KAORI

BRAZED PLATE HEAT EXCHANGER

User Manual

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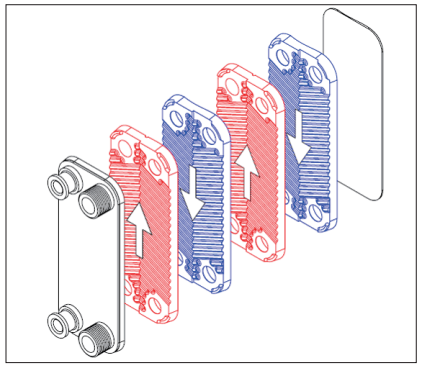
KAORI reserves the right to make changes without prior notice.
2023.08/1,000

KAORI HEAT TREATMENT CO., LTD.

1. Working Principle

Kaori's standard Brazed Plate Heat Exchanger (BPHE) is made by stainless steel chevron plates, brazed with copper or nickel. The brazing process seals the plates together making extremely durable. The spaces in between the plates become flow channels with one fluid flowing in odd number channels and the other in the even number channels. Heat exchange occurs through the designed plates over a large surface area making Kaori BPHEs very efficient.

We continue to provide a wide range or product choices, including working pressure from 2 to 140 bar, and the max. working temperature from 200°C to 900°C(specific model). Kaori's long experience in manufacturing and expertise in thermal technology allows us to be flexible in customizing our heat exchangers to meet you where you are. Kaori's BPHEs can be customized to handle a wide range of systems and capacities, and paired with the right connectors you need for easy installation.



2. Application

Kaori BPHEs, are the best suited for heat transfer between the following mediums.

- All types of refrigerants (gas).
- Water
- Oil
- Various brine solutions (glycol mixtures, Ethylene Glycol, Propylene Glycol, alcohols)
- Organic solvents

Application in strong acid or alkali (e.g. NH3) is suggested to use nickel-brazed plate heat exchangers.

Kaori BPHE can be used in:

- Heat Pumps and Solar Hot Water.
- Boilers, Domestic Heating, Floor Heating
- Chillers
- Refrigeration
- Refrigerated Showcase , Transport Refrigeration Systems
- Refrigerated Air Dryer, Temperature and Humidity Chambers
- Water Cooler (Drinking Water or Process Water for Various Industries)
- ORC Waste Heat Recovery Generator
- Fuel Cell, CHP, Wind Power
- Gear Box
- Plastic Machines, Welding Machines, Hydraulic Presses (Oil), and Compressor Oil Cooling

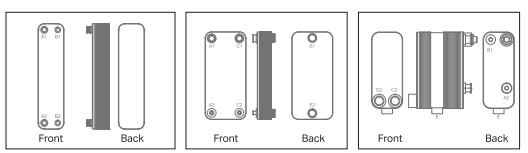
In refrigeration cycle, BPHE are widely used as:

- Evaporator
- Condenser
- De-superheater
- Subcooler
- Economizer
- Pre-cooler
- Inter-cooler
- Water / Oil cooler

3. Benefits

- Highly Efficient Thermal Design - High Performance
- More Efficient Use of Materials – Cost Effective
- Mass Reduction in Size – Compact, Less Space, Less Weight
- Proven and Reliable Quality - Long Life Time Durability
- Flexible in Customizing – Increase Production Efficiency

4. Installation



Flow Direction

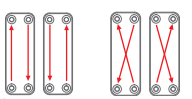
Application	Type	Fluid 1 (Side 1)	Fluid 2 (Side 2)	Fluid 3 (Side 3)
Evaporator (Single refrigerant)	K*1, K-S*1, R ,C, D*1	Refrigerant A2->A1	Chiller water B1->B2	
	Z400, Z401, Z600, Z601, D045, D046	Refrigerant A2->B1	Chiller water A1->B2	
Evaporator (Dual refrigerant)	K215D, K215S-D	Refrigerant 1 A2->A1	Refrigerant 2 C2->C1	Chiller water E1->E2
	Z415, Z416,	Refrigerant 1 A2->C1	Refrigerant 2 C2->A1	Water E1->E2
Condenser	K*1, K-S*1, R ,C, D*1	Refrigerant A1->A2	Cooling water B2->B1	
	Z400, Z401, Z600, Z601	Refrigerant B1->A2	Cooling water B2->A1	

