BROAD U.S.A.

Absorption Chiller Principle and Configuration Webinar 2021

The BROAD Group Founded in 1988,

World leader in high capacity HVAC systems along with chillers, ventilation, filtration, air purification solutions and sustainable building (Stainless steel modularized building)

Our products have been sold and serviced in over 80 countries, and deployed across a wide spectrum of industrial, commercial, educational, and institutional applications.

BROAD U.S.A. Office started in 1998

- **BROAD Air Conditioning Co., Ltd.**
- **BROAD Clean Air Technology Co., Ltd.**
- **BROAD Energy Service Co., Ltd.**
- **BROAD Sustainable Building Co., Ltd.**

80+

Countries we have served

60

Prefabricated buildings

3000+

Global employees

80%

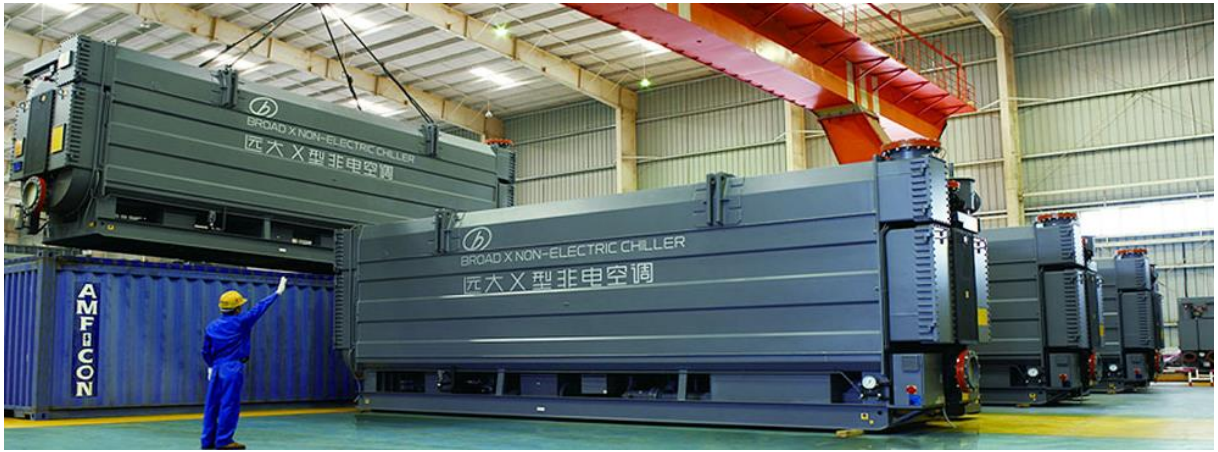
Energy saving in our systems and practices

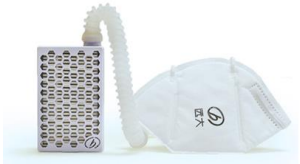
90%

Carbon emission reduction in life cycle

95%

Construction waste reduction rate


BROAD X NON-ELECTRIC CHILLER
远大X型非电空调
AMFICON




PM2.5 108
PM10 162

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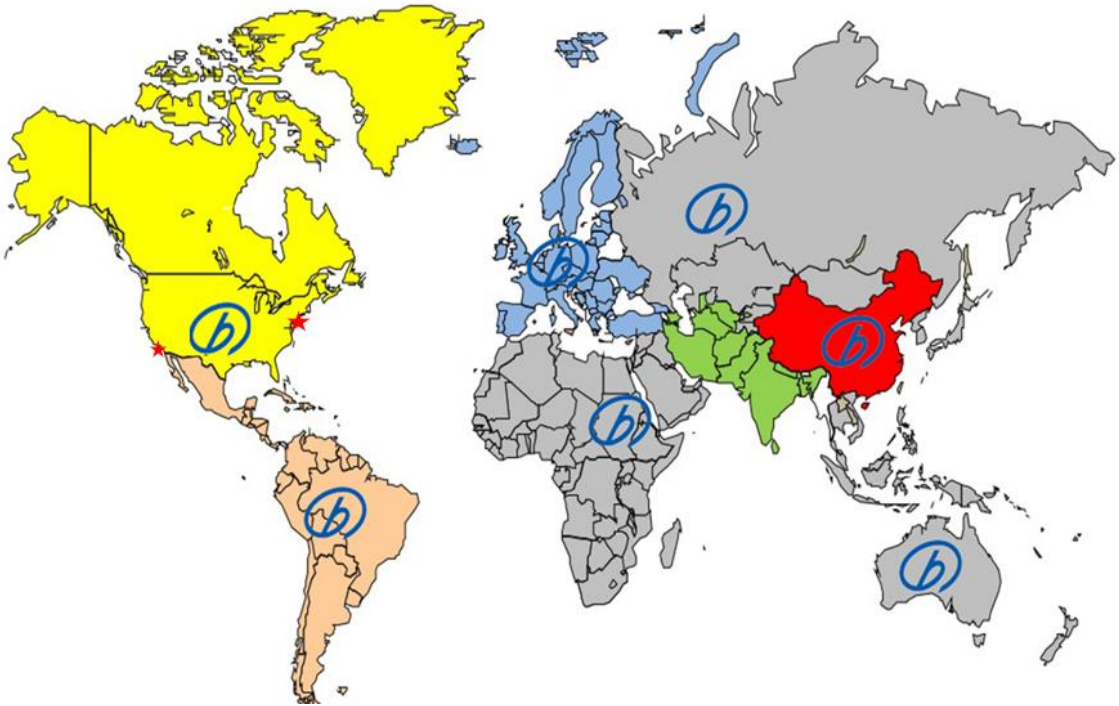
BROAD International Service



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Basic Principles of Absorption Chiller

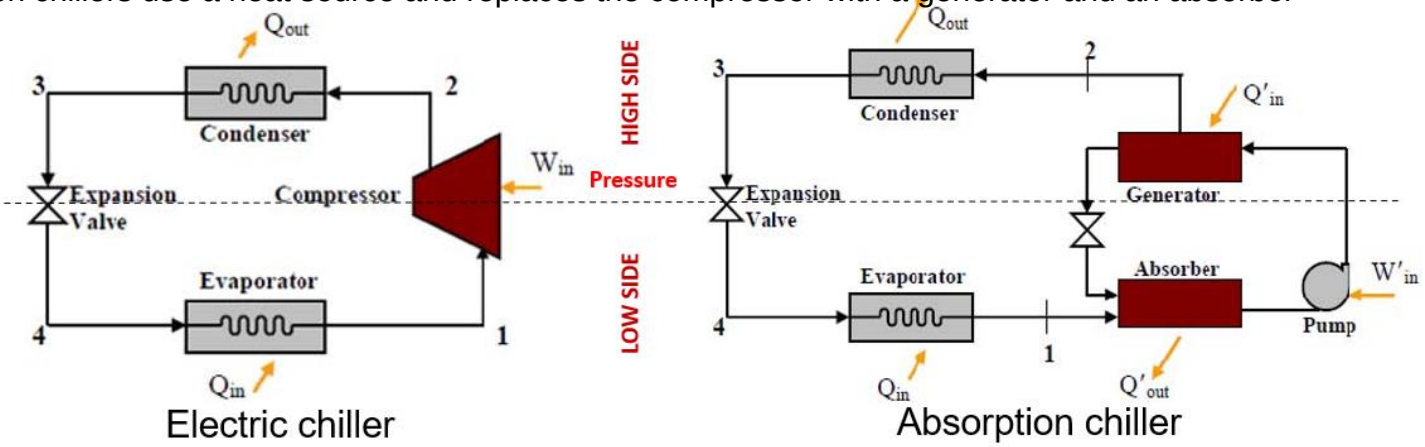
Electrical Chiller vs. Absorption Chiller

Both chiller refrigeration cycles are accomplished by: Heat Transfer and Phase Change

1. **Removal** of heat through the evaporation of a refrigerant at a low pressure
2. **Rejection** of heat through the condensation of the refrigerant at a higher pressure

Basic differences:

1. An electric chiller use a mechanical compressor to create the pressure differences necessary to circulate the refrigerant
2. Absorption chillers use a heat source and replaces the compressor with a generator and an absorber



Basic Principles of Absorption Chiller

Why Lithium Bromide(LiBr) Solution?

Distilled Water (Refrigerant)

Lithium Bromide (Absorbent)

Lithium Bromide (Solution)

- ❑ Stable
- ❑ Nontoxic
- ❑ Readily available
- ❑ Environmentally friendly

- ❑ High latent heat of vaporization
- ❑ High affinity for water (refrigerant)
- ❑ In solution, higher boiling point than water
  1,265° C (2,309° F)

Basic Principles of Absorption Chiller

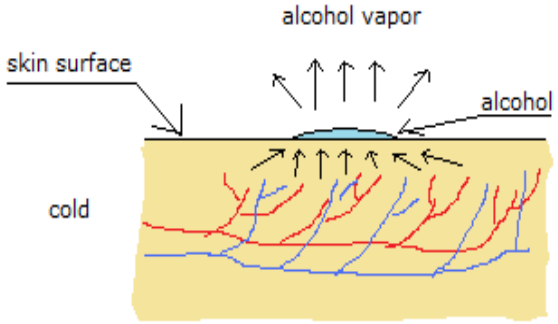
1. **Refrigerant phase change:**

   Vaporization — Liquid to gas (included boiling and evaporation) – Absorb heat

   Condensation— Gas to liquid – Release heat

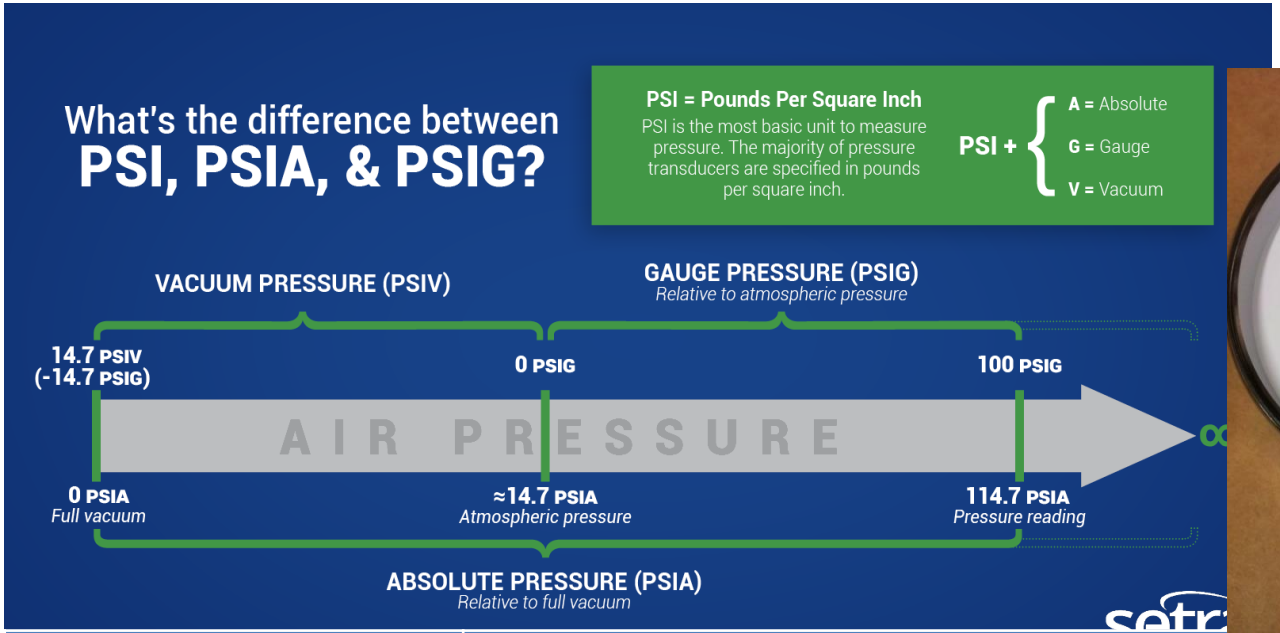
2. **Boiling temperature:**

   A liquid in a partial vacuum has a lower boiling point than when that liquid is at atmospheric pressure.



