinet(include the control of water system)	a. Check for heat radiation inside the components and aging b. Check whether or not the control cabinet fan runs normally and filters fan dust c. Make sure the inverter is running normally d. Check the reliability of the wiring terminal connections inside the control cabinet. Fasten if they are loose. Clean dust e. Check and make sure the temperature of the surrounding area is between 5 ~ 43 °C, and well-ventilated
3	Soot in the fire tubes and combustion chamber	Open auto pressure escape to check soot in HTG fire tubes. Check if the condensate drain pipes at front fuel chamber can drain smoothly. If soot exists, it should be cleaned and the excess air coefficient of the burner should be readjusted
4	Flue duct and chimney stack	Check and clean
5	Chiller paint	Check the chiller for external rust. If there is rust, clean the rust and paint again the repaired part or for the whole chiller (note: inside the chiller should be vacuum and normal temperature when paint is being applied)
6	Water box and tube sheet	Open all the water box covers to check whether there is rust withinthe tube sheet and inside the water box
7	Chilled/heating water quality	Analyze the water. Soften it if the quality standard is not met
8	Oil box	Completely clean dirt inside the daily oil tank and oil storage tank. Check whether the oil level probe works well
9	Grounding	Chiller grounding resistance should be ≤4Ω, all motor insulation resistance (to earth) should be ≥ 0.5MΩ
10	Water pumps	a. Check if the pump temperature increase is normal, The pump current must be less than the rated value. b. Check the running noise and vibration; also check if there is abnormal noise, cavitation, and check the foundation to see if it is flexible or not. c. Make sure the control system works well and flow rate is sufficient. d. Check the lubricant oil appearance, oil temperature, oil quality. There should be no oil emulsion and impurities. If necessary, replace or add new lubricants. e. Check the electrical wiring terminals and their reliability. Make sure the grounding resistance is ≤ 4Ω, and insulation resistance is ≥ 0.5MΩ f. Check whether the water system is full of water and sealing is normal or not. Check the pressure drop between the inlet/outlet and calibrate the pressure gauge, check the painting of the pump, repaint if it drops. h. The ambient temperature may be lower than 0 °C. If so, add antifreeze, or drain the water inside the pumps.
11	Pipes, valves and accessories	a. Check water leakage at connection joints and the valve seals b. Check whether there is any damage in heat and cold insulation or paint. Check whether the support is strong enough c. Check whether the valve switch is flexible, d. Clean the dirt in the pipes, valves and accessories

cont.

NO.	Items	Method
12	Flow meter	a. Confirm the displayed data on flow meter is the same as on the touch screen b. Clean the surface of flow meter by proper tools (do not use chemical method to wash). c. Check ambient conditions (air flow, humidity); check if the sealing of the connections is good or not, and if cable joints and fasteners are loose or not. d. Check whether or not the grounding is good, whether there is any interference or anti-interference influence.
13	Filter header and outlet box	Drain water and clean up filter and impurities in the boxes
14	Softener	a. Brine level should reach 1 / 3 of the brine tank, otherwise add industrial brine, lodized brine and powdered brine should not be used, otherwise, they will affect the performance and life span of the exchange resin b. Check and clean the filter of the inlet. Make sure that water pressure is not higher than 0.6MPa c. Make sure the ambient temperature is above zero and inlet temperature is below 40 ºC d. Check the quantity of resin and make up the resin around 5%-10% every year e. To avoid anti-dehydration, freeze and breeding germ of germen the resin, you should fill up with brine when the equipment is not in use
15	Automatic dosing device	a. Inspect records of adding and quantity of the chemicals; add some if insufficient. Note: To avoid direct contact with the chemicals, please take protective measures, such as wearing masks, gloves and safety glasses b. Check the strainer of the chemicals supply valve on the bottom of tube, and clean if dirty. Cleaning procedure: disconnect the tube connections which are connected with the anti-sludging pump or biocide pump, and lift the tubes with the fixer from the drum, then clean the strainer of valve on the bottom of the tube with clean water or neutral solution c. Check if pump head, pipe connections are in working order
16	Cooling tower	a. Check and clean the sprayer and strainer of cooling tower b. Check the shaft of reducer, if necessary, add some lubricating oil (which tends to use Lithium Grease # 3) from the filling hole. Make sure that oil does not enter the cooling water; otherwise it will affect heat transfer. c. Check fan driving belt, and make sure it is not tight or loose. Too tight may lead to damage of bearings, while too loose may lead to overheating or sliding. Make sure that oil does not enter the cooling water; otherwise it will affect heat transfer. d. Check fan blade damage or corrosion, clean fan blade and make sure vibration and noise are acceptable. Check the state of filler, clean inside of the cooling tower e. Check the electrical wiring terminals and reliability, the grounding resistance should be ≤4Ω, and insulation resistance of ≥0.5MΩ f. Check and fasten all steel structure, connecting bolts of cooling tower and impellers, make sure the reliability, decrease the noise and vibration. Check whether the make-up water valve, overflow tube, drain valve are normal or not g. Open all the drain valves and make sure there is no water in the system during cold winter
17	Expansion tank	a. Check automatic make up water valves, signal pipes, overflow pipes, drain valves and insulation are good or not b. Clean and repaint where necessary

MAINTENANCE

Maintenance every 2 years

NO.	Items	Method
1	Gas filter core	Replace
2	Water pumps	a. Disassemble, inspect and clean, in particular, scale on the inner and outer surface of the impeller and in the flow path b. Replace mechanical seals. Inspect seal wearing parts, such as shaft seal, shaft coupling and fillings and abrasion of the bearing
3	Cooling tower	a. Disassemble and check the wear of motor bearing b. Replace fan belt
4	Auto chemical dosing device	Replace diaphragm, ball valves, and spring of injection valve. Note: Do not use pliers or wrench. PTFE tape or piping sealing glue is also prohibited
5	Flow meter	Send to local technical supervision authority to test and calibrate. Reuse after passing precision test, otherwise, need to be adjusted by professional

Maintenance every 4 years:

NO.	Items	Method
1	Vacuum pressure gauge	Replace
2	Chilled water flow switch	Replace
3	Batteries of PLC and touch screen	Replace
4	Exhaust temperature sensor	Replace
5	Chilled water temperature sensor	Replace
6	Gas train or oil filter sealing elements	Replace
7	Water pump bearing , seal retainer washer	Replace
8	AC water pump filter box and return chamber	Drain water, filter and clean up debris box
9	Cooling tower fan bearings	Replace
10	Flange gasket	Replace
11	Three-way valve, check valve seals	Replace
12	Softener	Replacement of PVC piping components
13	Cooling water conductivity sensors	Replace
14	Automatic water processor	Replacement of PVC tube, the liquid level switch
15	Control cabinet	Replacement power indicator light, button
16	Inverter fan	Replace

Maintenance every 8 years

NO.	Items	Method
1	Cooling water flow switch	Replace
2	Cooling water temperature sensor	Replace
3	HTG temperature sensor	Replace
4	HTG crystallization probe	Replace
5	Heating water temperature sensor	Replace
6	Hot water temperature sensor	Replace
7	LTG crystallization probe	Replace
8	Ambient temperature sensor	Replace
9	Refrigerant level probe and UDK upper/lower jacket	Replace
10	Non-condensable probe and UDK upper/lower jacket	Replace
11	Solution leakage probe and UDK upper/lower jacket	Replace
12	Other sealing elements in low temperature area	Replace
13	Sight glass and sealing elements	Replace
14	Sealing gasket of chilled/cooling water box cover	Replace
15	Water pressure gauge	Replace

cont.

NO.	Items	Method
16	Control cabinet fan	Replace
17	Touch screen	Replace
18	Actuator of motor valve	Replace
19	Actuator of auto purge motor valve	Replace
20	Actuator of Refrigerant W. bypassing valve	Replace
21	Actuator of heat source valve	Replace (Including steam, hot water, electric gas valve)
22	Actuator of cooling W drain valve	Replace
23	HTG pressure control	Replace
24	HTG temperature control	Replace
25	Cooling tower	Replace nozzle, packing, and a ball valve and vent valve
26	Fan control cabinet	Replace
27	Inverter fan	Replace
28	Soft Starter fan	Replace
29	Cold & Heat insulations	Replace
30	Auto vent valve	Replace
31	Rubber isolator	Replace
32	Rubber soft connector	Replace
33	Auto dosing device	Replace metering pump (except the diaphragm), four-function valve, brine tank, dosing valve, liquid level probe
34	Softener	Replace water pressure gauge, brine safety valve, water distributor, central tube , brine tank, brine plate, brine well, cover and plane
35	Atomization tray of burner	Replace

Maintenance every 16 years

NO.	Items	Method
1	Components in the control cabinet	Replace PLC module, circuit breaker, relay, transformer, contactor and solution level control
2	Canned pump	Replace
3	Burner	Replace combustion head, gas upper/lower pressure switch, ignition cable, ignition transformer, air pressure switch, inner oil pipe, oil/gas meter, air damper actuator, controller and motor
4	Front and rear flue chamber firebricks	Replace
5	Vent valve	Replace
6	Drain valve	Replace
7	Pump impeller	Replace
8	Pump motor	Replace
9	Cooling fan blade	Replace
10	Cooling fan motor	Replace
11	Butterfly valve	Replace
12	Ball valve	Replace
13	Motor valve body	Replace
14	Control cabinet	Replace cabinets, PLC modules, circuit breakers, relays, contactors
15	Water softener	Replace valve control components, air valve, resin tank
16	Soft starter	Replace
17	Gas/oil flow meter	Replace
18	Auto dosing devise	Replace dosing pump
19	Wires of whole control panel	Replace

LITHIUM BROMIDE SOLUTION FILTERING

a. Solution filtering

The solution must be filtered under the following two conditions: 1) during chiller commissioning; 2) the solution is observed to be turbid from the sight glass. In this case, at least one week filtering is required until the color of the solution in the inlet/outlet of the precision filter is the same.

1. Installation of the precision filter:
   The filter should be installed vertically, hanged at the right position on the chiller and fixed reliably with a separate bracket.
2. Operation of the precision filter:
   - Recycle the solution inside the chiller adequately before filtering and sample 50 ml of solution for storage.
   - Install the valve and flexible tube as per filtering sketch(See next page), lock with 2-level clamp collar, and reinforce the connection with steel wires to prevent its breaking off due to solution pump vibration.
   - After the filter is installed and firmly connected, start the vacuum pump, open the purge valve, solution inlet/outlet valve to purge all the air inside the flexible tube and the filter (check the air tightness of the filter and conduit by bubble comparison method before each purge operation). Close the purge valve and stop vacuum pump.
   - Under cooling operation when the solution pump is confirmed in operation, open the LTHE sampling valve and the diluted solution sampling valve to filter the solution. Observe the flow rate and color during the filtering process.
   - When the solution filtering is complete, close the diluted solution sampling valve, then the solution inlet valve, solution outlet valve and LTHE sampling valve in turn.
   - The filtering time for the new chiller is about 100-150 hours. For the degenerative solution duration depends on the need of each specific situation.