*1. Except K215D, K215S-D, D045 and D046, the aforementioned models are listed separately in the table.
Note: In case the installation is different from above illustration, please consult KAORI sales representative at sales@kaori.com.tw

Application	Type	Fluid 1 (Side 1)	Fluid 2 (Side 2)	Fluid 3 (Side 3)
Heating, Cooling	K*1, K-S*1, R ,C, D*1, E, F	Cold water (or hot oil) A2->A1	Hot oil (or cold water) B1->B2	
	Z400, Z401, Z600	Cold water (or hot oil) A2->B1	Hot oil (or cold water) A1->B2	
Oil cooler	K*1, K-S*1, R ,C, Q	Cold water (or hot oil) A2->A1	Hot oil (or cold water) B1->B2	
	Z400, Z401, Z600	Cold water (or hot oil) A2->B1	Hot oil (or cold water) A1->B2	
Air Dryer (Refrigerant)	A030, A070	Refrigerant A2->B1	Air C2-> Separator ->D2	
	A140, A210	Refrigerant A2->B1	Air D2-> Separator ->C2	

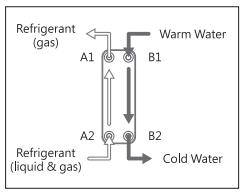
*1. Except K215D, K215S-D, D045 and D046, the aforementioned models are listed separately in the table.
Note: In case the installation is different from above illustration, please consult KAORI sales representative at sales@kaori.com.tw

- Always install your BPHE vertically, especially for a refrigerant system. This is done to keep a minimum amount of water below the connector.
- In order to achieve high thermal efficiency and high heat transfer rates, BPHE has to be installed in a counter flow direction as the graph on the right side.

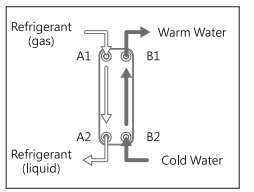


Refrigerant(Gas) Piping:

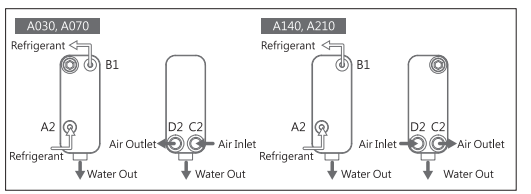
- **Graph(1) Evaporator:** the two-phased (liquid and gas) refrigerant enters the evaporator at the bottom left connector (A2) and the single-phased (gas) refrigerant leaves the evaporator from the top left connector (A1) after the heat transfer process. The water enters at the top right connector (B1) and leaves from the bottom right (B2). In the case of the evaporator, heat is transferred from water to refrigerant and both fluids are in counter flow direction as the graph (1) shown below.
- **Graph(2) Condenser:** the single-phased (gas) refrigerant enters the condenser at top left connector (A1) and the single-phased (liquid) refrigerant leaves the condenser from the bottom left connector (A2). The water enters the condenser at bottom right (B2) and leaves the condenser from top right (B1). In the case of the condenser, heat is transferred from refrigerant to water and both fluids are in counter flow direction.
- **Graph(3a) Air Dryer A030, A070:** the refrigerant enters from the bottom left connector (A2), after the heat transfer process, the refrigerant leaves from the top right connector (B1), and the air enters from the bottom right connect of the reverse side (C2). When air flows through the separator, the water pours from the bottom connector, and the dry air leaves from the bottom left connector (D2) as the graph(3a) shown on the left.
- **Graph(3b) Air Dryer A140, A210:** the refrigerant enters from the bottom left connector (A2), after the heat transfer process, the refrigerant leaves from the top right connector (B1), and the air enters from the bottom left connect of the reverse side (D2). When air flows through the separator, the water pours from the bottom connector, and the dry air leaves from the bottom right connector (C2) as the graph(3b) shown on the right.