Boiling point	Pressure
212° F	14.7 psia = **0 psig** = 29.92 inHgA
39° F	0.117 psia = **-14.58 psig** = 0.24 inHgA

Basic Principles of Absorption Chiller



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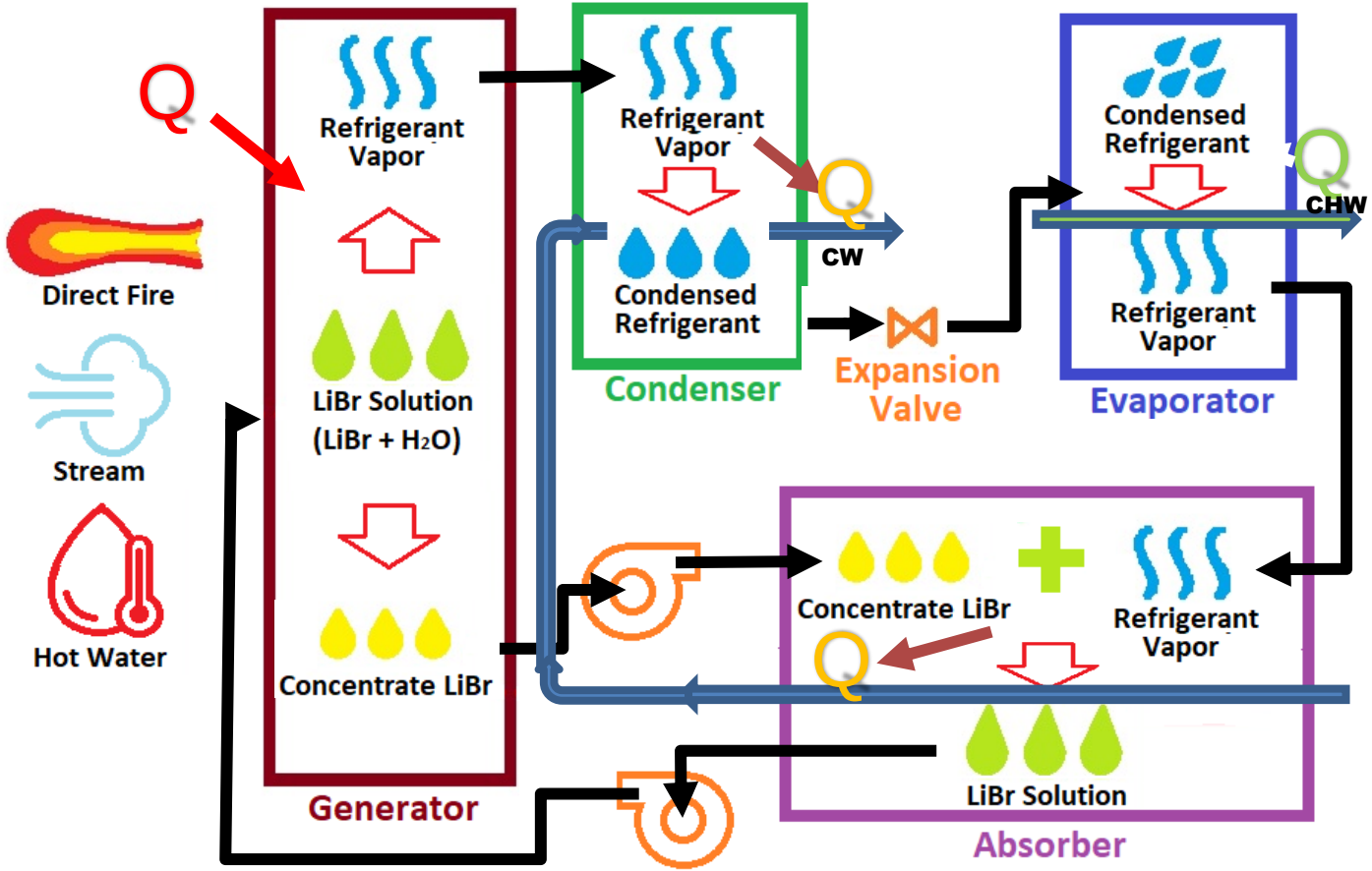
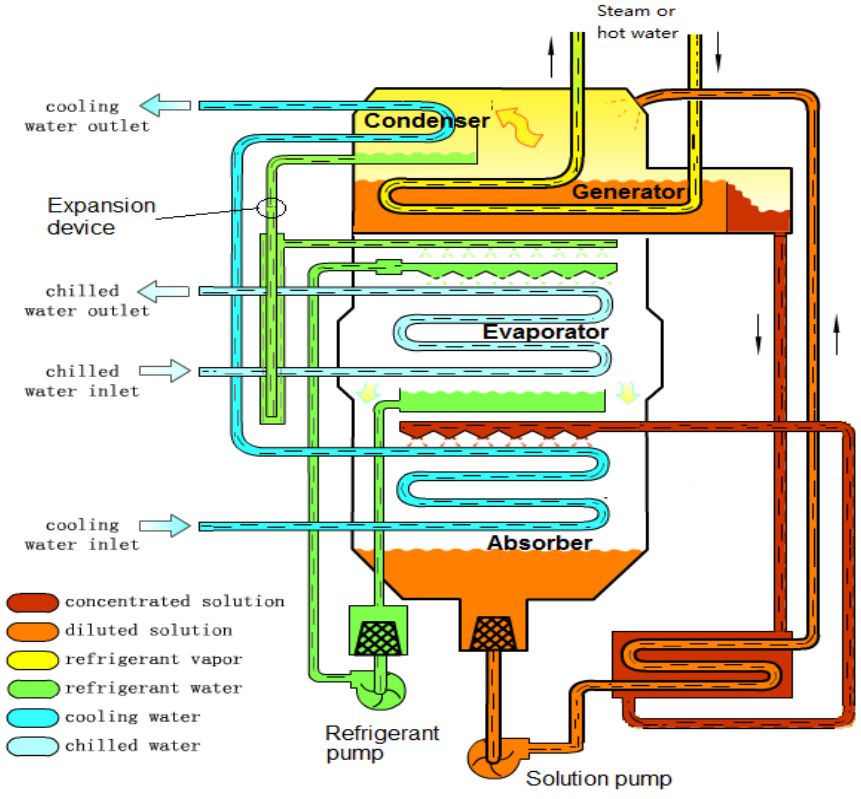
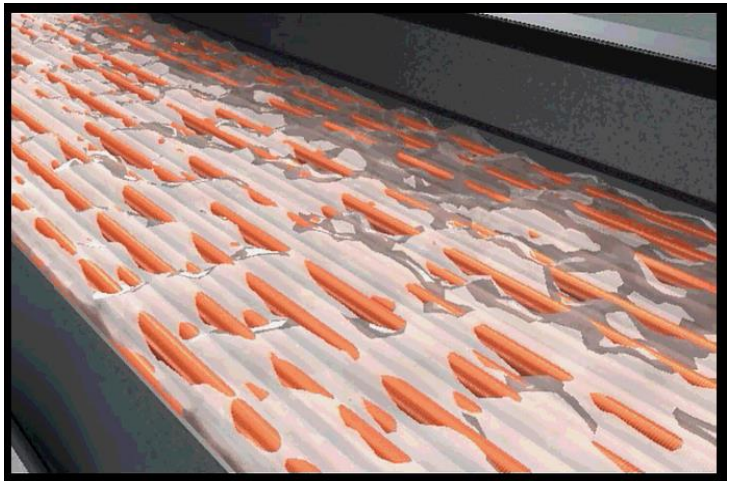

Q
Refrigerant Vapor
Direct Fire
LiBr Solution (LiBr + H2O)
Stream
Hot Water
Concentrate LiBr
Generator
Refrigerant Vapor
Condensed Refrigerant
Q
CW
Condenser
Expansion Valve
Condensed Refrigerant
Q
CHW
Refrigerant Vapor
Evaporator
Concentrate LiBr
Refrigerant Vapor
Q
LiBr Solution
Absorber