NOTE: As solution filtering needs certain pressure at the inlet of the filter, filtering can only be done in cooling operation. The opening of the diluted solution sampling valve cannot be too large. After the filtering is complete, the solution inside the chiller should be analyzed and its chemical composition adjusted as per the analysis report.

b. Maintenance of the precision filter

1. Cleaning
   - The filter element should be back washed to restore infiltration and filtering function.
   - Close valve 1, 2, 4 and 5 in turn, open the fouling collector clog 6 and valve 3, blow a small amount of nitrogen gas, and collect the residual solution and recycle it after sedimentation. Connect valve 3 to the city water pipe to back wash the filter elements (the higher the water pressure the better), blow nitrogen gas (P≤0.06MPa) through valve 3 for 20 minutes after flushing for 1 hour. If the solution is dirty, repeat the process 1 or 2 times. The filter can be used only after the air tightness is again confirmed.
   - For the new chiller, backwashing is unnecessary. For degenerative solution, the filter shall be cleaned at least once every 2 days during the filtering process.
2. Checking
   Check the filter element once every 2 years. Clear away all broken capillaries and replace all sealing elements.
3. Anti-freezing and anti-cracking
   - The filter must be placed in a wet environment; otherwise, its capillaries are easy to break. Clean the filter completely by the backwashing method and blow the filter element dry with nitrogen gas after use.
   - If the ambient temperature is above 5 °C, the filter can be maintained with distilled water or clean, diluted LiBr solution. If the ambient temperature is below 5 °C, it can only be maintained with clean, diluted LiBr solution.

DANGER: It is prohibited for non-solution manufacturers to treat the solution. Otherwise solution deterioration, cooling capacity decrease or even chiller corrosion and damage can result.

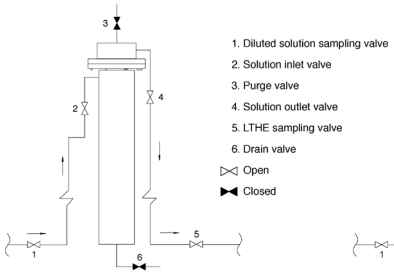


Illustration of solution filtering

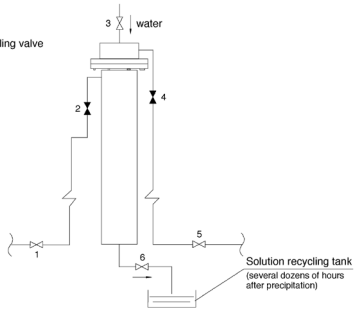


Illustration of filter draining

ANALYSIS OF THE EXCESS AIR COEFFICIENT

1. The amount of air required for complete combustion of the unit volume or unit weight of fuel is called the theoretical air amount. In fact, to assure a thorough and safe combustion, the required air amount will be more than the theoretical one. The ratio of the actual air amount to the theoretical one is defined as the Excess Air Coefficient (λ).
2. To make sure that the burner works steadily, the Excess Air Coefficient should be well adjusted. If the air supply is too high, more heat will be taken away by the exhaust gas through the chimney which will waste energy. This might also cause unstable combustion or even blow out the flame. If the air supply is insufficient, the flame will become longer or the CO content in exhaust will go up, or even secondary combustion will take place in the flue duct, which is very dangerous. From the environmental protection point of view, reducing the Excess Air Coefficient moderately will lower NOX emissions, which means the reducing pollution generated by the chiller as well as heat loss.
3. The standard value of the Excess Air Coefficient (λ): gas type--1.18~1.25, oil type--1.13-~1.20. To achieve optimal combustion efficiency, this coefficient shall be examined with an exhaust analyzer every 3 months. If a deviation from the standard is found, adjustment is necessary.

FUEL FILTER CLEANING AND AIR VENT

a. Fuel filter cleaning

1. Gas filter

The gas filter is composed of a filter cylinder, filter element, etc. It is used for filtering impurities in the gas to keep them from entering the pressure governor and the solenoid valve, thus to ensure the normal operation of the burner. The whole procedure is as follows:

- Close the ball valve, open the inlet clog of the main solenoid valve and diffuse the gas in the pipe section between the ball valve and the solenoid valve.
- Remove the cover plate on the filter and take out the filter element.
- Get rid of the impurities clinging on the filter element by swinging or cleaning with a vacuum cleaner.
- The filter element shall be cleaned with water if there are too many impurities (add non-corrosive detergent into the water if necessary). Reinstall the filter element after it is dried.
- If the filter element is capillaceous after being cleaned, replace it immediately otherwise it might cause leakage in the solenoid valve.
- Leakage detection shall be processed after cleaning to avoid any gas leakage.

WARNING: If the gas filter is not cleaned in a timely manner, the impurities in the gas will enter into the solenoid valve, thus causing the valve not getting closed tightly, and gas can leak into the combustion chamber. In this case when the burner is reignited, deflagration and other problems will take place which will influence the normal operation of the chiller and more seriously even cause equipment damage and personnel injury.

2. Oil filter
   Close the inlet valve of the oil filter. Dismantle the drain nozzle cover on the bottom of the oil filter. Collect the dirty oil in the filter and oil pipe through the drain nozzle. Take off the nuts and bolts of the filter flange, remove the flange plate, and dismantle the setscrew and gasket of the filter element. Take out the filter element and wash it with clean water from inside to outside, and dry it removing the impurities. Clean the fouling collector of the oil filter with rags and reinstall the filter element. Make sure its bottom edges are completely put into the slot on the base. Reinstall the flange plate. Open the oil inlet valve and vent air in the oil filter and pipe.

b. Oil System Air Vent

If there is air in the oil system, it will enter the oil pump and prevent the pump gears from completely dipping into the oil. Under these circumstances, the gears will be damaged quickly due to dry friction when the oil pump is in high-speed operation. Therefore, after each initial filling or filter cleaning the air within the oil system must be purged.

1. Air vent of oil filter: Open the inlet valve of the oil filter; loosen the screw of the air vent device slowly until the oil filter is air free. Tighten the screw again.
2. Air vent of oil pump: Use an Allen key to loosen the Allen screw on the oil inlet pipe, and tighten it after the air is completely vented. If it is difficult to unscrew the nut, the oil pressure gauge can be loosened to vent the air.

REPLACEMENT OF SEALING ELEMENTS

Sealing elements to be replaced: Solution level probe, vacuum valve, regulating valve, compound gauge, pressure control valve and sight glass, etc. Note the following during replacement:

1. Charge nitrogen with purity >99.995% into the chiller to make the internal pressure equal to or a little higher than the atmospheric pressure.
2. If there is solution around the sealing parts, transfer part of the solution to HTG or drain out of the chiller till the solution level is below the level of the replacement.
3. The replacement of the sealing parts for compound gauge and for liquid level probe under urgent cases can be done swiftly when the chiller is under vacuum condition.
4. The parts for replacement must be exactly the same as the originals.
5. Clean up the rust and oil stain on the sealing surface.
6. All valve covers must be installed and tightened after replacement.
7. Apply soap solution around the valve nozzle to detect leakage when the external vacuum valve is closed tightly. Tighten the valve screw at the same time.
8. When the sealing elements are found deformed, damaged or destroyed, they must be replaced immediately.
9. The replaced sealing element must be labeled properly or destroyed to avoid mixing them with the new ones.

NOTE: The replacement of vacuum sealing parts is an important job for maintenance. Aging or damage to the sealing elements will lead to vacuum deterioration, which will cause serious harm to chiller operation and shorten the chiller life span.

PUMP FILTER HEADER CLEANING

1. Close A/C (or cooling) water inlet and outlet valve.
2. Open drain valve and drain all the water in filter header.
3. Take off insulation carefully and open service door.
4. Clean the filter header from inside.
5. Close service door and if bolts are damaged, replace them.
6. Put insulation back and make sure it is tight without any gap.

COOLING FAN MOTOR BELT REPLACEMENT

1. Loosen the fixing bolts of the motor.
2. Take off motor belt, and then fit with the new belt of same model.
3. Regulate motor horizontal adjustment bolt to tighten/loosen the new belt.
4. Tighten the horizontal adjustment bolt and fixing base bolts.
5. Test run cooling fan.

NON-OPERATION MAINTENANCE

If the chiller needs to be stop for more than 8 months due to some special reasons, non-operation maintenance should be carried out.

1. Shut off all inlet/outlet valves, and open the water drain valves to drain out the water inside the copper tubes.
2. Charge the nitrogen gas of high purity (above 99.995%) into the chiller to 0.01~0.02Mpa and check periodically (every 1~2 months) for the pressure drops.
3. Check carefully whether all valves are closed tightly, screws are properly mounted, sight glass covers are covered and fuel supply valves are shut off.
4. Cut off the power supply after informing BROAD Remote Monitoring Center.
5. The doors and windows of the machine room should be steady and reliable, and cannot be used for other construction purposes. Unauthorized personnels are prohibited to access into the machine room. The burner, tools, spare parts and documents should be well kept.
6. Keep the humidity and temperature of the machine room normal. Some dehumidification measures shall be taken for electrical parts, e.g. the control cabinet.
7. A comprehensive maintenance and inspection is necessary before restarting the chiller.