Graph(1) Evaporator



Graph(2) Condenser



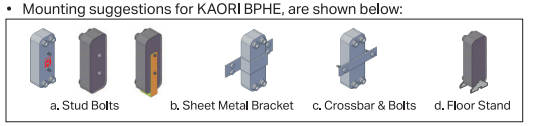
Graph(3a) Graph(3b)

- The BPHE should be mounted in an upright position or absorbers.
- Use flexible hoses or vibration dampers to reduce pulsation to protect the heat exchanger against vibrations, thermal and hydraulic induced stress.
- All items should be supported independently.
- The BPHE should be installed as below instruction:

Setting / flow direction of product	Vertical	Horizontal	Lying back	Slanted	Slanted
Counter flow	Evaporator: ○ Condenser: ○ Cooler: ○	Evaporator: ✕ Condenser: ✕ Cooler: ✕	Evaporator: ✕ Condenser: ✕ Cooler: ✕	Evaporator: ✕ Condenser: ✕ Cooler: ✕	Evaporator: ✕ Condenser: ✕ Cooler: ✕
Diagonal flow	Evaporator: ○ Condenser: ○ Cooler: ○	Evaporator: ○* Condenser: ○* Cooler: ○	Evaporator: ✕ Condenser: ✕ Cooler: ○	Evaporator: ✕ Condenser: ✕ Cooler: ○	Evaporator: ✕ Condenser: ✕ Cooler: ○

X: Not recommended, it might reduce the heat transfer performance.
*: Performance may be affected. For further information, please consult KAORI representative.

- Mounting suggestions for KAORI BPHE, are shown below:



* The installation fixture of the diagram is for reference only. The product itself does not include the above accessories. If you have related requirements, please consult KAORI representative.

- To avoid damage on stud bolts caused by excessive force, please refer to the reference chart below when installing stud bolts.

ITEM	First time bolting torque(MAX) (kgf-cm)	First time loosing torque(MIN) (kgf-cm)	Fifth time loosing torque(MIN) (kgf-cm)
M6	30.6	4.60	3.06
M8	61.2	8.67	6.12
M10	107.1	15.3	10.2
M12	158.1	23.4	16.3

This chart is base on ISO 2320:1997(E) Table 8. Over-torque of the heat exchanger connections can result in damage on stud bolts.

5. Anti-Freeze Protection Methods for BPHE

Any freezing or icing will damage BPHE and the refrigeration system. The following methods will minimize BPHE from freezing:

- Use Strainer or filter <1mm, 16 mesh before inlet water.
- Use brine (e.g. glycol) when evaporating temperature is close to the freezing point.
- Low working pressure will cause low evaporating temperature. If the evaporating temperature is below 0 °C, it will cause water to freeze. Since the bottom portion has the lowest temperature, it is the most likely spot for the BPHE to crack.
- To start the refrigeration system, always start the water pump for a few minutes and then start the compressor. To stop the system, always stop the compressor first then stop the water pump to avoid pump down operation.

(1) **Low Pressure Cut-off Switch (LP)**
A low-pressure cut-off switch should be installed with properly set values. When the actual evaporating pressure is lower than the setting value, the compressor will be cut off automatically.

(2) **Low Temperature Thermostat (LT)**
The function of the thermostat is to prevent evaporating temperature going under 0°C. If evaporating temperature is always above 0°C, then water has no chance to freeze and expand.

(3) **Water Temperature Sensor**
Installation of an antifreeze temperature sensor near the water outlet is another method to prevent the water from freezing. The suggested setting temperature is at 4°C for buffering purposes.

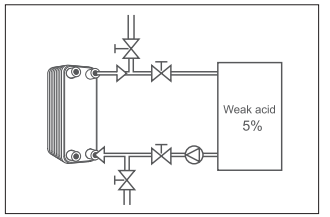
(4) **Water Flow Switch**
Installation of a water flow switch in the water circuit can prevent possible BPHE freezing due to low water flow rate. Usually, low water flow rate may be caused by malfunction of water pump, leaking pipes, pipe blockage due to pipe contamination or dirty filter.