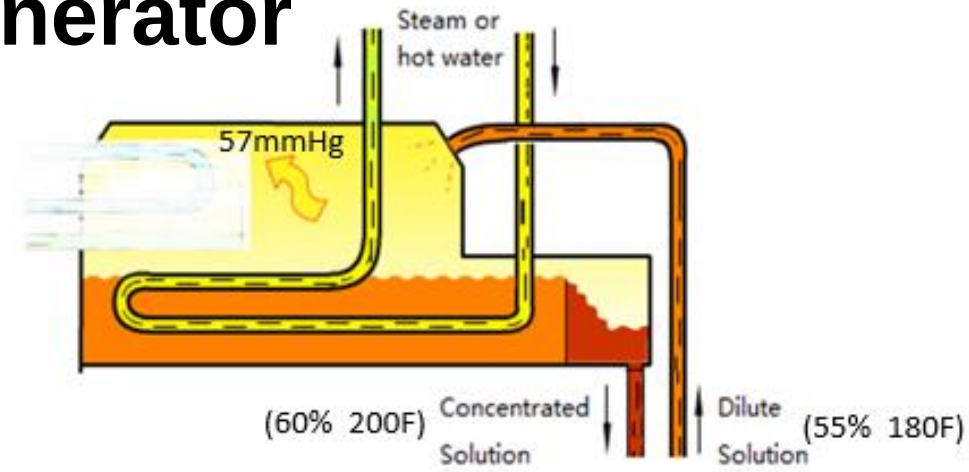
Basic Principles of Absorption Chiller



Generator

1. Hot water enters the copper tubes and heats the diluted solution to **194° F**





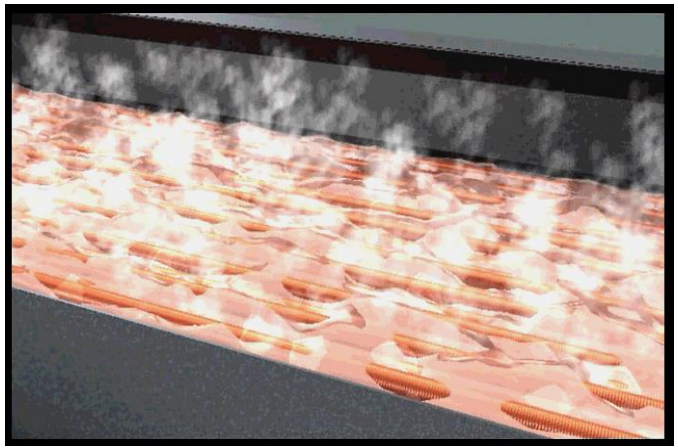
Pressure = -13.59 Psig = 2.25 in Hg

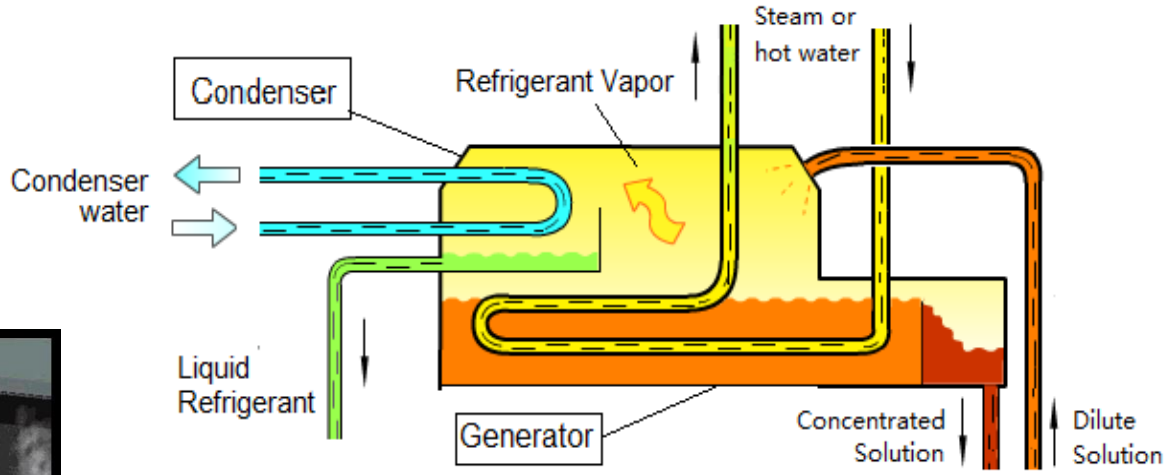
2. The refrigerant(water) boils and separates from solution, traveling to the condenser

3. The generated refrigerant vapor travels to the condenser

Condenser

1. The refrigerant vapor surrounds the condenser (cooling) water tubes



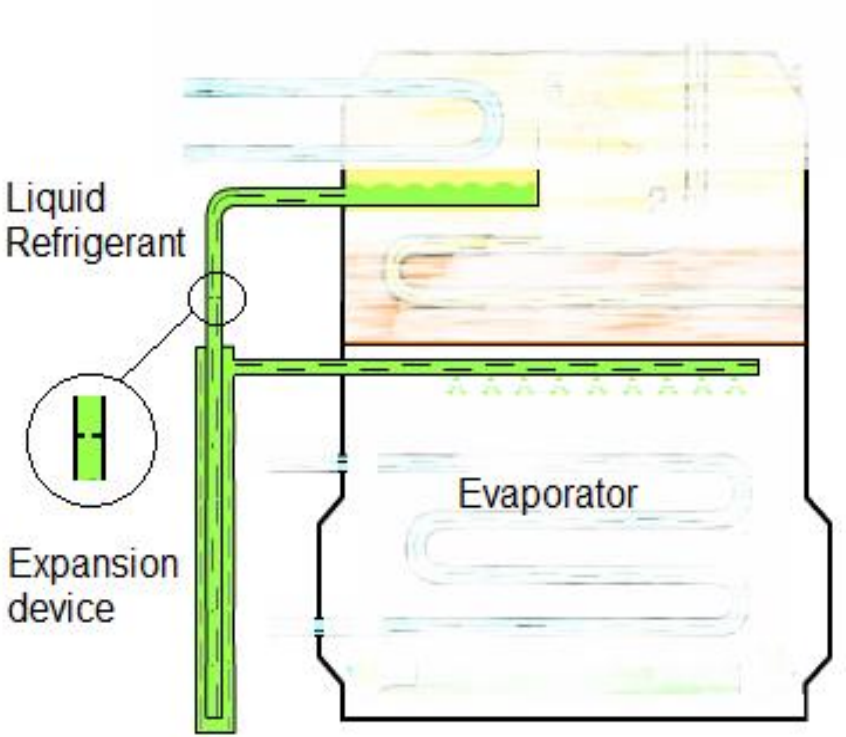


Pressure = -13.59 Psig = 2.25 in Hg

2. Heat from the refrigerant vapor transfer to the condenser(cooling) water

3. Refrigerant condenses resulting in refrigerant water

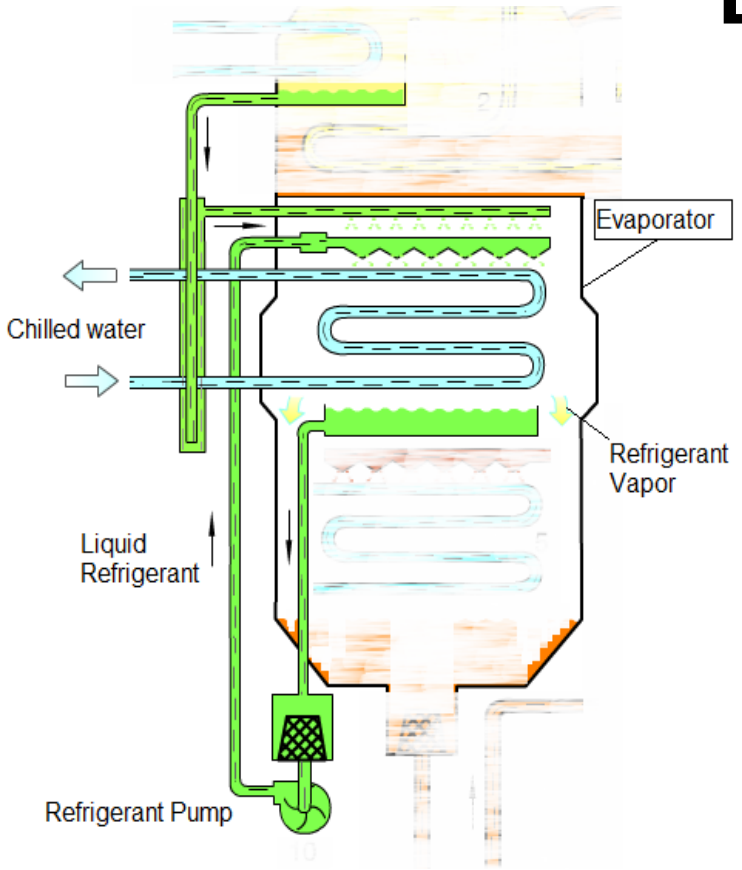
Expansion device

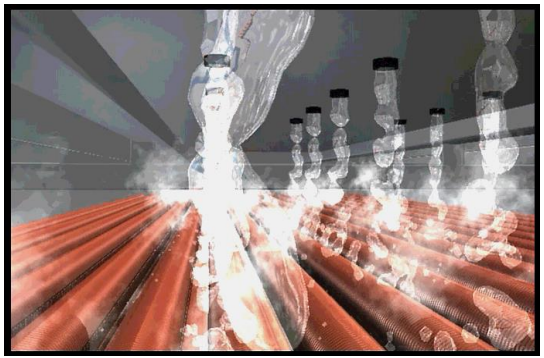


The expansion device is a throttling pipe, which is a long section of pipe with an orifice restriction in it.

- Refrigerant water flows through the expansion device
- Expansion device maintains the pressure difference between high pressure(condenser) and low pressure (evaporator)

Evaporator

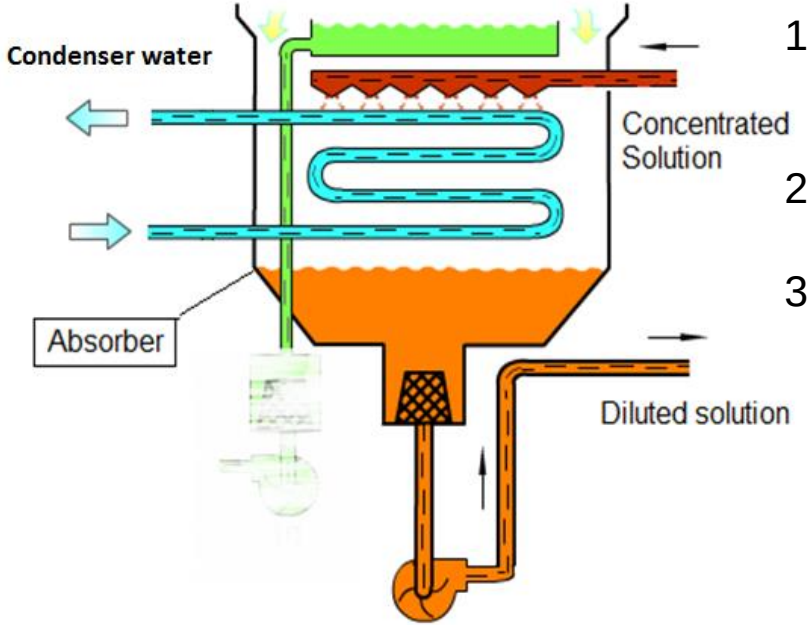




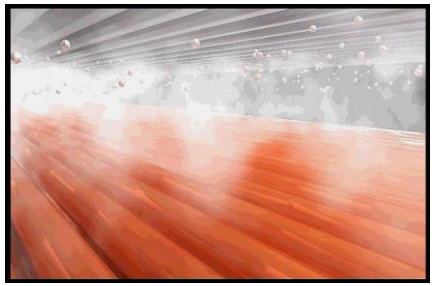
1. 39° F refrigerant water from condenser sprays on the chilled water tube in vacuum condition
   Pressure = -14.58 Psig = 0.25 in Hg
2. Partial water evaporates and goes into absorber
3. Unevaporated Refrigerant water will be recycled thru R-pump and sprayed again