ANTIFREEZE IN WINTER

Before winter every year, users should double-check the unit and system to confirm that they are in accordance with antifreeze requirements. If not, take the following steps to prevent a unit or system from freezing.

a. Air-conditioning water system antifreeze

When the air-conditioning system is disabled and if the ambient temperature may be lower than 0 °C, water in the system pipes needs to be drained out completely. Add antifreeze to the system, the antifreeze freezing point should be lower than the minimum ambient temperature of the system to ensure that the water system and chiller have no freezing accident. This step will also help to prevent water pipes and copper tubes from corrosion.

b. Cooling water system antifreeze

Completely drain cooling water completely from the pipes, cooling towels and copper tubes inside the chiller and especially, make sure no water remains in the lower positions of system.

c. Domestic hot water system antifreeze

1. Without secondary heating exchange, if the ambient temperature is lower than 0 °C, and if domestic hot water is not in use in winter, you must open the drain valve to drain all water out of the system. This will help to prevent the domestic hot water system from freezing.
2. With a secondary heating exchange system, if domestic hot water is not in use in winter, it is not necessary to drain out all water from the system. This will help prevent water pipes and copper tubes from corrosion. If ambient temperature is lower than 0 °C, antifreeze needs to be added into the first heating exchange cycle system, and its freezing point should be lower than the minimum ambient temperature. However, water in the secondary cycle system has to be drained out.

d. Unit antifreeze

1. If ambient temperature is lower than 0 °C, but antifreeze has been added, water in the copper tube inside the unit does not need to be drained out. If no antifreeze has been added, drain the water to prevent the unit from freezing.
2. When the ambient temperature is lower than 0 °C, because of the residual refrigerant water in the refrigerant water pump, refrigerant water pressure-drop pipe and condenser pressure-drop pipe, when the ambient temperature is lower than 0 °C, freeze may occur. In this case, pass refrigerant water into the absorber and keep the unit in a vacuum state.
3. Long-time-disabled chillers in a nitrogen state as well as chillers that have not yet been put to use but have been previously tested on the testing platform and delivered with nitrogen in the system, should be charged with some LiBr solution in refrigerant water box from refrigerant water sample valve. The best concentration of solution in the refrigerant water box is 52%.

e. Fuel system antifreeze

Appropriate grade of diesel should be chosen for the ambient temperature.

1. In regions where the lowest temperature is above -5 °C, light oil NO.-10 should be used;
2. In regions where the lowest temperature is above -14 ~ -5 °C light oil NO.-20 should be used;
3. In regions where the lowest temperature is above -29 ~ -14 °C light oil NO.-25 should be used;
4. In regions where the lowest temperature is above -44 ~ -29 °C light oil NO.-50 should be used.

f. Antifreeze instructions

1. Effect
   Antifreeze is solution of various chemical reagents in A/C water or domestic hot water, which make the freezing point of the water lower. Properly selected antifreeze will lower the freezing point of the water to below the lowest ambient temperature, and in this way the antifreeze can prevent pipes from freeze.
   At the same time, in order to maintain completely normal working conditions within the pipes, in addition to antifreeze, anticorrosion, anti-scaling and anti-microbial chemical reagents mush be added to the A/C water or domestic hot water. Under normal operating conditions, antifreeze can protect a unit against freezing forever, and can extend life span of unit.
2. Formula
   Preparation of antifreeze must be based on the minimum ambient temperature and total volume of water in the unit's system. Measure the total volumes after first drain out of the unit, and then add antifreeze as following.
3. Test
   Density and pH values of antifreeze should be tested. Use a 1.000~1.100 densimeter, and test the liquid at about 20 °C. Use a universal pH test paper for the PH test.

Formula list for 100 liters antifreeze

Local minimum temperature °C		-5	-10	-15	-25	-30	-40
99% Glycol (kg)	Secure formula	12	19	27	38	43	48
	Density ± 0.002kg/L 20 °C	1.021	1.029	1.038	1.051	1.056	1.062
	Economic formula	5	8	12	16	20	22
	Density ± 0.002kg/L 20 °C	1.014	1.017	1.021	1.026	1.030	1.033
Water (L)		The total volume increased to 100 liters of water required					
Additives(kg)		Borax 0.6, sodium hydroxide 0.15, sodium benzoate 0.5, BTA0.02, if in the preparation hard water is used, add 50ml of anti-corrosion inhibitors					
pH value		9~11.5(If not appropriate, add sodium hydroxide to adjust)					

NOTE: The secure formula will not freeze at the temperature and the economic formula will form ice crystal as a result of freezing, but the formula will not freeze the pipes, nor will it be cycled immediately. The secure formula is based on the lowest temperature records in the local history. But there is always the possibility of an even lower temperature than in recent history occurring and therefore causing chiller shutdown. So the economic formula is provided for reference. The relationship between antifreeze density and temperature is: density at X °C = density at 20 °C- 0.0003 (X-20) ($10 \leq X \leq 35$).

ENERGY SAVING MANAGEMENT

ENERGY CONSUMPTION ANALYSIS

a. Energy cost

1. In order to make an accurate energy analysis, separate metering for heat sources, electricity, water, and cooling/ heating consumption of air conditioning is necessary.
2. To make a comparative analysis of the data from different years or from different time periods under similar loads, charts and graphics are helpful. According to BROAD experience, normally 30-60% cost savings can be achieved by introducing effective energy analysis management.

b. Energy consumption survey

BROAD completes energy consumption and energy cost surveys every year. By supporting BROAD engineers in their energy consumption surveys, users gain important information on their BROAD systems, including, whether their energy consumption is reasonable or not, why energy consumption might be high, what is the system's energy saving potential and how can I better manage my energy consumption.

c. High energy consumption troubleshooting

Abnormality	Possible reasons	Solution
1. Energy consumption is too high	A/C or hot water load is too high	Conduct a check to see whether there is too much waste on air conditioning and hot water consumption, and examine the building insulation. For example, check whether doors, windows are opened or not, the air conditioning is on in rooms without people and the hot water tap has been closed, etc.
	Chilled(heating)water outlet temperature is set too low(high)	Adjust the temperature setting by 2 to 3 °C higher (lower), or choose the "Energy Saving Mode".
	Management is not strict	Work out the rules accordingly and implement strictly
	Poor chiller performance	Troubleshoot
	Incorrect energy consumption metering	Find the reason and fix it.
2. Energy consumption is intolerably high	If it is not for the items in "1", then it may be due to the too high ambient temperature in summer or too low temperature in winter, or energy prices may be excessively high.	If there are cheaper energy sources like natural gas or waste heat, replace current energy source (for example, change oil to gas)
		Select the mode of "High Energy Saving Mode" or "Medium Energy Saving Mode"
		Adjust the temperature of all indoor units 2 to 3 °C higher (lower)
		Stop some indoor units which are running unnecessarily
		Reduce the flow rate of fresh air (If there is a fresh air system)
		Conduct intensive training on energy saving and collect energy saving proposals, including heat insulation enhancement and reducing the use of heat radiating equipment, etc.
3. There is a difference between the amount of fuel consumed and fuel purchased	If not for the items in "1", then there is a problem with the fuel meter.	Require the fuel supply company to change to a calibrated meter or send the meter for re-calibration.

ENERGY SAVING MANAGEMENT

ENERGY SAVING MANAGEMENT FOR CHILLER

NO.	Items	Methods	Effect
1	Scientific maintenance	Do maintenance work strictly according to periodic maintenance and load maintenance requirements	Ensure that the chiller is always in the highest efficiency under all conditions
2	Choose an appropriate energy source	Choose waste heat such as waste steam, exhaust, etc	Recycle waste energy to save fuel costs
3	Lower the cooling water inlet temperature	If the chiller can be guaranteed to run in a stable fashion, keep the cooling water inlet temperature between 26 and 28 °C	Improve COP by 5% ~ 6% when the cooling water inlet temperature is 1 °C lower
4	Keep the chiller running continuously	If the stop time of the chiller is less than 3 hours, it is recommended to keep the chiller running	Achieve greater reliability, higher efficiency and more stable burner combustion by running chiller continuously at partial load
5	Scientifically adjust the chilled/ heating water outlet temperature	If the room can be maintained at a comfortable temperature, then set the chilled water outlet temperature higher in summer and heating water outlet temperature lower in winter	Improve chiller efficiency with higher chilled water outlet temperature or lower heating water outlet temperature
6	Select "Energy" Saving Mode	Refer to P6 "Energy Saving Setting"	The same as above
7	Strengthen water quality management	Refer to P22 "AC, Hot Water Quality and Fouling" and P23 "Cooling Water Quality and Fouling"	Ensure high heat exchanging efficiency

SYSTEM ENERGY-SAVING MANAGEMENT

NO.	Item	Method	Effect
1	Use inverter control for cooling water pump and cooling fan	Add inverters for cooling water pump and cooling tower fan and get them linkage controlled with the chiller. This will also help to maintain cooling water temperature	Save 50% to 70% electricity consumption, which amounts to 12% to 20% of the total running cost of chiller and system
2	The customer who needs cooling in winter can get cooling from the cooling tower	Introduce a plate heat exchanger between the chilled water system and cooling water system	Get cooling without running the chiller. Economical, safe and reliable
3	Use simple piping	Use a low resistance valve (e.g. butterfly valve) rather than a high resistance valve (e.g. shut off valve). Use zero resistance filters. Use elbows with big radius. Remove all unnecessary valves and pipe fittings	Reduce resistance and heat loss
4	Design a reasonable fresh air system with a heat recovery device. Establish a complete fresh air and exhaust air management system	Design a linkage controlled adjustable air damper for fresh and return air, and control the fresh air ratio through an enthalpy controller, so that the fresh air flow can be adjusted. Install a heat recovery device on the fresh air system	The reasonably designed fresh air system can effectively delay the start and pre-stop of the chiller, reduce the load and running time of chiller and reduce energy consumption
5	Install a motorized/ solenoid valve and heat meter for indoor units	Choose or add indoor units, which are equipped with motorized/ solenoid valves and heat meters, such as BROAD indoor units	Shut off different indoor units on time to reduce heat loss and improve behavioral energy saving consciousness
6	Install automatic speed/ temperature adjustment equipment for indoor units	Choose indoor units which have automatic speed / temperature adjustment functions	Control the room temperature to avoid excessive cooling in summer or excessive heating in winter; comfortable and also energy saving
7	Use variable flow air supply for indoor units	Air flow is changeable according to load changes in the room.	Reduce electricity consumption
8	Energy computation management	Calculate the fuel and electricity consumption of indoor units separately, and implement strict supervision mechanisms	Reduce energy consumption by 10% to 20%

cont.