6. Welding Procedure

Cleaning and degreasing the surface of copper pipes and BPHE connectors before welding. To avoid oxidation in the copper pipes and BPHE, protect the inside with N2-gas. Place the BPHE on a flat surface and wrap a wet rag around the connectors to protect the BPHE from excessive heating. **Use a 40~45% silver alloy soldering rod to weld the copper pipe into the connector at a maximum temperature of 800°C.** After soldering, clean and dry the connector and BPHE.

7. Cleaning

While fouling on the plate heat exchangers, back flushing is always possible to remove most of the soft debris that is blocking the inside. Weak acids with concentration less than 5%; for example: citric acid, oxalic acid add in a tank. Circulate the cleaning solvent through BPHE and flush thoroughly with clean fresh water. Before restarting the system, flush the plate heat exchanger with large amounts of fresh water to purge any remaining acid solution. If the acidity is too high, the copper and stainless steel inside the BPHE may be etched or corroded.



8. Warning

- Maintain a safe work environment to get a risk free of Personal injury or equipment damage.
- Fluid that is explosive, extremely flammable, highly toxic, highly corrosive, or hazardous in nature cannot be used with the BPHE. Examples are nitric acid, sulfuric acid, ammonia (for copper models) etc.
- When the water applied to the BPHE is of unknown quality, filter and strainer <1mm should be placed at the water inlet of BPHE to filter out the dirt or large particles.
- Mesh size of around 16 is suitable for most cases. Blockage of evaporator due to dirt or large particles will reduce the flow rate of water which might cause freezing effect and consequently damage the integrity of the BPHE.
- Chlorinated water, seawater, etc. are not suitable for BPHE due to their corrosive nature on regular stainless steel and copper. Please refer to the Water Quality Standard(JRA-GL-02-1994) as below chart.
- Ground water with high levels of sulfuric compound, sulfuric acid, or low PH value, may cause gradual copper corrosion and damage the BPHE in a few years.
- When moving the BPHE, always wear gloves and pay attention to the sharp edges around the bottom of BPHE.
- Storage in a dry and heated warehouse between 1°C and 50°C is required.

Water Quality Standard (JRA-GL-02-1994)

	ITEM		Cooling Water			Cool Water		Possibility	
			Circuit Water		Direct Pump				
			Close Circuit	Open Circuit	Instant Drain Water	Close Circuit 20°C below	Open Circuit	Corrosion	Scale
Basic Element	PH(25°C)		6.8~7.2	6.8~7.2	6.8~7.2	6.8~7.2	6.8~7.2		●
	EC(25°C)	μS/cm	≤800	≤300	≤400	≤400	≤300	●	●
	(Cl^{-1})	mg/l	≤200	≤50	≤50	≤50	≤50	●	
	(SO_4^{-2})	mg/l	≤200	≤50	≤50	≤50	≤50	●	
	$(PH4.8,CaCO_3)$	mg/l	≤100	≤50	≤50	≤50	≤50		●
	Total $(CaCO_3)$	mg/l	≤200	≤70	≤70	≤70	≤70		●
	Ca $(CaCO_3)$	mg/l	≤150	≤50	≤50	≤50	≤50		●
	SiO_2	mg/l	≤50	≤30	≤30	≤30	≤30		●
Reference Element	Fe	mg/l	≤1.0	≤0.3	≤1.0	≤1.0	≤0.3	●	●
	Cu	mg/l	≤0.3	≤0.1	≤1.0	≤1.0	≤0.1	●	
	S^{-}	mg/l	N.F	N.F	N.F	N.F	N.F	●	
	NH_4^{-1}	mg/l	≤1.0	≤0.1	≤1.0	≤1.0	≤0.1	●	
	Free Chlorine	mg/l	≤0.3	≤0.3	≤0.3	≤0.3	≤0.3	●	
	CO_3^{-2}	mg/l	≤4.0	≤4.0	≤4.0	≤4.0	≤4.0	●	
	Stability Value		6.0~7.0	——	——	——	——	●	●

1. The Water Quality for Heat Exchanger should be applied to above standard.
2. When using De-ionized water, pure water, extra pure water, nickel brazed is recommended.
3. If you are concerning about certain elements which are not listed on this chart, please contact our sales representative at sales@kaori.com.tw.