Absorber

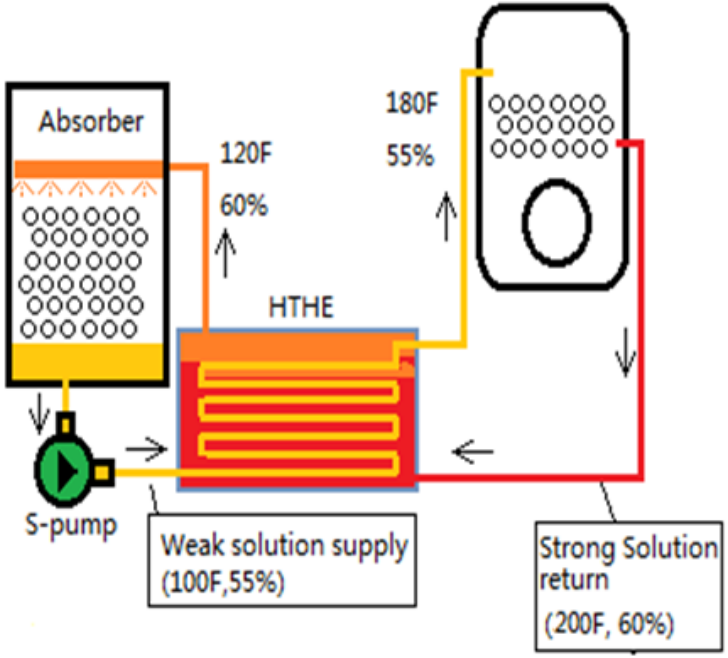
Absorption of the refrigerant vapor creates a low pressure area within the absorber, along with the absorbent's affinity for water, induces a continuous flow of refrigerant vapor from the evaporator.



1. Refrigerant vapor produced in the evaporator is absorbed by LiBr solution
2. Refrigerant vapor condenses back to liquid
3. Heat generated is rejected to the cooling (condenser) water



Heat exchanger



Purpose of HTHE (LTHE)

1. Preheats the diluted solution， reducing the heat energy consumption.
2. Precools the concentrated solution, reducing the required flow rate of cooling water

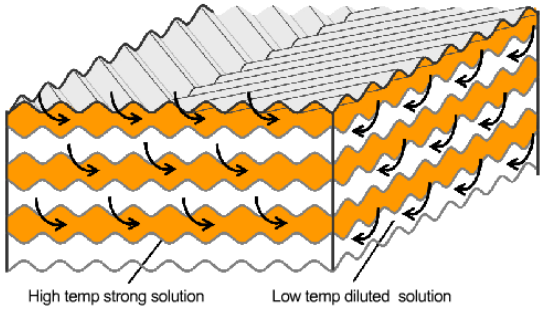
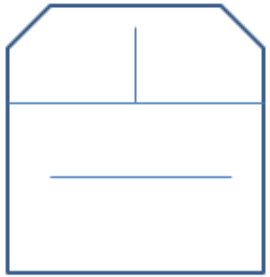
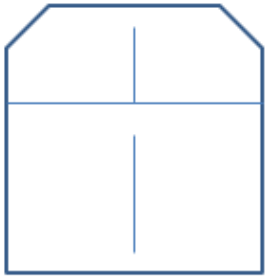


Plate type heat exchanger

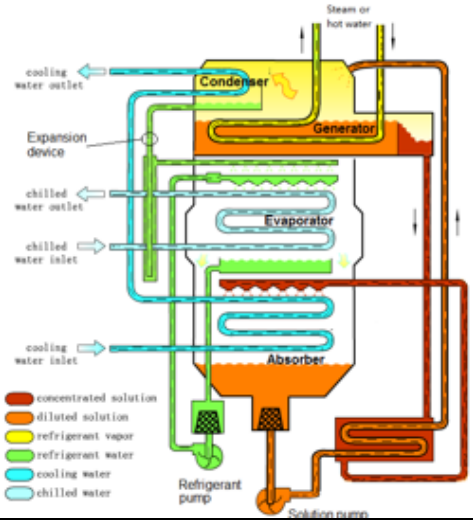
Basic Principles of Absorption Chiller

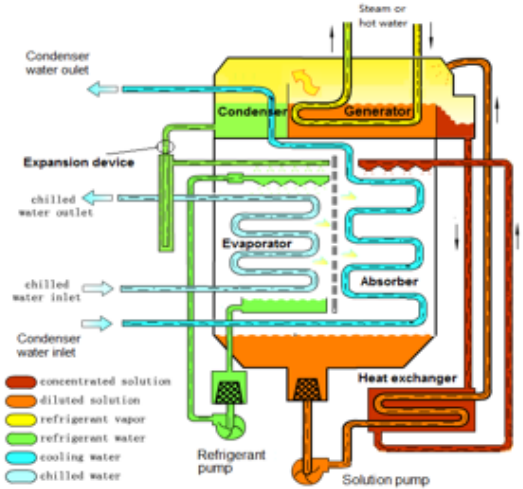


UP-Down Structure



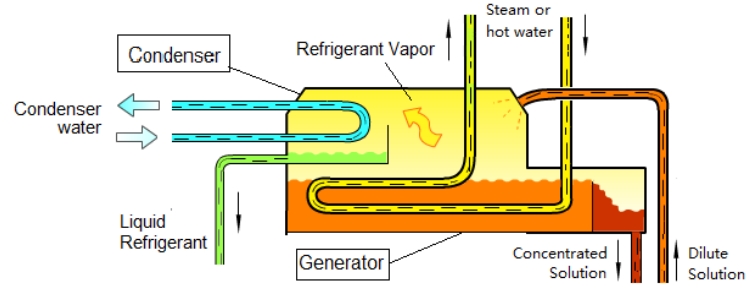
Left-Right Structure

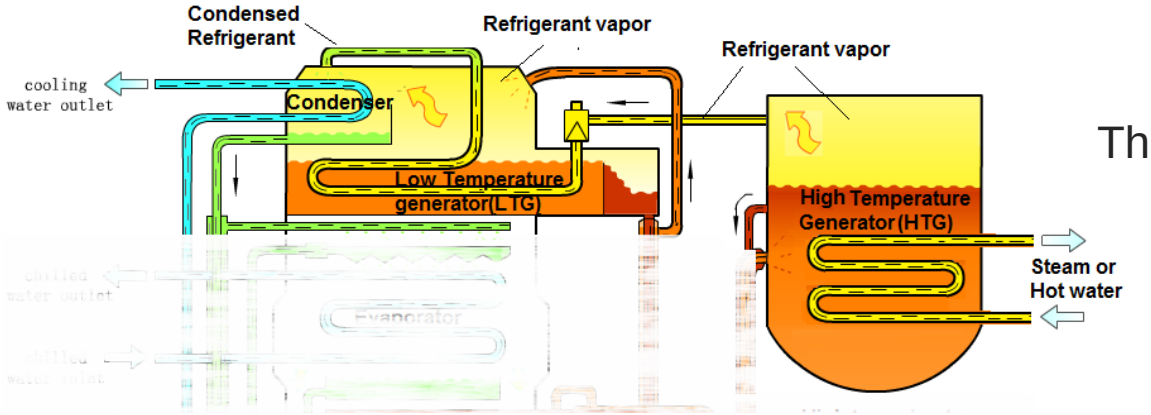




Basic Principles of Absorption Chiller

Single stage chiller Vs Two stage chiller





COP: coefficient of performance

Type	COP
Single stage chiller	0.7~0.8
Double stage chiller	1.3~1.4

The equation is: $$COP = \frac{Q}{W}$$

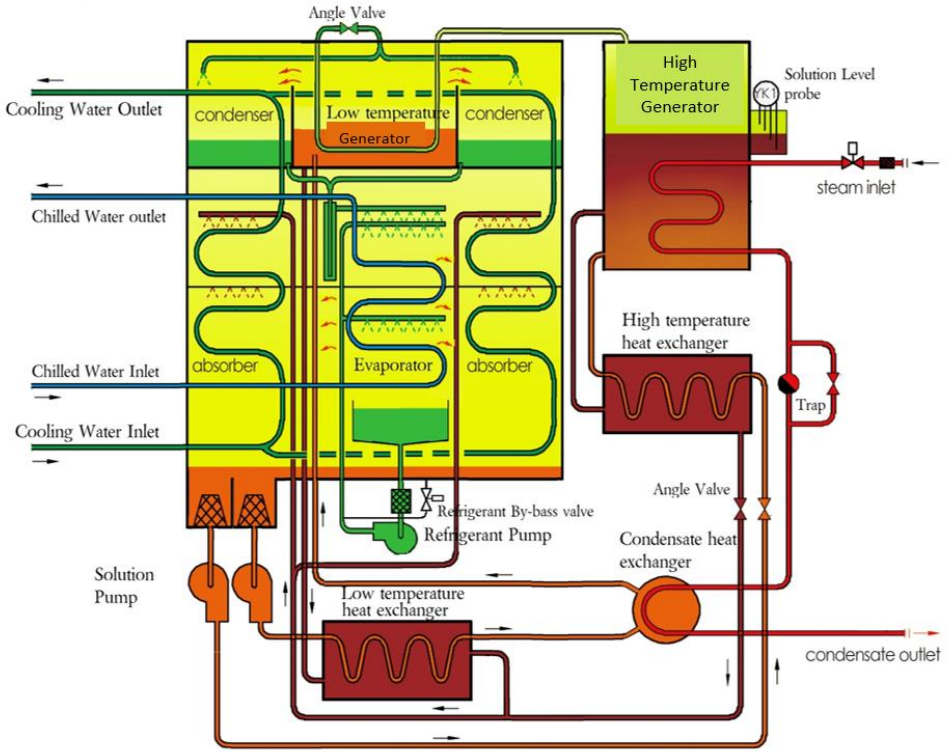
where

Q is the heat supplied to or removed from water.

W is the work consumed by the Unit.