NO.	Item	Method	Effect
9	Ensure insulation of the whole system is in good condition	Check the insulation periodically	Avoids energy loss and equipment damage from poor insulation performance
10	Avoid leakage of water pipes	Check the pipes periodically	Save water and energy
11	Cycling mode of water system	Closed circuit is recommended	Reduce electricity consumption, help anticorrosion and anti-scaling and extend life span of pipes
12	Distribute cooling (heating) load reasonably	The water supplying temperature can be lowered and flow rate increased if the temperature humidity requirement is low in the room, and vice versa. Adjust the fresh air rate according to different requirements and clean the air filters periodically.	Avoid unreasonable energy waste
13	Divide water pumps into different sections	Arrange pumps according to different pressure drop areas. For example, separately design closed loops for high-level areas and low-level areas.	Avoid excessive pressure loss in the low-level area, and reduce unnecessary water pump use
14	Reasonable air duct system	Choose reasonable air duct size according to economical air speeds, avoid air leakage of equipment or air ducts, avoid air "short-circuit" between supply and return air and clean the air ducts on time	Avoid unreasonable energy loss during air transportation
15	Ensure all equipment is well maintained	Solve equipment problems on time	Avoid increased energy consumption
16	Eliminate heat generated by room lights by utilizing a return air system	Install air return windows above the lights so that the heat of the lights will be taken off by the return air	Reduces the room load so that the air supply can be reduced and power for air supply can also be reduced
17	Manage doors and windows strictly	Prohibit the opening of doors and windows when the air conditioning system is working. Use an infrared ray sensing automatic door, and also the door curtain	Avoid heat loss
18	Use a cold-light or natural-light system	Install energy efficient lights.	Reduce indoor load
19	Improve the thermodynamic performance of the building	Reduce the area of windows. Use vacuum heat-insulated glass or film plated reflecting glass in the windows. Use sealing bar and heat insulating window curtains. Use a screen on the building roof. Use heat insulation materials with good performance on heat reflecting for outdoor envelope	Reduce indoor load
20	Use 100% automatic and intelligent control for air conditioning system	The air conditioning system will adjust all equipment according to load, so that best performance is achieved at all times	Heavy energy waste due to poor operations will be avoided
21	Lower indoor temperature and humidity standards	Summer: No less than 26 °C, humidity 40% to 60% Winter: No higher than 20 °C, humidity ≥ 35%	When the indoor temperature is adjusted from 26 °Cto 28 °C in summer, the cooling load can be reduced by 20% When the indoor temperature is adjusted from 20 °Cto 18 °C, the cooling load can be reduced by 30%
22	Clean all kinds of filters in the air conditioning system periodically	The filters of the cooling water system and fuel system should be cleaned at least every 3 months. The filters of the chilled (heating) water system, and indoor units should be cleaned at least every one year or less. The cleaning interval should be shortened if the system is new, depending on water quality material of ducting, etc.	Avoid low heat transfer efficiency

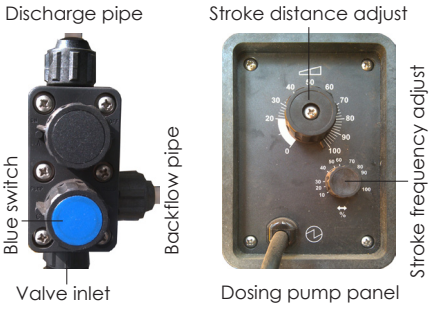
AUTO DOSING DEVICE

Start

a. Pump head injection

Anti-fouling pump head and bacteria-kill pump head were discharged before shipment, so it is needed to inject it before it starts to work at site.

1. Dismantle 4-function valve and take off the valve ball, fill the pump head with water, then assemble the valve.
2. Start anti-fouling pump and sterilization pump on "Commissioning interface" of chiller operation screen.
3. Switch the stroke distance and frequency to 100% mark when pump is working.
4. Rotate blue 4-function valve by 1/4 circle clockwise to drain out the air in pipes.
5. Suck pipe starts sucking liquid medicine.
6. Rotate the blue button anticlockwise by 1/4 circle to close the pump after liquid medicine flows out from the backflow pipe of 4-function valve.
7. Adjust output flow rate.



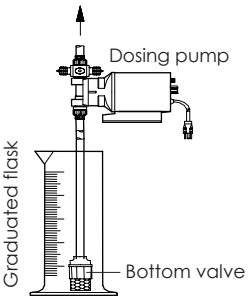
b. Output flow rate adjustment

Stroke distance adjust switch and frequency adjust switch on anti-fouling and sterilization pump panel are for flow rate adjustment. Rotate clockwise to increase flow rate percentage.

Output flow rate = max. output flow rate × set value.

c. Demarcate

1. Put dosing pump suction pipe and bottom valve into a container(capacity about 1000ml) as shown in the picture on the right.
2. Start the pump to venting the air in pump head and suction pipe.
3. Turn off the pump and record the original solution level.
4. Start the pump and run it for some time and count the stroke quantity (at least 50 strokes, every sound "Ka" means 1 stroke. The longer the pump operates, the more accurate the result is)
5. Stop the pump, record the time and output volume, then calculate output per second(ml/s), inserts the result to "Dosing speed" on operation screen.
6. If there is deviation of output value, adjust the flow rate switch on the adjustment panel(Normally adjust stroke distance). Repeat step 3~5 till the output matches the requirement.



Demarcating drawing

USE

a. Put the medicine (Shipped together with chiller) into anti-fouling tank (white) and sterilization tank (yellow).

b. Make sure dosing pump inlet/outlet pipe tightly connected to the connector. Insert backflow pipe into dosing tank and fix it, do not immerse pipe connector into the solution.

c. Set manual dosing time, dosing concentration, dosing speed, dosing internal time through water system specifications on chiller operation screen.

Set dosing concentration according to cooling water hardness:

Hardness		>120mg/l	60~120mg/l	<60mg/l
concentration	Anti-fouling agent	60ml/m^3	50ml/m^3	40ml/m^3
	Bacteriacide	Normally set 100ml/m^3		

Manual dosing time set according to cooling water pipe and cooling tower water storage quantity and dosing speed.

Dosing time(s)=cooling water storage quantity(m^3) × dosing concentration(ml/m^3) ÷ dosing speed(ml/s)

MAINTENANCE

a. Dosing tank cleaning

1. Release pressure of the dosing pump and outlet pipe
   · Confirm the injection valve is installed correctly and in working condition.
   · Rotate the blue knob of the 4-function valve by 1/4 circle and vent the air in the outlet pipe until the solution flows from the return pipe to the brine tank.
2. Cleaning of corrosion inhibitor & anti-sludge agent tank
   · Open the discharge valve at the bottom of the chemical tank, expel the residues and rinse with clean water until it is clean.
   · Close the discharge valve, open the lid at the top of chemical tank and add the proper amount of chemicals to the box.
   · Fill chemicals to the level of the pump head then put into operation.
3. Cleaning of the biocide tank
   · Loosen the suction pipe and take out the bottom valve and clean it.
   · Loosen the fixed ring, take out the chemical tank, expel out the residues and clean it with clean water.
   · Reassemble the chemical tank, bottom valve and suck pipe.
   · Add liquid chemical to the tank from the opening of chemical tank.
   · Inject the biocide at pump head and put it into operation.

b. Replacement of spare parts

1. Membrane replacement.
   · After pressure releases of the outlet pipe, drain and take out one end of the discharge pipe. Put the end valve into the clean water, start the pumps, wash the pump head and then lift the valve off the liquid and continue to run the pumps until the pump head is filled with air. If the membrane is broken, the pump will stop working.
   · Put on latex gloves, remove the inlet and outlet pipes carefully, remove the four screws on the pump head then submerge the pump head in water or neutral solution.
   · Adjust the flow to zero, and then stop it.
   · Seize the edge of membrane carefully, loose it anticlockwise and remove the membrane and the disc on the back of membrane (if any). Check if the size code of the new membrane is in line with the old membrane.
   · Fit on the new membrane and disc; align its orientation line to the hollow of the EPU. Note: Do not scratch the surface of the TEFLON.
   · Start the pump; recover the flow knob setting. When the pump is running, tighten the new membrane clockwise until its center locks inwards closely, then stop the pump.
   · Seize the edge of membrane carefully; rotate its center to align with the brim of Spacer.
   · Load the membrane, put the pump head back into the original place. Check that the screws are still tight after one week.
2. Replace seals, ball valve and injection valve spring.
   · Clean the pump head with clean water and remove it after draining out.
   · Remove the pipe joints, the damaged seals and the ball valve. (Pay attention to the front/back side and position sequence).
   · Fit on the new ring and ball valve.
   · Fit a new injection valve spring.

c. Antifreeze in winter

If temperature in machine room is possibly lower than 0 dgr., then wash the dosing pump head & pipes and drain out, to prevent it from freezing and cracking

Fault and troubleshooting

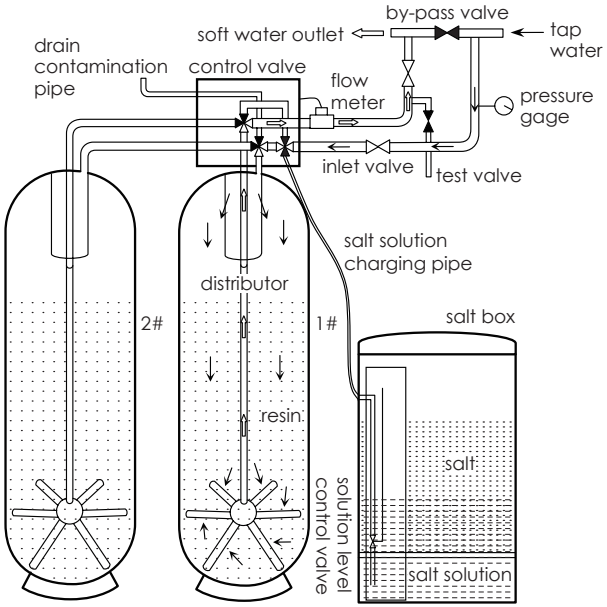
NO.	Phenomenon	Reason	Solution
1	Pump head unable to injection automatically	Pump is turned off or not powered	Turn on the pump or connect it to the power on the touch screen.
		Improper output flow rate	Set flow rate to 100% while injecting pump
		Bottom valve doesn't stand on dosing tank bottom vertically	Make bottom valve stand on dosing tank vertically, straighten the suck pipe
		Connection seal ring distortion causes leakage	Replace seal ring, and tighten the connection properly
		Suck pipe leakage or air discharge incompletely	Check if there is any split, make the suck pipe vertical and vent the air completely
2	Output flow rate too small or pump doesn't work under pressure	Rated pump pressure is lower than injection pipe pressure	Injection pipe pressure should be lower than rated pump pressure
		Seal ring damaged	Replace seal ring
		Dissepiments split	Replace of dissepiments
		Stroke distance set improperly	Check and adjust the pump to 0 position
		Bottom valve filter jam	Take protection measures and clean the filter
3	Output flow rate too large	4-functions valve abnormal, and low pressure of injection point	Check 4-function valve, set the injection point pressure to be > 0.2MPa
		Stroke with high frequency	Replace of the impulse generator or resistance
4	Can't work	Pump is turned off or not powered	Turn on the pump or input power
		Pump electromagnetism device failure	Check electromagnetism device, and check if it groundings
		Impulse generator failure	If the driver electrical circuit works well, then replace impulse generator

WATER SOFTENER

Principle
Ion exchange principle

Softening
The Ca^{2+}, Mg^{2+} metal ions in tap water is absorbed by resin layer in resin tank, and releases Na^{+} and produces softening water.

Regeneration
After the resin becomes saturated, the control valve will automatically use the brine y water in brine tank to wash the resin layer to replace the Ca^{2+}, Mg^{2+} and drain out, then the resin get recovered.



Start

a. Wash inlet and outlet pipes: turn off softener inlet&outlet valve and bypass valve, open drain valve on outlet pipe, wash the pipe till it's clean then close the drain valve and bypass valve.
b. Check the brine tank: when starting it for the First time, please add water to empty brine tank till the water level is 30mm higher than brine y board (water input automatically after operation),and add industrial brine (NaCl) till it reaches 2/3 of tank (Make sure the brine remains more than 1/3 of the tank capacity).
c. Discharge the air in resin tank: Make sure the control valve is working normally, turn on power, open inlet valve, inject water to tank. Close inlet valve after water stop running, rotate the manual regeneration tray (refer to flow rate controller drawing), and adjust the control valve to "reverse washing program" position(refer to regeneration controller drawing) to release pressure, then open inlet valve slowly to drain out the air in tank. Repeat the process on the other tank to vent out the air.
d. Total flow rate setting: softening water output from the softener between 2 regenerations.(unit: ton)

1. Formula for calculating the water output: 25×resin quantity (L)÷hardness of source water(mg $CaCO_3$/L)
2. Reference value for water output:

Model type	Resin total quantity (L)	Total flow rate(t) Inlet water hardness (mg $CaCO_3$/L)					
		150	200	250	300	350	400
BRS-2	150	25	19	15	13	11	9
BY75~100	200	42	31	25	21	18	16
BY125~150	450	75	56	45	38	32	28
BRS-6							
BY200	650	108	81	65	54	46	41
BY250	700	117	88	70	58	50	44
BRS-10							
BY300~400	1050	175	131	105	88	75	66
BY500~600	1550	258	194	155	129	111	97
BRS-20							

NOTES: BY matches package chiller machine room, shipment with pipes .BRS for non-packaged chiller machine room, shipment without pipes.

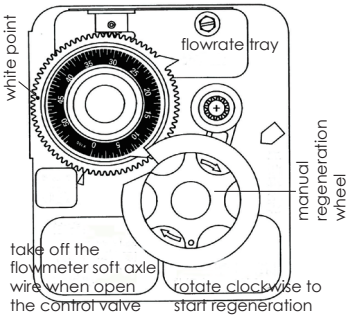
3. Setting: Pull out the flow rate tray, rotate it and make the white point on the tray targeting to set flowrate value and then loose the button to original position. Regeneration will start automatically when the tray point to settled value position.

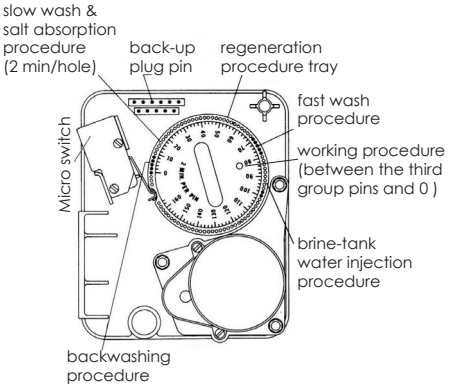
e. Regeneration time setting:
Rotate regeneration button clock wise and make the micro-adjustment switch points to 0 position, the regeneration will start automatically after a sound(refer to regeneration controller drawing). Regeneration time is set in factory, but can be reset according to user's demand and local conditions.

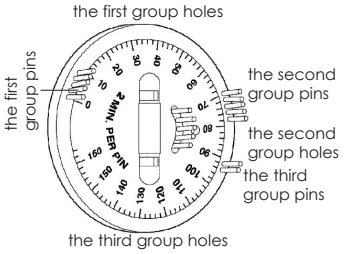
1. Backwashing time setting: The first group of pins decide backwashing time, and the time is changed by increasing or decreasing number of pins.
2. Brine-suction & slow-wash time setting: The first group holes decide brine –suction & slow -wash time, and the time is changed by changing the hole number.
3. Fast-wash time setting: The second group pins decide the fast-wash time, Change time by changing pin position. Usually backwashing & fast-wash time is set to be 10 minutes, decreased by 2 minutes when water inlet pressure ≥0.5Mpa.
4. Brine tank water-adding time setting: The second group holes decide water input time. Change the time by moving the third group pin to change the number of second group holes.

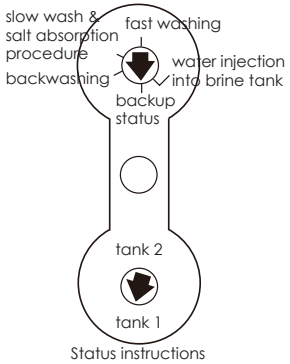
Model type	Slow-wash time (min)		Water-input time (min)	
	Tap water pressure(MPa)		Tap water pressure(MPa)	
	0.2~0.4	0.4~0.6	0.2~0.4	0.4~0.6
BRS-2	≥30	≥24	8	6
BY75~100	≥48	≥38	12	10
BY125~150	≥46	≥40	10	8
BRS-6				
BY200	≥44	≥38	10	8
BY250	≥48	≥40	12	10
BRS-10				
BY300~400	≥64	≥50	10	8
BY500~600	≥72	≥52	8	6
BRS-20				

Open the cover of control valve, there is an instructor on the right side. Bottom arrow instructs water supply tank, top arrow instructs another tank situation. Left side drawing shows NO. 1 tank is supplying water and NO. 2 tank is for backup.









Application

a. Open the cover of control valve and make sure the manual regeneration gear already turned back to "work" position, regeneration procedure set as well.
b. Make sure that, the total flow rate has been set correctly(set flowrate equals the calculated periodic water production quantity minus the necessary remaining water quantity) and make sure the flow meter flexible axle inserted into flow meter already.
c. Make sure the quantity of brine in brine tank no less than 1/3 of the tank and liquid level is 1/4~1/3 of brine tank
d. Closing bypass valve, testing valve, open inlet/outlet valve, softener starts to work.
e. At the beginning of operation, the inspection of water quality should be strengthened. According to in/out water quality and variation to adjust the regeneration procedure's time and flow rate etc, in order to make sure the system working at best operation state.

Maintainance

a.Regular checking and period

NO.	Item	Period
1	Check the brine tank, add industrial brine if the bring quantity less than 1/3 of the tank. Iodate brine and fine salt is not allowed, otherwise it will influence the regeneration result and resin's life span.	1month
2	Check and clean inlet filter of softener	
3	Make sure the ambient temperature of softener>0 °C, inlet water temperature lower than 40 °C	
4	Make sure the water pressure lower than 0.6MPa	
5	Check resin tank and resin, and add proper resin	1year
6	Take anti-dehydration and phycomycetes breeding measurements when the softener is left unused	
7	Change water pressure gauge, brine solution safty (safety)valve, water distributor, central tube, components in brine tank and eletronic component	8 years

b.Manually add brine

Because the softener will consume regeneration brine continually, therefore in order to keep softener work at normal condition, sufficient regeneration brine should be manually added in to brine tank, industrial brine only(Brine particles), No iodate brine, fine brine, etc., adding brine is quite simple, just open the brine tank cover and add brine in till it's full.

Model	Different hardness period (mgCaCO3/L)			Brine addition kg/times
	200	300	400	
BY75	25days	17 days	12 days	140
BY100	19 days	12 days	9 days	140
BY125	22 days	14 days	11 days	200
BY150	18 days	12 days	9 days	200
BY200	22 days	14 days	11 days	320
BY250	17 days	11 days	9 days	320
BY300	18 days	12 days	9 days	400
BY400	20 days	13 days	10 days	600
BY500	16 days	11 days	8 days	600
BY600	18 days	12 days	9 days	800
BY800	20 days	13 days	10 days	1200
BY1000	16 days	11 days	8 days	1200

NOTE: Above data is calculated on condition that the cooling operation functions 10hours/day.

c. Add resin

About 5%~10% resin will be consumed every year, so resin should be added in time.
1. Close inlet/outlet valve of softener
2. Open softener drain valve to drain out the residual water.
3. Loosen the flexible connection on control valve's outlet/inlet pipe and screw off the control valve
4. Add proper resin into control valve installation hole, and avoid the resin enter into central tube.
5. Fix the control valve and inlet/outlet pipe.

d. Anti-freeze in winter

1. When the temperature in machine room is lower than 0°C or the softener is left unused for a long time, it is necessary to regenerate the resin, then fill the tank with brine after washing(Replace the brine when start it next time) to avoid resin dehydration, phycomycetes breeding and freeze.
2. Drain out all the water in softener pipe when doing the anti-freeze.

Faults and troubleshooting

NO.	Fault phenomenon	Reasons	Troubleshooting
1	Softener irregeneration (Regeneration)	a. Power fault b. Timer fault	a. Check and troubleshoot b. Change the timer
2	Softener invalidation	a. Bypass valve not shutdown b. No brine in Brine tank c. Insufficient of water d. Leakage of Central tube e. Valve inside leakage f. Actual softener working output capacity is lower than flowrate set value g. Procedure gear doesn't work while Flowrate output h. Flowmeter doesn't work i. Control valve not in working position	a. Close bypass valve b. Add brine into the brine tank to keep brine level above the water level c. Check the water-injection time and clean brine adsorption device d. Check and replace the seal ring, water distributor and central tube. e. Replace seal ring, gasket and piston f. Check brine consumption, calculate the periodic water output and adjust it . g. Extract soft axis from flowmeter, rotating flow tray should be rotated flexibly. (Regeneration procedure under operation). When it comes to the halt position of regeneration, coupling button will clickety-clack, otherwise fix or replace it. h. Check whether the front gear of timer works well. i. Check drive motor and switch
3	Over consumption of brine	a. Improper use of brine b. Excessive water in brine tank	a. Check the brine quality and brine-absorption setting b. Refer to Q. 4
4	Excessive Water in brine tank	a. Block of draining& current limiter b. Timer out of work c. Dirt in brine tube and valve d. Power failure during absorption	a. Clean draining& current limiter b. Replace timer c. Clean brine valve, tube and replace the bottom of brine valve d. Check the power
5	Brine absorption failure	a. Block of draining& current limiter b. Brine absorption pressure too low c. Valve inside leakage	a. Clean draining tube and current limiter b. Increase the tap water pressure to be above 0.2 MPa c. Replace seal ring, gasket and piston
6	Draining doesn't stop	a. Control valve set improperly b. Dirt inside the valve c. Valve inside leakage	a. Check the position of timer procedure and control valve. Replace the control valve parts if the position is incorrect. b. Clean the dirt, and check whether the valve functions well in regeneration. c. Replace seal ring, gasket and piston
7	Huge loss of water pressure	a. Block of softener inlet pipe b. Irony stuff piles up inside softener c. Block of control valve inlet	a. Clean filter and pipe b. Clean control valve and add cleaning agent into resin layer to increase regeneration frequency c. Remove the piston and clean control valve
8	Resin flows away through draining pipe	a. There is air inside the system b. Draining& current limiter improper	a. Make sure the air check valve in brine pit functions well b. Replace draining& current limiter
9	Softened water has irony stuff	Resin layer is contaminated	Check backwashing, brine absorption and water injection in brine tank to increase regeneration frequency
10	Regeneration functions repeatedly	Micro switch failure or short circuit	Replace the switch or timer if they fails to work, or replace the whole controller if the problem remains.