Basic Principles of Absorption Chiller

Two stage chiller



Basic Principles of Absorption Chiller

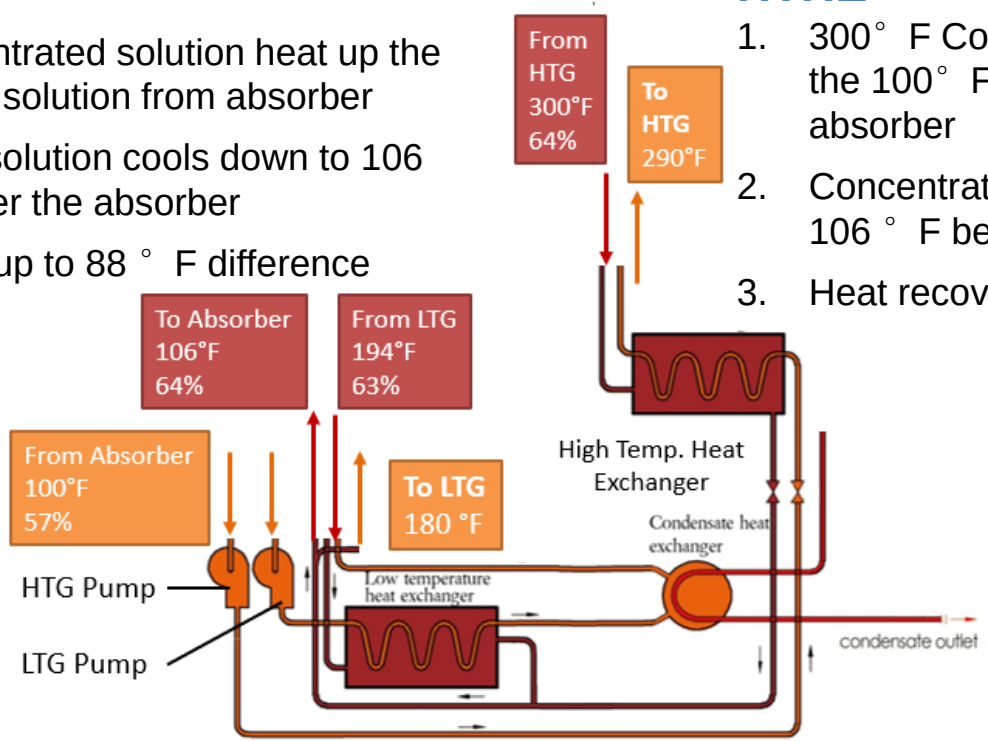
Two stage chiller

LTHE

1. 194° F Concentrated solution heat up the 100° F diluted solution from absorber
2. Concentrated solution cools down to 106 ° F before enter the absorber
3. Heat recovery up to 88 ° F difference

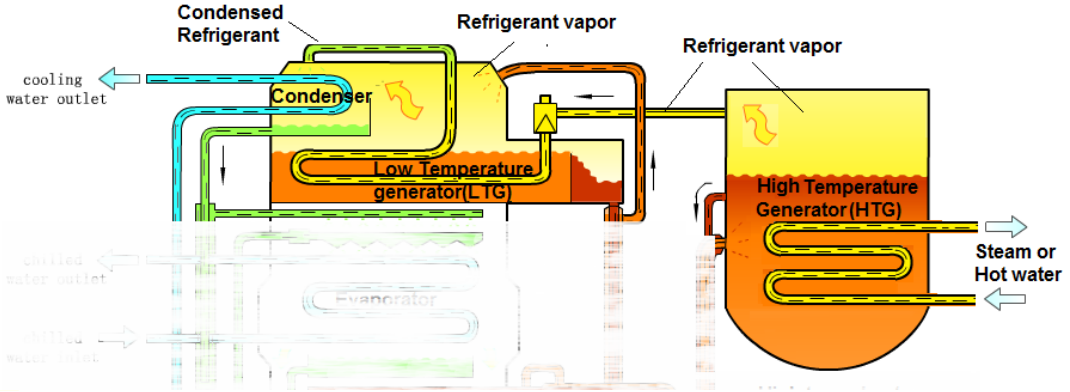
HTHE

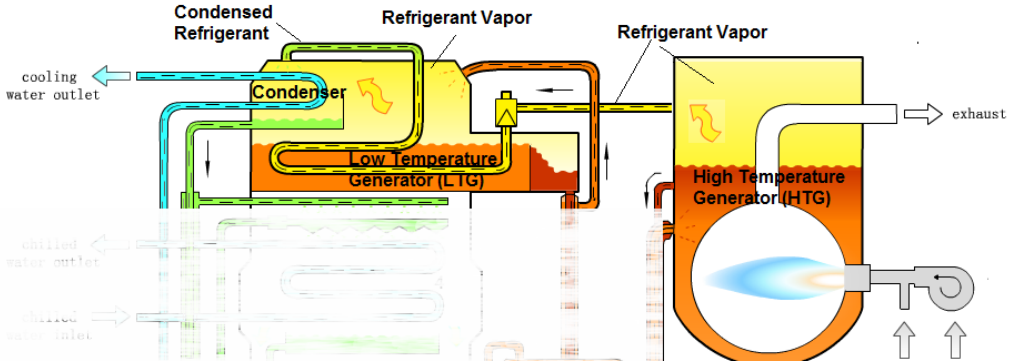
1. 300° F Concentrated solution heats up the 100° F diluted solution from absorber
2. Concentrated solution cools down to 106 ° F before entering the absorber
3. Heat recovery up to 202 ° F difference



Basic Principles of Absorption Chiller

Indirect fire absorption chiller VS Direct fire absorption chiller





Configuration of Broad Chiller

Functions: Cooling, heating, hot water (dedicatedly or simultaneously)

Energy Sources: Natural Gas, Oil, steam, hot water, exhaust(multiple energy)

Configuration of Broad Chiller

Single Stage Chiller

Main Function: Cooling

Heat Source:

- Hot Water
- Steam
- Exhaust

Application: CHP Systems, systems with excess heat source energy

Configuration of Broad Chiller

Two-Stage Chiller

Main Function:

- Cooling

Heat Source:

- Hot Water
- Steam
- Exhaust

Application:

- Hospitals or Schools with waste or excess steam or hot water from their power plant

Configuration of Broad Chiller

Two-Stage Direct Fire Chiller

Main Function:

- Cooling
- Heating
- Hot Water
- Cooling and Hot Water

Heat Source:

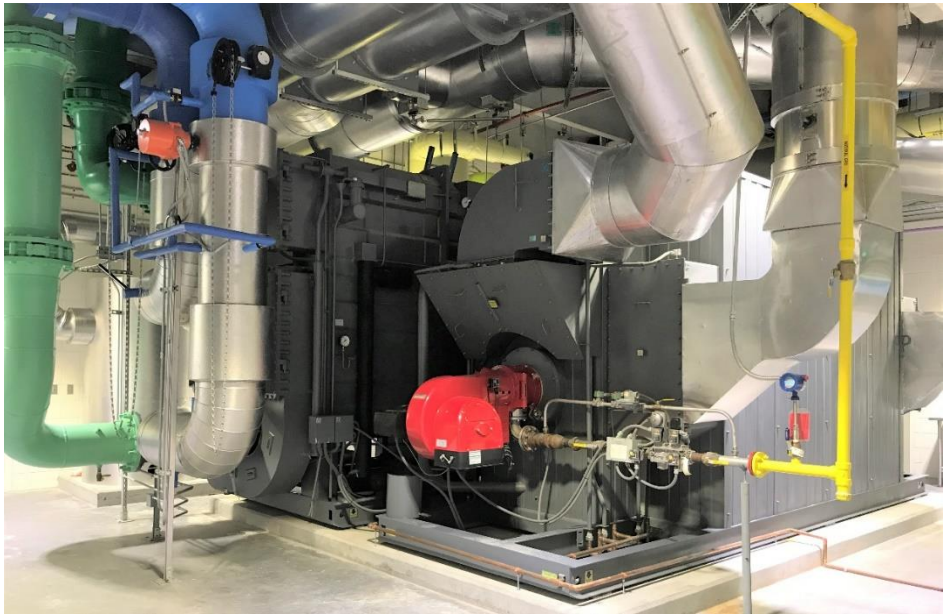
- Gas/Oil Burner

Application:

- Building with all Year load
- Need to use minimum electrical suppy
- Substitute electrical supply for gas/ oil

Configuration of Broad Chiller

Multi Stage Chiller



Main Function:

- Cooling
- Heating
- Hot Water
- Cooling and Hot Water

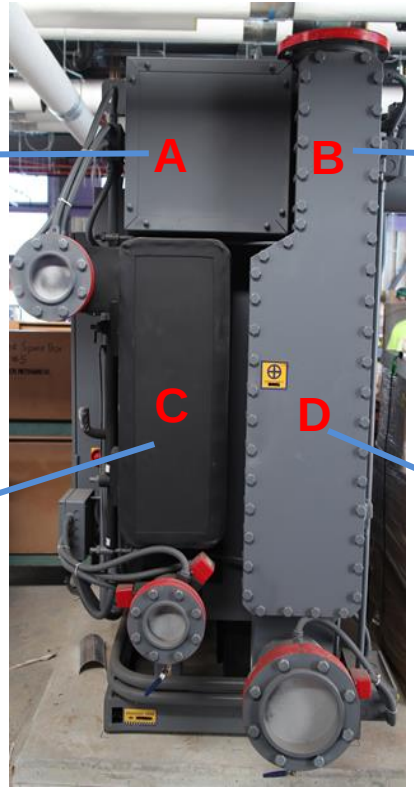
Heat Source:

- Gas/Oil Burner with Exhaust/Hot Water

Application:

- CHP Systems
- Building with all Year load
- Need to use minimum electrical suppy
- Substitute electrical supply for gas/ oil
- Excess exhaust or Hot water heat source energy

Configuration of Broad Chiller



Generator

Condenser
(Condenser W Bundle)