SERVICE RESPONSIBILITY

Maintenance and operation of central air conditioning should be conducted by BROAD service engineer and user's operator.

a. BROAD service engineer
Givesguidance for lifting, installation, checking and accepting the chiller; takes care ofthe operation, repairing, maintenance, and energy-saving operational guidance of the chiller

b. Operator
Assists the service engineer; takes care of the operation, simple maintenance and energy-saving operation of the chiller and system.

c. Senior operator
Assists the service engineer; takes care of the operation, maintenance, simple trouble-shooting; manages and instructs operator on energy-saving work.

d. Operation engineer
Instructs lifting, installation, checking and accepting the chiller; takes care of the commissioning, operating, maintenance, common trouble-shooting; manages and instructs energy-saving work.

WARRANTY SERVICE AND PAID SERVICE

a. Warranty service

1. Warranty period
   18 months from the shipment date or 12 months from the commissioning date, whichever comes first.
2. Appointment of the responsible engineer
   After receiving the Contract Technical Sheet, BROAD Overseas Service Branch shall appoint a responsible service engineer accordingly within 15 days.
3. Check & lift & transportation tips
   - The BROAD service engineer, together with the user, should confirm the dimensions and accessibility of the machine room. If anything abnormal happens, BROAD will inform the user in written form and discuss with the user to find a solution.
   - When the chiller arrives at the jobsite, BROAD service engineer can give guidance for checking and accepting the chiller at site or through telephone.
   - A BROAD service engineer should inform the user of any important information regarding lifting.
4. Installation guidance
   - A BROAD service engineer shall put forward to the users the machine room installation and management requirements. If necessary, BROAD can organize the user, installer and designer to visit the BROAD standard machine room and share the experiences of the user.
   - A BROAD service engineer should help the user to check if the machine room installation drawing conforms to national codes and BROAD catalogue requirements, and offer written advice in this regard.
5. Jobsite commissioning
   - A BROAD service engineer checks the user's system against the "System Check & Accept Form" and conducts the commissioning for the chillers which pass the reception check; for user's systems which fail the check and accept process, a BROAD engineer will issue a written rectification requirement document. Commissioning cannot be done until the commissioning requirements are met. After the commissioning, the BROAD service engineer hands over the chiller management to the user.
6. Training
   Training is divided into 2 types:Training in BROAD Town or training on jobsite.
   - Centralization training in BROAD town will be done by BROAD engineering institute, the training has three levels, operator, senior operator, operating engineer.
   - BROAD service engineer shall train operators at jobsite about onsite operation, maintenance, energy saving and management during commissioning or maintenance.
   - Operators who have already received BROAD training and obtained the qualification can operate the chiller independently.
   - Centralization training process
   - BROAD Training Statistic Notice → Feedback → Training Registration Notice → Training → Training evaluation → Get level qualification/ Credit certificate/Training certificate
   - After Centralization training finished, only the people who get all credits and the performance (such as discipline, study attitude) is excellent can get the level certificate. Those who do not get all credits, but have good performance can get training credit certificate, and after they get the rest credits, they can get the level certificate. If anyone can not get any credits or the performance is bad, then they can onlyget the training certificate.
7. Maintenance
   - BROAD bears the materials, labor and travel costs during the warranty period. During the life-span of the chiller, BROAD's service engineer will offer free energy-saving advice.
   - Any costs incurred due to the user damaging the chiller (for example the fuel, power and auxiliary devices and man-made damage) or force majeure (for example typhoon, earthquake, flood and war) shall be borne by the user.

b. Paid service

Service after the warranty period or for users, unless under some specific clauses, belongs to the paid service category. BROAD service engineers shall issue a "Warranty Service Expiration Notice" to the user 1~2 months before the warranty period expires.

For payment service, the user has the following options:

1. Signing of the annual payment service agreement:
   - After the warranty period, the user is recommended to sign an annual service agreement with BROAD. The period can be between 1 and 5 years. The agreement should be in standard format and stamped.
   - Charge policy: The expense standard depends on the size, function, amount and age of the chiller. The "Annual Service Agreement" should cover periodical maintenance, trouble shooting and some other service work.
2. Technology upgrading
   In order to create more value for the customer, BROAD will inform the customer of the latest technical achievements so that the customer can decide whether or not to upgrade his chiller; if the user has the intention, they can sign the "Single Agreement" with BROAD.
3. Spare parts ordering
   The users can sign the "Single Agreement" to buy spare parts from BROAD. Under this agreement, if after the warranty period the part that was replaced causes a problem, BROAD will offer free service to that part within three months of the original date of purchase of the part.

c. Limited declaration

Excluding the responsibilities which are clearly outlined above, BROAD will not take responsibilities for any direct, indirect, special or attached damages.

d. Service disciplines

It is prohibited for a BROAD service engineer to charge the users privately or make money by selling products from other companies; otherwise, the service engineer will be charged with corruption and cheating and bear the corresponding legal and economic liability.

e. Service requirements and standards

Requirement	Standard
Routine maintenance and spare parts replacement	Strictly follow the requirements for the load maintenance and routine maintenance;
Maintenance quality	Ensure that the performance and cleanliness of the chiller after maintenance is just like that of the new chiller; non-stop operation should also be guaranteed;
Response time	Where there is a BROAD local service branch, BROAD service engineers should reach the jobsite within 6 hours for the users inside the city and 12 hours outside the city (with the agreement of the user, two parts can appoint the time);
Service Quality Feedback	1. Routine telephone return visit from BROAD headquarter 2. BROAD customer routine visit 3. 24 hours hot line service: 0731-84611352 4. Email:yz@broad.net

Contact

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The United States	001-2016783010 / 001-2016783011(F)	Yangdezhi@broadusa.com
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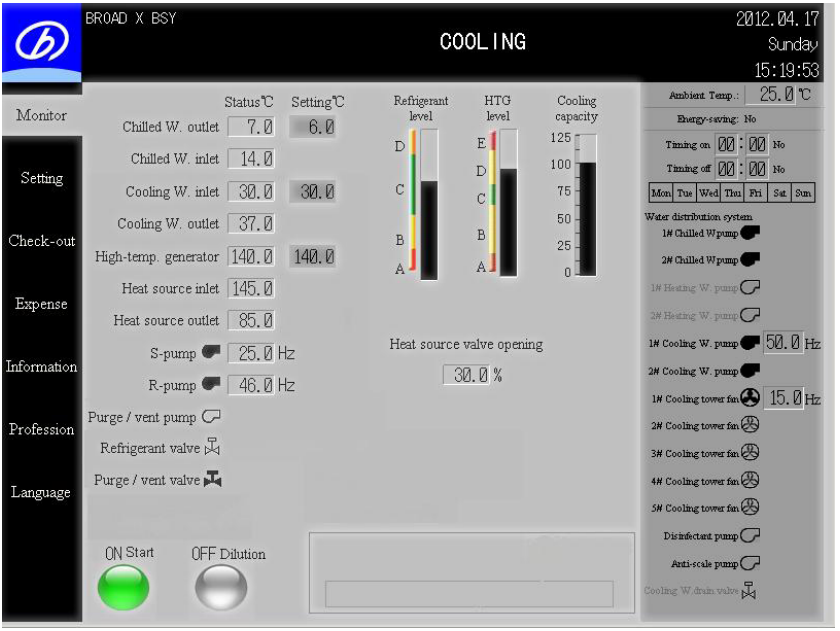
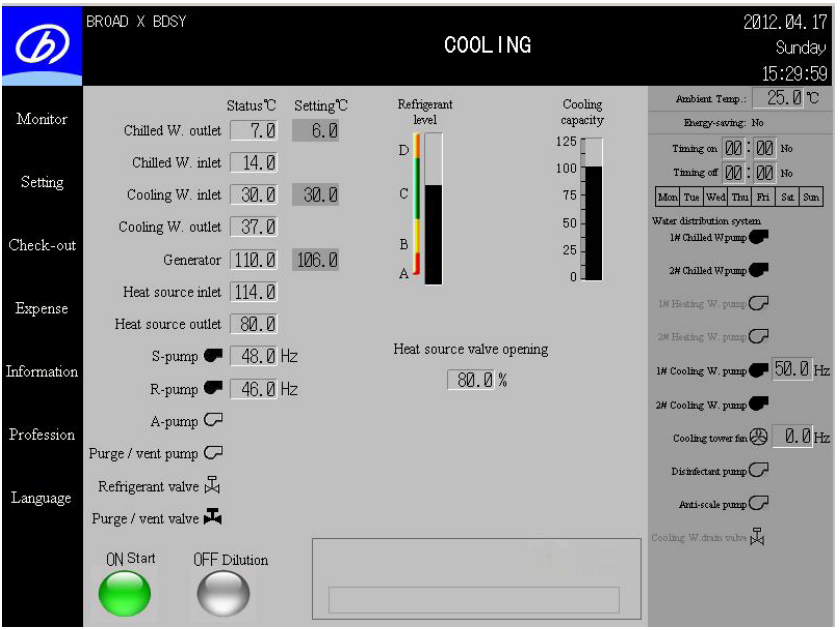
IFA MAIN INTERFACE

DOUBLE STAGE STEAM CHILLER MAIN INTERFACE



SINGLE STAGE STEAM CHILLER MAIN INTERFACE



IFA SAFTY REGULATIONS

OPERATION

1. **When the chiller is started for cooling operation, the chilled water pump must be started before the cooling water pump. If the chilled water pump stops, the cooling water pump must be stopped prior to the chilled water pump. Otherwise copper tubes will get frozen.**
   Although the On/Off sequence of "Auto Control" mode is set out in the above mentioned requirements, a reconfirmation is needed once every 3 months in case of any accidents like incorrect connection of cables or software viruses occur.

2. **Random adjustment of solution concentration regulating valves is prohibited.**
   Otherwise it will cause crystallization, reduce cooling capacity and waste energy.

3. **Manually drain condensed water in heating source pipe before starting the chiller. Close manual valves on heating source pipe before chiller dilution off.**
   This will prevent water from leaking into the chiller when the pressure in the heating water pipe is too high.

CONTROL

1. **Anti-freezing protection for the chilled water tubes must be strictly carried out.**
   BROAD's requirement of the 3-stage protection and interlock electrical diagram of the chilled/heating water system must be followed to avoid poor operation, otherwise tubes will be frozen. The 3-stage protection should be checked every quarter.

2. **The chiller must be started by "Auto Control".**
   There are some protection procedures under "Commissioning Mode", but they can be used only under the supervision of professionals, otherwise serious failure will occur.

3. **Safety devices cannot be short-circuited nor can their settings can be changed at will.**
   Before the cooling period begins, all the safety devices must be calibrated, especially the chilled water flow switches, temperature sensors and HTG pressure controllers; otherwise the copper tubes may become frozen and serious personal injuries may occur.

4. **Power supply must be correct and voltage must be stable.**
   Voltage fluctuation must be within 10% of the rated value. A dedicated grounding wire must be available in the machine room. At least a 6.0 mm2 wire must be adopted as the grounding wire, and the grounding resistance should be ≤4Ω; otherwise, it will damage the electrical components and control system or even cause personal injuries.

5. **The electric wire must be reliable.**
   If the electric wire is damaged, the wire should be replaced by a professional to ensure safety.

6. **The chiller must be on line 24/7/365.**
   To ensure collecting the data and monitoring the chiller, the chiller must be on line 24/7/365. Otherwise the BROAD monitoring center will not know if the chiller is working normally. If the chiller is to be stopped for more than 3 months, BROAD monitoring center must be informed before power-off.

7. **Computing data must be set correctly.**
   If the data is wrong, it will cause unexpected chiller shut-off and affect the user's energy management.

HEAT SOURCE

1. **The heat source should not have corroding components.**
   Otherwise it will corrode the heat exchange pipes in generator, even bore a hole and causes huge loss.

2. **The heat source pressure and temperature should be stable.**
   The pressure fluctuation range should be within ±0.02MPa of the rated value, and the working pressure and temperature should be less than 10% of the rated value. Stable equipment should be installed (offered by the users) at inlet of the heat resource.

3. **If the chiller is shut down for over 2 hours, the manual valve on the heat source pipe should be closed.**
   To prevent the solution crystallization and other accidents occurs because of high pressure leakage of heat source.

IFA SAFTY REGULATIONS

VACUUM AND LIFE-SPAN

1. Confirm the vacuum conditions and good condition of auto purge and vent device according to the "Vacuum Management Regulations".

2. Prevent others from handling the vacuum valve randomly.
The handle of the vacuum valve must be removed and well kept after operation to avoid unauthorized access.

3. Conduct chiller shut-off management with care.
If the expected shut-off is over 8 months, it should be charged with 0.01 mpa ~ 0.02 mpa high-purity nitrogen(purity > 99.995%).

4. Use only BROAD solution; it is forbidden to use solution regenerated by others.
It is required to sample the solution and test it once a year, and The solution should be fully circulated and diluted before sampling. If the result can't come out at site or the user needs a more detailed report, sample solution with special bottles and send it to the BROAD lab., and fill the label on the bottle correctly. BROAD will confirm the vacuum and rust condition of the copper tubes and steel material to ensure 25-year life span. The solutions need not be taken out for regeneration. If it is too feculent, it can be filtered with the BROAD precise Regenerator without stopping the unit and free of charge. If the solution is regenerated by others, BROAD will not be responsible for the unit any more.

5. Without BROAD's written permission, it is forbidden to clean the copper tubes with chemicals.
If the chemicals are not property used and the cleaning is not strictly controlled or the chemicals are not drained completely, it will seriously corrode the copper tubes, affect the life-span and even destroy the chiller.

6. Strengthen water quality management.
An auto water quality stabilizer charging device should be installed (auto dosing of biocide and anti-sludging agent). Analyze water quality at least once every 3 months and select the appropriate anti-sludging agent according to this result. Quality of make-up cooling water should meet the quality standard of city water. Poor water quality will cause more energy consumption, reduce cooling capacity and result in corrosion of copper tubes, or even destroy the chiller.

OTHERS

1. It is forbidden for the piping system to be vibrated or chiller to bear any external forces. Otherwise it may affect the chiller's life-span, or even damage the chiller.

2. The chiller must be well kept.
The doors and windows of the machine room must be installed with firm locks and balusters. No access to unauthorized persons. The shipped spare parts and documents should be well kept.

3. Users should install lightning protection themselves.

4. Humidity of machine room should be less than 85% with temperature ranging from 5 °Cto43 °C.
If the temperature in the machine room is lower than 0 °C, the inlets and outlets of the chilled water and cooling water system should be closed. Drain valves should be opened (if conditions permit, it is better to add antifreeze instead of draining the water to avoid rust in the copper tube), otherwise the copper tube will freeze. If the temperature in the machine room is over 32 °C, the machine room ventilation and control cabinet cooling must be improved. If the temperature is over 43 °C, electrical components will be destroyed in hours and serious damage will occur to the chiller.

5. The chiller should be installed at an elevation less than 1000 meter. Transportation and storage temperature should be between -25-55 °C.

6. Maintain, operate and commission the chiller strictly following the User's Manual and Service File.

NOTE: This regulation is applicable to BSY, BDSY, BHY, BDHY.

IFA TROUBLE-SHOOTINGS

Faults	Phenomenon	Causes	Keys
Steam/ Heat source water inlet/ Exhaust inlet/Condensate/ Heat source water outlet/Exhaust outlet/Generator temperature sensor fault	The chiller continues to run and the touch screen reminds corresponding temperature sensor faults	a. Temperature module damaged b. Break/short circuit c. Temperature sensor damaged	a. Replace b. Check temperature sensor wiring c. Replace
Heat source valve fault	The chiller continues to run and the touch screen displays corresponding valve faults	a. Poor connection of valve feedback contact b. Loose wiring of valve feedback circuit c. Valve actuator fault	a. Adjust to make reliable b. Repair c. Repair or replace
Condensate over-temperature	The chiller continues in normal operation	a. Condensate temperature upper limit setting too low b. Solution circulation in condensate heat exchanger too low c. Steam temperature too high d. Deviation of temperature sensor too big e. Steam trap has malfunctioned	a. Increase the setting * b. Adjust c. Reduce * d. Replace c. Repair
Absorption pump fault	Absorption pump stops. Cooling operation continues and touch screen alarms	a. Pump motor overload protection b. Pump damaged c. Pump blocked	a. Troubleshoot and relieve protection b. Replace absorption pump c. Find the cause and replace
Generator overpressure	Pressure control actuates too close to the heat source valve. The valve re-opens after the pressure control is reset. After 5 occurrences, start-up will automatically turn to “fault alarm”	a. Heat source temperature too high b. Poor internal vacuum c. Pressure control abnormal or setting too low d. Cooling water temperature too high or flow rate too low e. Fouling in cooling water copper tubes	a. Reduce * b. Refer to item 14 of 5.3.3 “Abnormal Reminder” c. Readjust the setting or replace d. Reduce cooling water temperature or increase flow rate e. Descale. The method is subject to BROAD written approval
Generator over-temperature	The heat source valve is closed and re-opened when the generator temperature drops by 10 °C	a. Heat source temperature too high or heat input too high b. Cooling water temperature too high or flow rate too low c. Poor vacuum condition d. Solution circulation too small e. Generator valve close temperature setting too low f. Generator temperature sensor abnormal	a. Reduce heat source temperature or heat input * b. Reduce cooling water temperature or increase flow rate * c. Check vacuum condition and repair leakage d. Adjust solution circulation rate e. Increase the setting f. Replace
Heat source water outlet temperature abnormally high	Normal operation	a. Fouling in HTG or generator copper tubes b. Heat source water flow rate too high	a. Descale. The method is subject to BROAD written permission b. Lower the heat source water temperature or pressure, or reduce the heat source valve opening
Heat source water outlet temperature abnormally high	Normal operation	a. Soot in HTG or generator fire tubes b. Exhaust flow too high	a. Clean soot on time and provide clean exhaust * b. Reduce the exhaust valve opening

 NOTE: “*” indicates the work which can be performed by the user.

SATURATED WATER VAPOR PRESSURE (0~100 ºC)

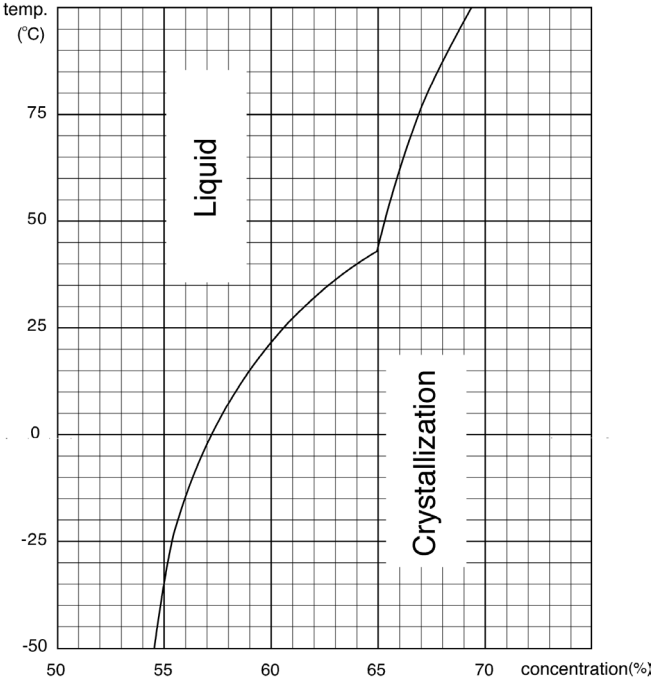
Temp. ºC	Steam Pressure	Temp. ºC	Steam Pressure	Temp. ºC	Steam Pressure	Temp. ºC	Steam Pressure	Temp. ºC	Steam Pressure
0	4.579	21	18.65	42	61.50	63	171.4	84	416.8
1	4.93	22	19.83	43	64.80	64	179.3	85	433.6
2	5.29	23	21.07	44	68.26	65	187.5	86	450.9
3	5.69	24	22.38	45	71.88	66	196.1	87	468.7
4	6.10	25	23.76	46	75.65	67	205.0	88	487.1
5	6.54	26	25.21	47	79.60	68	214.2	89	500.1
6	7.01	27	26.74	48	83.71	69	223.7	90	525.8
7	7.51	28	28.35	49	88.02	70	233.7	91	546.1
8	8.05	29	30.04	50	92.51	71	243.9	92	567.0
9	8.61	30	31.82	51	97.20	72	254.6	93	588.6
10	9.21	31	33.70	52	102.1	73	265.7	94	610.9
11	9.84	32	35.66	53	107.2	74	277.2	95	633.9
12	10.52	33	37.73	54	112.5	75	289.1	96	657.0
13	11.23	34	39.90	55	118.0	76	301.4	97	682.1
14	11.99	35	42.18	56	123.8	77	314.1	98	707.3
15	12.79	36	44.56	57	129.8	78	327.3	99	733.2
16	13.63	37	47.07	58	136.1	79	341.0	100	760.0
17	14.53	38	49.65	59	142.6	80	355.1		
18	15.48	39	52.44	60	149.4	81	369.7		
19	16.48	40	55.32	61	150.4	82	384.9		
20	17.54	41	58.34	62	163.8	83	400.6		