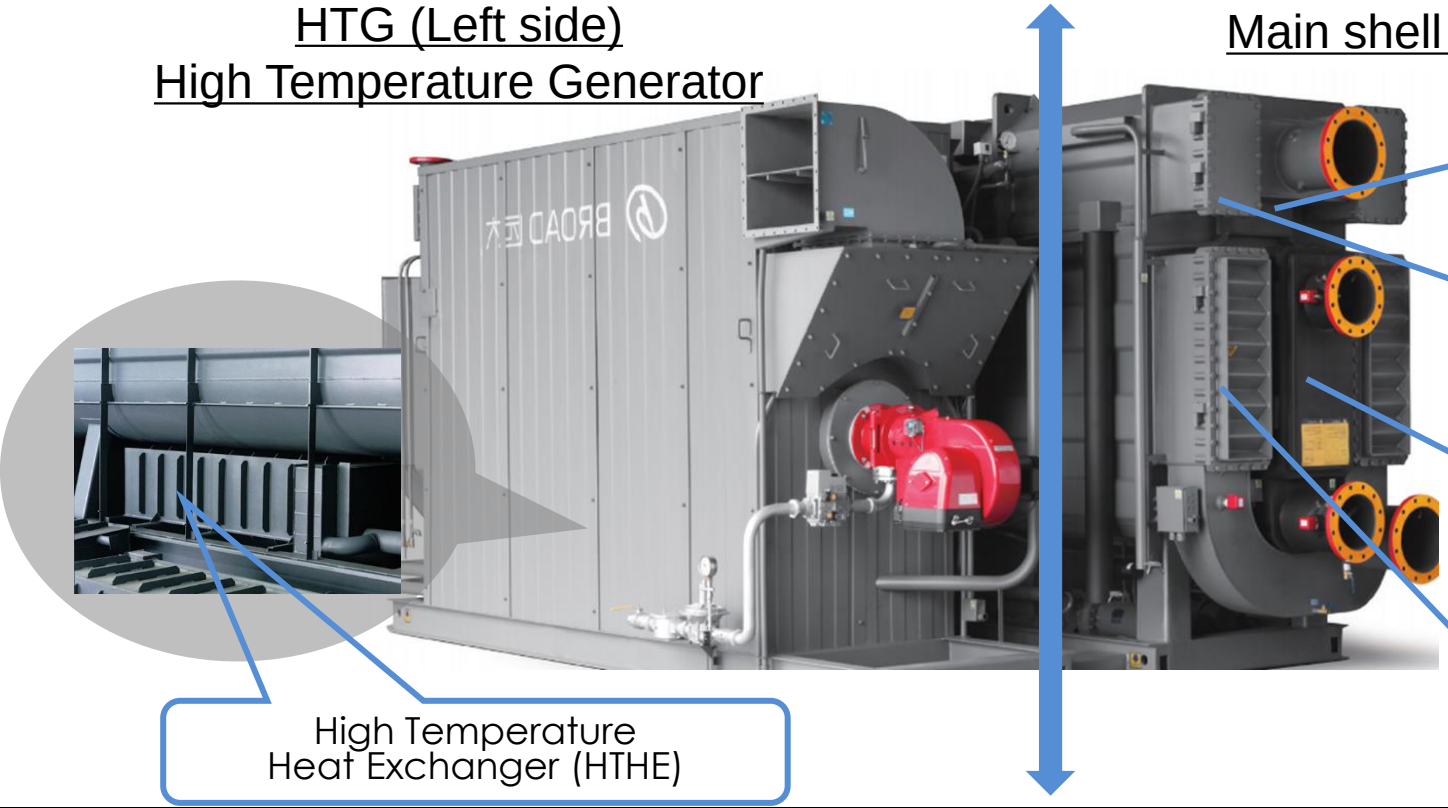
Evaporator
(Chilled Water bundle)

Absorber
(Condenser W. bundle)

Configuration of Broad Chiller

HTG (Left side)
High Temperature Generator

Main shell (Right side)



Low Temperature Generator (LTG)

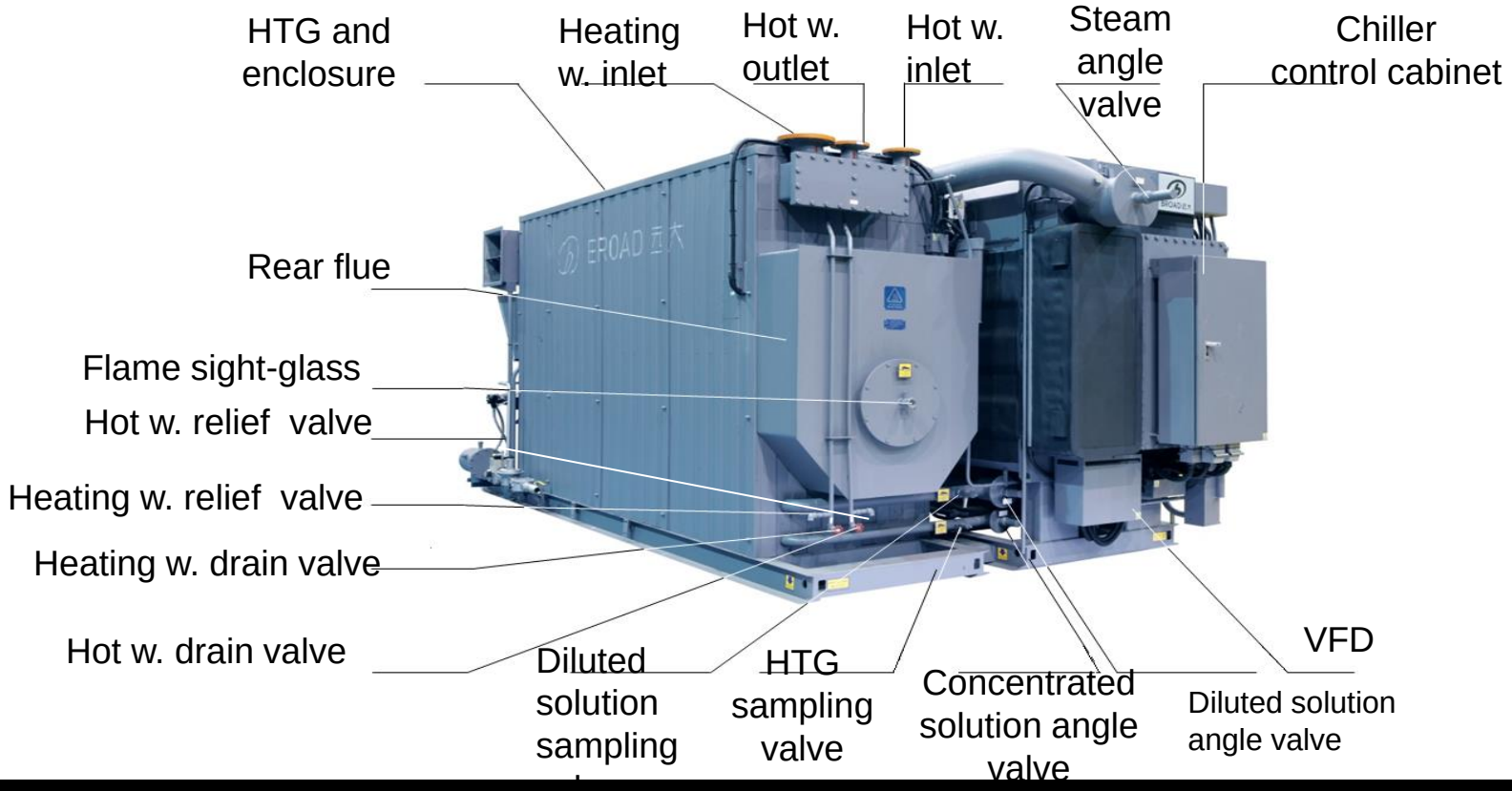
Condenser (Condenser W Bundle)

Evaporator (Chilled Water bundle

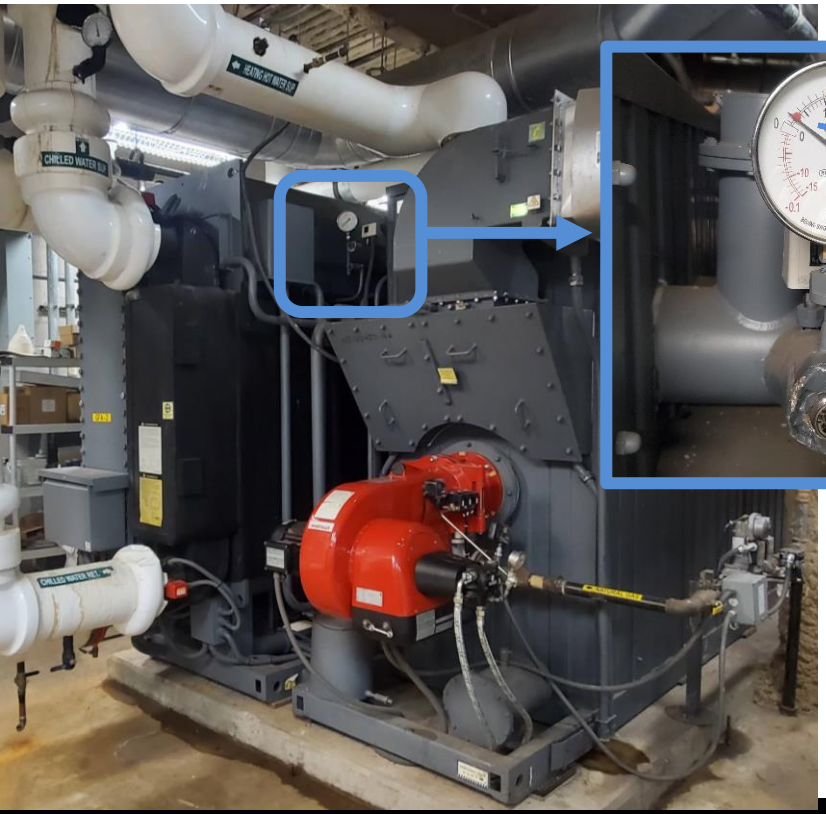
Absorber (Condenser W. bundle)

High Temperature Heat Exchanger (HTHE)

Configuration of Broad Chiller



Configuration of Broad Chiller



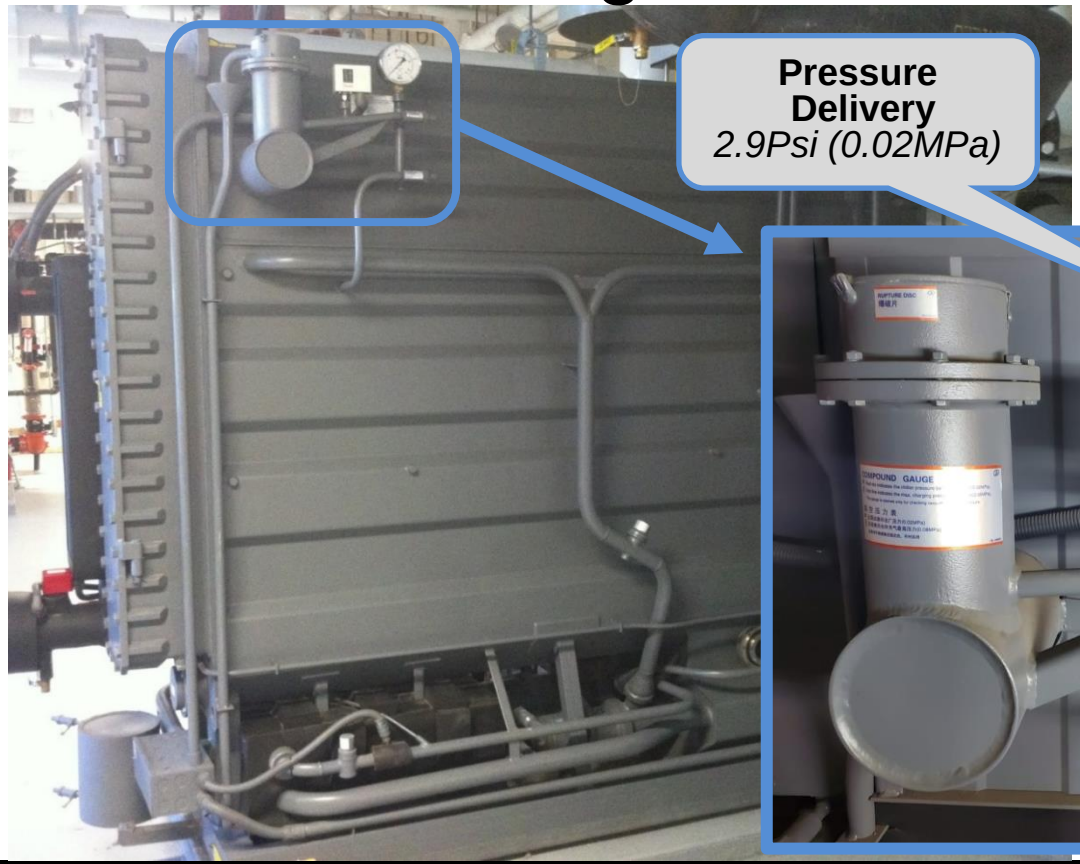
HTG Pressure Gauge

Pressure Limit
11.6Psi (<0.08MPa)

Pressure Delivery
2.9Psi (0.02MPa)

Mainshell Pressure Gauge

Configuration of Broad Chiller



Pressure Delivery
2.9Psi (0.02MPa)

Pressure Gauge

Pressure Limit
11.6Psi (<0.08MPa)

Generator

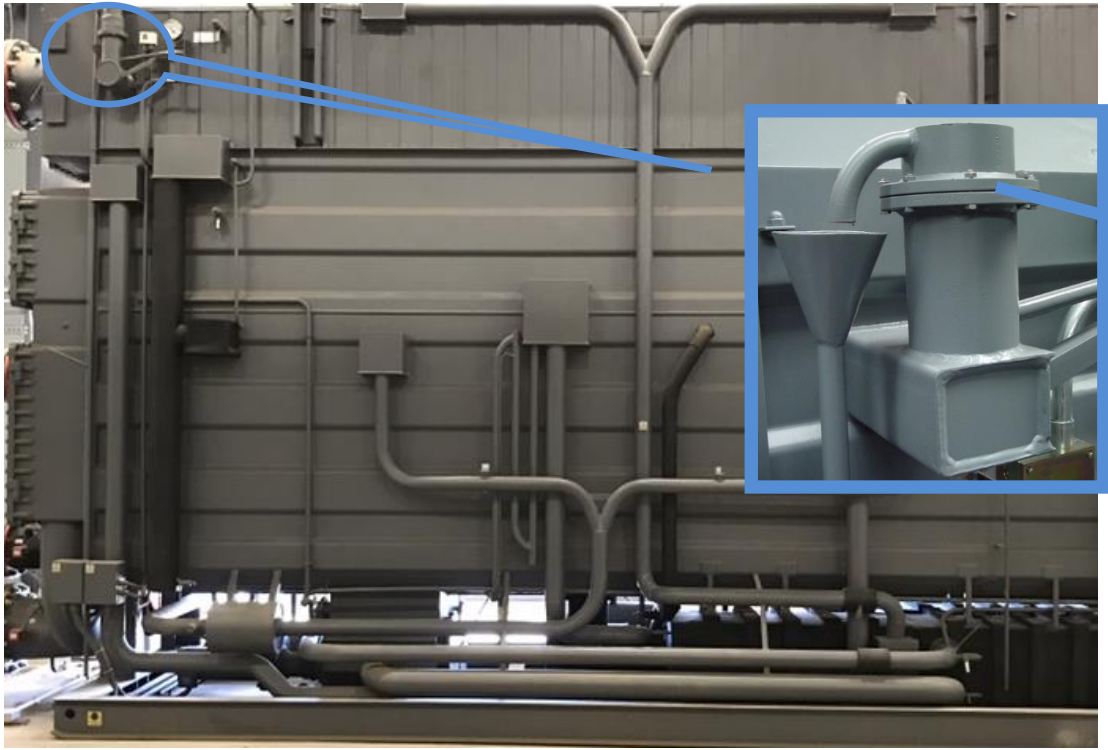
Mainshell

Configuration of Broad Chiller

DANFOSS Pressure Controller

- Setting pressure: 2.9 psig
- Auto reset pressure :-2.9 psig/24.02 inHgA

Configuration of Broad Chiller



Rupture Disk
Limit = 24.6 Psig

Configuration of Broad Chiller

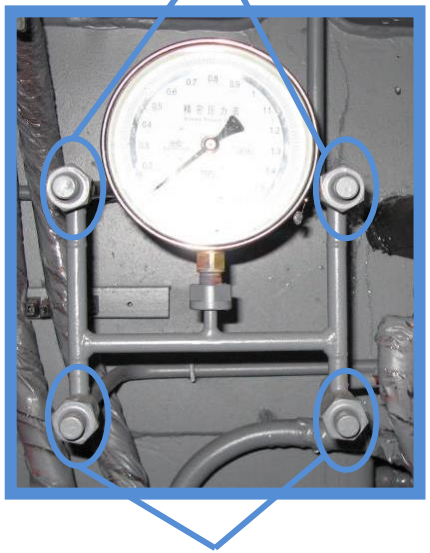
Flow Switches

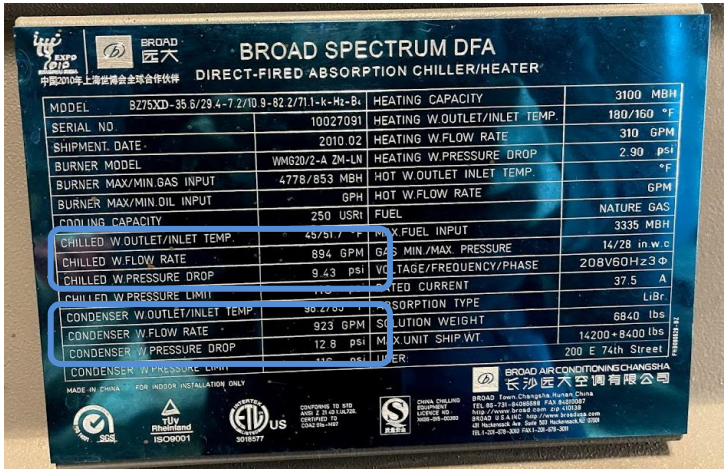
- 3 - Chilled water
- 1 - CondenserWater

Configuration of Broad Chiller

Precision Pressure Gauge

Chilled W. pressure checking valve





Condenser W. pressure checking valve

Configuration of Broad Chiller

Chilled water outlet temp. sensor

- Detects chilled water outlet temperature
- Controls the cooling load accordingly
- Prevents tube freezing in the evaporator

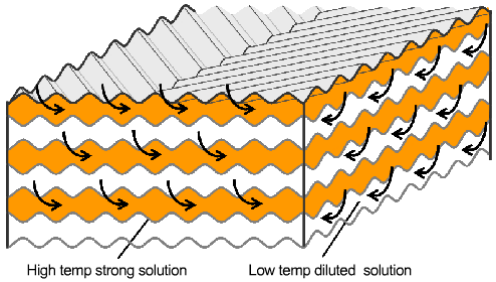
Chilled water calibration temp. sensor

- Checks the chilled water outlet temperature
- Avoids copper tube freezing in the evaporator caused by chilled water outlet temperature error

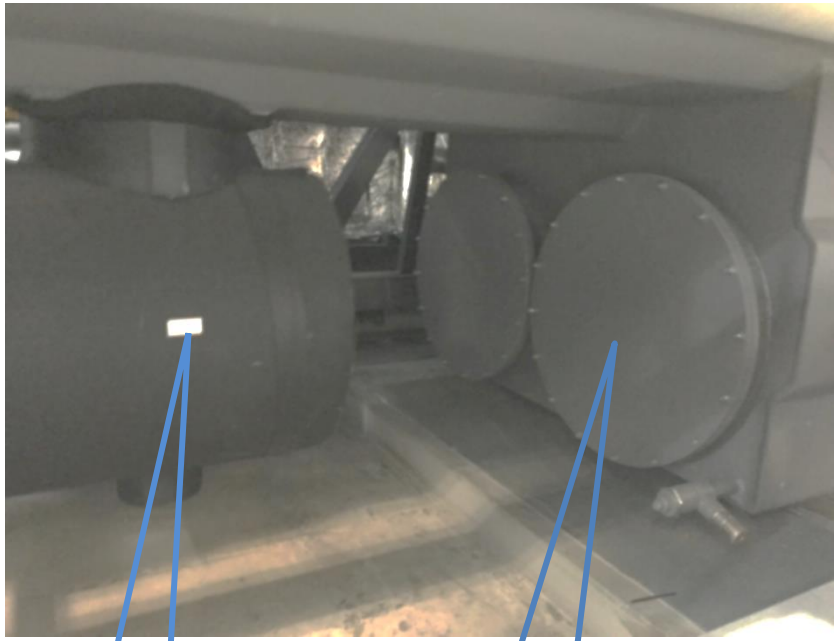
Chilled water inlet temp. sensor

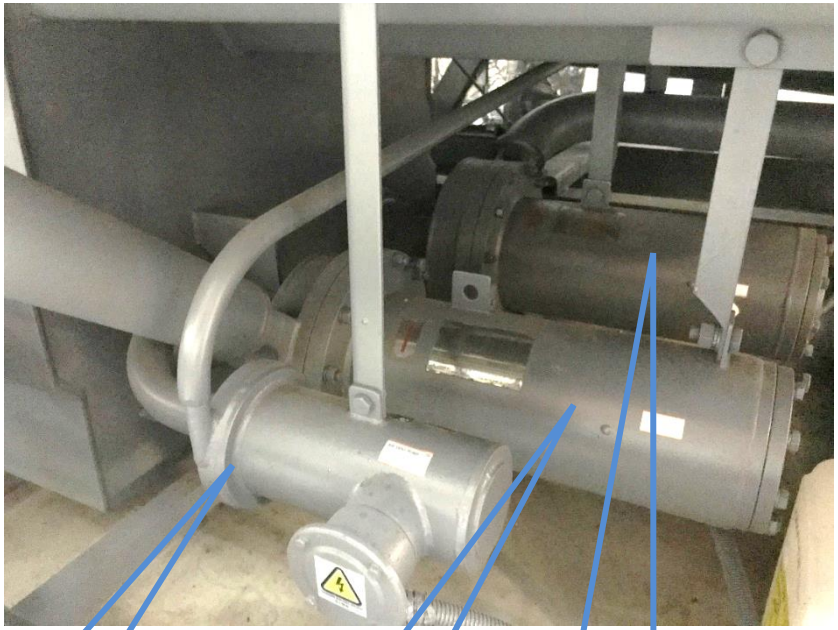
Configuration of Broad Chiller

Low Temperature Heat Exchanger (LTHE)