SATURATED STEAM PRESSURE FOR LIBR SOLUTION

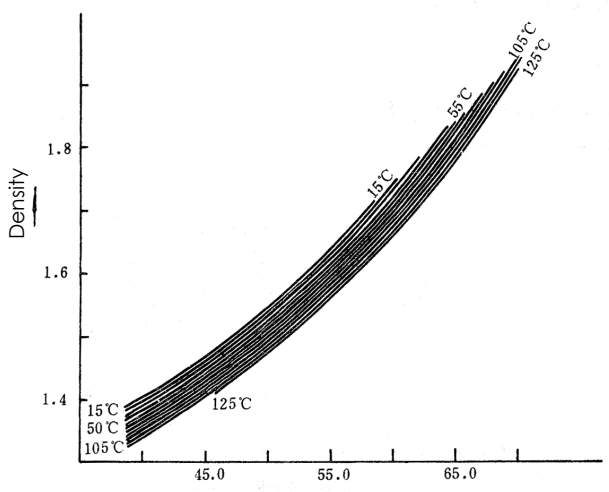
concentration / pressure / temp.	50%	51%	52%	53%	54%	55%	56%	57%	58%	59%	60%	61%	62%	63%	64%	65%
10 °C	2.37	2.09	1.84	1.62	1.42	1.25	1.09									
11 °C	2.60	2.25	1.99	1.73	1.62	1.35	1.18	1.04								
12 °C	2.70	2.38	2.11	1.88	1.72	1.44	1.27	1.12								
13 °C	2.90	2.55	2.26	2.05	1.78	1.55	1.37	1.20	1.05							
14 °C	3.10	2.73	2.42	2.13	1.90	1.67	1.48	1.28	1.15							
15 °C	3.35	2.95	2.61	2.30	2.05	1.81	1.59	1.38	1.24							
16 °C	3.60	3.15	2.81	2.45	2.20	1.93	1.69	1.50	1.33	1.15						
17 °C	3.87	3.35	3. 02	2.65	2.33	2.05	1.81	1.61	1.42	1.25						
18 °C	4.23	3.60	3.20	2.89	2.50	2.19	1.94	1.71	1.52	1.34						
19 °C	4.35	3.85	3.42	3.05	2.65	2.35	2.09	1.85	1.62	1.44						
20 °C	4.70	4.18	3.65	3.25	2.88	2.51	2.22	2.00	1.75	1.56						
21 °C	4.85	4.45	3.95	3.45	3.05	2.72	2.39	2.13	1.88	1.67						
22 °C	5.25	4.70	4.22	3.70	3.25	2.88	2.45	2.24	2.00	1.79						
23 °C	5.65	4.95	4.45	3.95	3.45	3.07	2.65	2.32	2.12	1.90	1.69					
24 °C	5.96	5.35	4.71	4.35	3.70	3.30	2.90	2.50	2.30	2.02	1.80					
25 °C	6.39	5.65	5. 02	4.50	3.95	3.50	3.12	2.65	2.45	2.19	1.92					
26 °C	6.75	6.00	5.35	4.75	4.35	3.73	3.35	2.85	2.63	2.32	2.05					
27 °C	7.23	6.40	5.70	5.18	4.50	3.96	3.55	3.15	2.82	2.50	2.20					
28 °C	7.65	6.75	6. 05	5.45	4.75	4.25	3.80	3.35	3.00	2.65	2.35					
29 °C	8.23	7.35	6.47	5.75	5.15	4.50	4.05	3.57	3.22	2.85	2.55	2.22				
30 °C	8.65	7.65	6.82	6.15	5.39	4.80	4.35	3.82	3.45	3.05	2.72	2.38				
31 °C	8.94	8.15	7.26	6.50	5.80	5.20	4.65	4.15	3.70	3.25	2.85	2.53				
32 °C	9.75	8.65	7.75	6.95	6.25	5.40	4.85	4.36	3.90	3.45	3.05	2.73				
33 °C	10.20	9.23	8.25	7.35	6.60	5.75	5.20	4.65	4.15	3.70	3.25	2.88				
34 °C	11.00	9.84	8.75	7.80	6.98	6.20	5.50	4.90	4.40	3.95	3.50	3.10	2.75			
35 °C	11.75	10.23	9.30	8.35	7.42	6.51	5.85	5.25	4.70	4.20	3.75	3.30	2.90			
36 °C	12.41	11.00	9.80	8.80	7.90	6.95	6.25	5.55	5.00	4.45	3.95	3.52	3.13			
37 °C	13.10	11.78	10.50	9.40	8.42	7.45	6.70	5.85	5.30	4.75	4.20	3.75	3.35			
38 °C	13.95	12.60	11.20	10.00	8.97	7.85	7.15	6.35	5.60	5.15	4.50	4.00	3.45	3.25		
39 °C	14.79	13.15	11.80	10.55	9.50	8.40	7.50	6.65	6.05	5.40	4.75	4.25	3.80	3.45		
40 °C	15.55	14.00	12.50	11.15	10.00	8.90	8.00	7.10	6.40	5.75	5.10	4.65	4.15	3.68		
41 °C	16.30	14.85	13.20	11.80	10.55	9.40	8.50	7.50	6.75	6.15	5.40	4.90	4.30	3.90	3.45	
42 °C	17.20	15.55	14.00	12.50	11.20	9.95	9.00	7.95	7.20	6.50	5.75	5.20	4.65	4.15	3.75	
43 °C	18.30	16.30	14.80	13.20	11.95	10.60	9.50	8.50	7.60	6.85	6.15	5.50	4.85	4.38	3.95	
44 °C	19.50	17.25	15.75	14.05	12.65	11.25	10.00	9.00	8.20	7.30	6.50	5.85	5.25	4.70	4.25	
45 °C	20.72	18.28	16.50	14.85	13.45	11.95	10.70	9.50	8.70	7.75	6.85	6.20	5.60	5.00	4.51	
46 °C	21.70	19.25	17.40	15.70	14.15	12.75	11.25	10.00	9.15	8.20	7.40	6.65	5.95	5.35	4.72	
47 °C	22.75	20.20	18.50	16.50	14.95	13.40	11.85	10.50	9.60	8.70	7.80	7.00	6.30	5.65	5.15	
48 °C	24.00	21.25	19.50	17.50	15.85	14.15	12.65	11.15	10.20	9.20	8.25	7.50	6.70	5.95	5.40	4.85
49 °C	25.20	22.25	20.30	18.50	16.70	14.95	13.20	11.85	10.85	9.75	8.75	7.90	7.15	6.35	5.70	5.20

LIBR SOLUTION PERFORMANCE CURVE

LiBr solution crystallization curve



Libr solution temperature, density and concentration curves



MISSION OF BROAD SERVICE ENGINEERS

The mission of service engineers is to ensure there is no downtime occurring on chiller product even once during its life span, energy efficiency is not lower than 95% of its design level, and air purification function of BROAD terminal remains its high level for lifetime.

To achieve this mission, service engineers should love users and cherish the global environment.All the engineers should understand that if a chiller shuts down, it will cause users a great loss which may even exceed the cost of the chiller; if the energy consumption exceeds the standard, it will not only affect the users'economic interest, but also increase greenhouse gases as well---8 kilogram oil or 15 m3 natural gas or 19 KWH waste per year equal to cutting down a big tree which has annual 18.3kg CO2 absorption capability, Besides, the disabler of purification function will result in great expenses for users to buy purification device--which have more value if the investment used to improve the users'health.All these situations will be completely against the users'expectations on BROAD.

To achieve this mission, service engineers should love BROAD, deeply appreciate the service essence of Broad.Every service engineer should understand that if the downtime, energy waste or purification disablement occurred, not only the BROAD brand which is built by all BROAD staff hardwork will be ruined, but also the trust from BROAD on them.

To achieve this mission, service engineers have to study hard, to master testing, maintaining, energy-saving running and air purifying knowledge, and also consolidate and update these knowledge through annual refresher training.

To achieve this mission, service engineers have to be able to be aware of the defects in product design and manufacturing and also can report to the production department in time. Only if each engineer takes an active part in quality improvement, the products can be developed constantly.

To achieve this mission, service engineers have to work hard rigorously everyday,such as making regular maintainance plan,managing well tools and repair spare part,monitoring the operational condition of chiller, ensuring the precise maintainance and technology upgrade proceed as planned. Avoid any urgent repair after breakdown of chillershave happened or any maintainance after obvious weakening of energy efficiency and purifying capability because no matter how speedy the repair and maintainance is, it cannot make up for the customers' loss.

To achieve this mission, service engineers have to find out any defect in design and installation of the users'system timely and precisely, and help users to slove them. They have to take the responsiblity and be initiative on supervising users to take regular maintainance of the machine,and to conduct energy-saving management well. We should always take the user's system as our own.

To achieve this mission, service engineers have to build close and deep relationship with users, to ensure that the more BROAD products they use and longer the life span of these products, the more trust they have on BROAD. Every engineer has to keep in faith that if you fulfill your mission, and build good relationship with users, customers will take BROAD as their first choice, or even most of them will consider BROAD as their only choice. Hence, the BROAD ideal will be realized.

All the service engineers,the great mission is on your shoulder!

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BROAD Air Conditioning has obtained international certificates from ISO, CE, ETL, ASME and so on.

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