Configuration of Broad Chiller





Refrigerant pump

Pump Strainer and flange

Auto Vent pump

LTG Solution pump

HTG Solution pump

Configuration of Broad Chiller

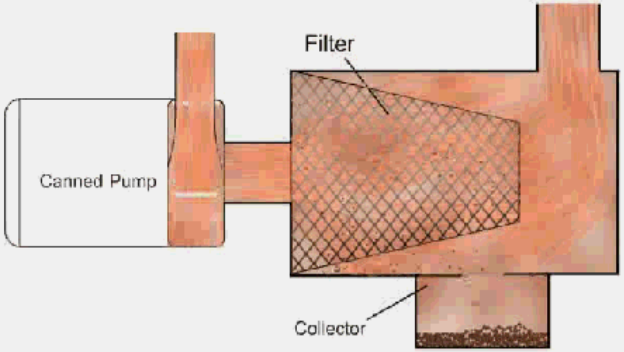
Pump Strainer

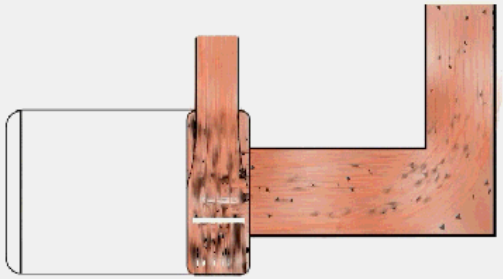
BROAD Advantages

Prevent pump from being clogged.

Prevent spraying nozzle being blocked.

It is unnecessary to dismantle the filter for cleaning and maintenance work load is reduced.





Conventional:

Pump is easy to be clogged and motor damaged, which results in blockade of spraying nozzles and fouling with copper tubes.

Configuration of Broad Chiller

Refrigerant Bypass Valve

Configuration of Broad Chiller

Sight Glass

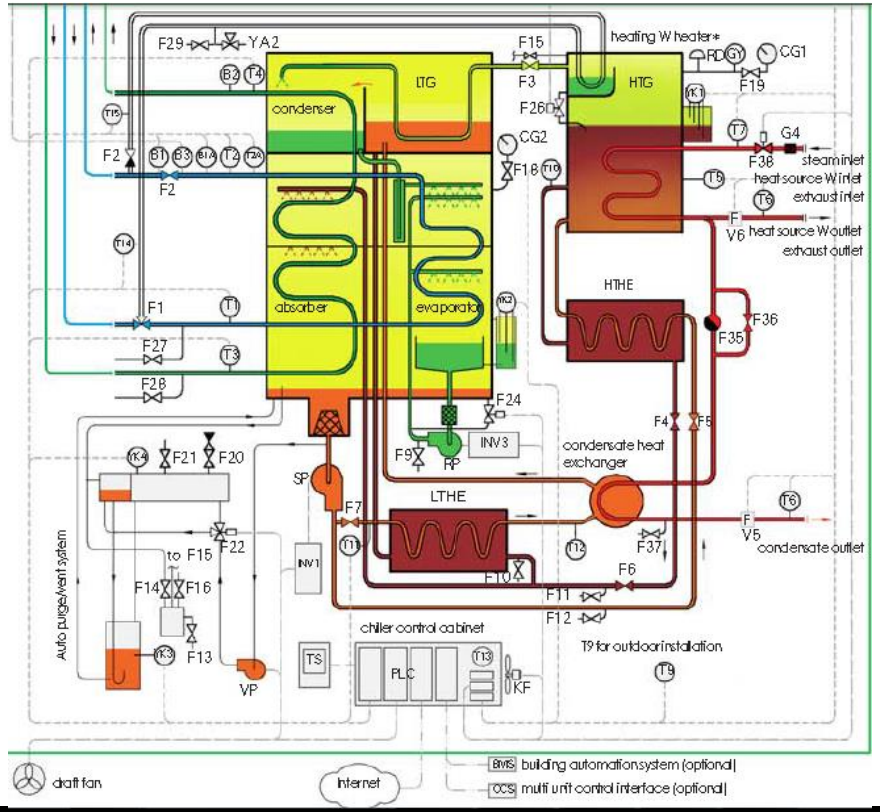
- Check corrosion or clogging of the nozzles etc.

Under full cooling load

1. **LiBr Solution sight Glass:**
   - Solution level below copper tubes
   - Solution should cover absorber's bottom
   - Solution pump should not be empty
   - Solution color should be Yellow or Clear

2. **Refrigerant sight Glass:**
   - Should not be over or touching the copper tubes
   - Check refrigerant level
   - Refrigerant Color should be clear

Configuration of Broad Chiller



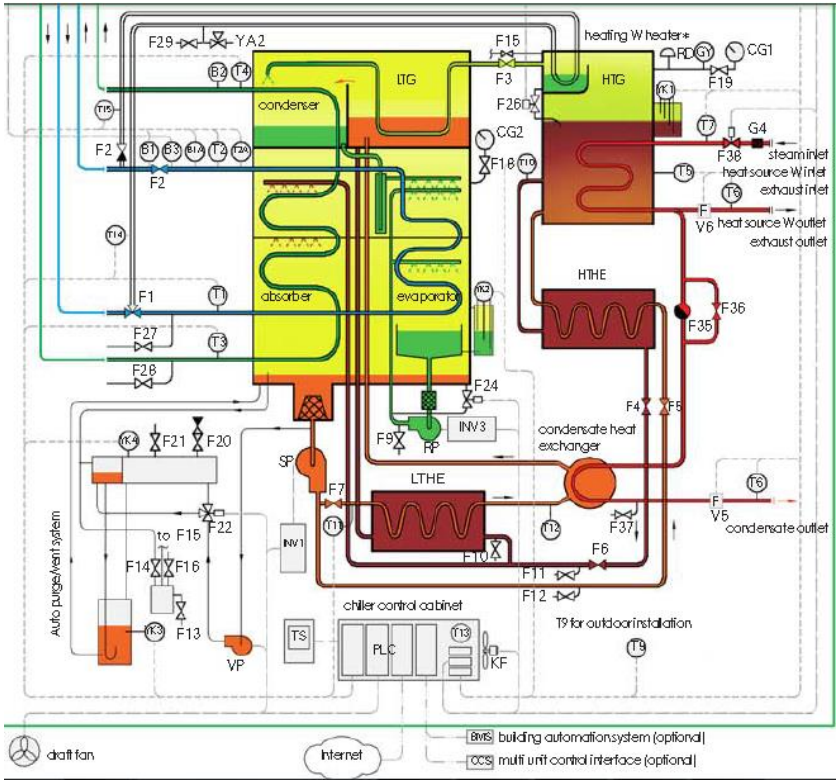
P&I Diagram(Sensors)

Sensors:

T1	chilled W inlet temp sensor
T2	chilled W outlet temp sensor
T2A	chilled W calibration temp sensor
T3	cooling W inlet temp sensor
T4	cooling W outlet temp sensor
T5	generator temp sensor
T6	heat source W outlet temp sensor
T7	heat source W inlet temp sensor
T9	ambient temp sensor
T11	crystallization sensor
T12	control cabinet temp sensor
T13	heating W inlet temp sensor
B1	chilled W flow switch
B1A	chilled W flow switch
B2	cooling W flow switch
B3	chilled W flow switch
GY	pressure control
YK1	generator solution level probe
YK2	refrigerant level probe
YK3	non-condensable probe

Configuration of Broad Chiller

P&I Diagram(Control



Control Devices:

INV1	solution pump inverter
INV3	refrigerant pump inverter
TS	touch screen
PLC	programmable logic controller

Controlled Objects:

RP	refrigerant pump
SP	solution pump
VP	air vent pump
AP	absorption pump
LQFJ	cooling tower fan
F22	auto purge valve
F24	refrigerant motor valve
F38	heat source motor valve (exhaust motor valve is optional)

Configuration of Broad Chiller

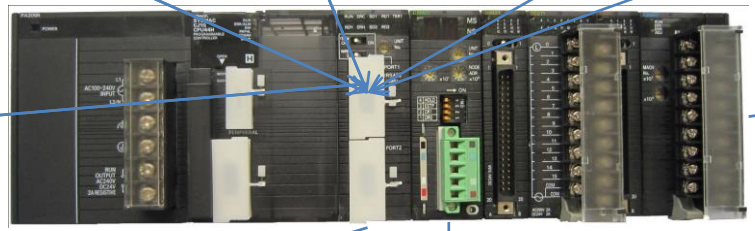
Level Sensor

Flow switch

Pressure switch

Temperature Controller

12~16 of Temperature Sensor



Program Logic controller(PLC)

Inverter for pump

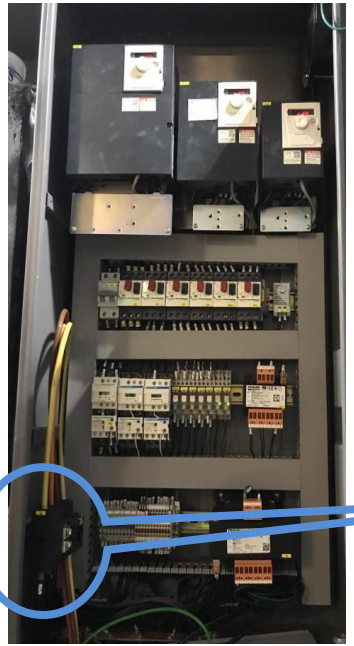
Touchscreen

Burner

Valve

Configuration of Broad Chiller

Control Panel



Main Power

Configuration of Broad Chiller

Touch Screen