9. Warranty

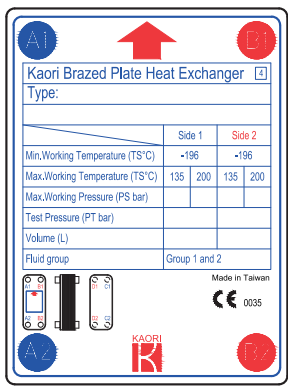
- Warranty period is **12 months from the date of shipment under normal use. The warranty covers manufacturing defects only.**
  This regulation is not applied if you have received an advance notice that KAORI will not provide the product warranty because of the unsuitable working environment.
- Exclusive warranty are:
  (1) Altered working condition or repaired in a manner affecting the efficiency of performance of the unit.
  (2) Damages caused by freezing, flood, fire, any natural disaster or accident.
  (3) Damages caused by incorrectly installed or operated.
  (4) The BPHE is surrounded by corrosive environment, or use inappropriate fluids (please refer to the Water Quality Standard).
  (5) Claims due to sediment deposits.

10. Disclaimer

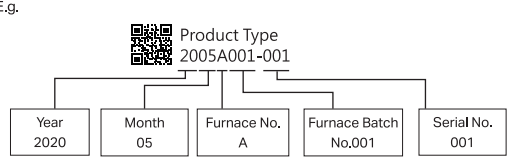
Kaori take every care to assure the accuracy of the information, however, the information is provided as it is for a reference and is not subject to guarantee. The information may be changed or updated without notice. KAORI is not liable for any direct or indirect damages of any kind arising use of the information.

11. Labeling and Marking

The following nameplate is an example of KAORI BPHE:



Model name will be shown on the label attached. For tracking purposes, a serial number will be carved on the front cover plate in QR Code format.
E.g.



KAORI

EU DECLARATION OF CONFORMITY

Manufacture : Kaori Heat Treatment Co., Ltd.
Address : (HQ) No. 11, Songjiang N. Rd., Chungli District, Taoyuan City, 320 Taiwan
(Plant KH) No. 3, Bengong 2nd Rd., Gangshang Dist., Kaohsiung City, 820 Taiwan

The Company mentioned above certifies under its sole responsibility that the equipment specified below satisfies the requirements of the pressure equipment directive - 2014/68/EU and is in conformity with the relevant Union harmonization legislation.

Brazed Plate Heat Exchanger (BPHE)

Type	K series	K010 / K025 / K030 / K040 / K050 / K060 / K070 / K095 / K105 / K200 / K205 / K210 / K215 / K415
	KS series	K015S / K025S / K030S / K040S / K050S / K060S / K070S / K095S / K105S / K200S / K205S / K210S / K215S / K416
	R series	R020 / R035 / R040 / R050 / R095 / R110 / R200 / R215 / R021 / R036 / R041 / R051 / R096 / R111 / R201 / R216
	B series	B050 / B075 / B080 / B110 / B051 / B076 / B081 / B111
	Z series	Z015 / Z070 / Z085 / Z400 / Z415 / Z600 / Z016 / Z071 / Z086 / Z401 / Z416 / Z601
	D series	D030 / D045 / D070/ D205 / D031 / D046 / D071/ D206
	I series	I030 / I050 / I070 / I095 / I105 / I200 / I205 / I210 / I400
	Q series	Q035 / Q055 / Q085
	A series	A030 / A032 / A033/ A070 / A072 / A073 / A140 / A143 / A210 / A211 / A300
	E/F series	E010 / E015 / E030 / E035 / E040 / E050 / E060 / F025
	C series	C020 / C021 / C022 /C036 /C040 / C041 / C042 / C095 / C096 / C097 / C200 / C201 / C202
Description		Plate Heat Exchanger
Year of manufacture		2023

- Harmonized standards applied :
  EN 13134:2000, EN13585:2012, EN14276-1:2020, EN13445-3:2021
  DIN EN 10028-7 Steel No. 1.4301/1.4307/1.4401/1.4404:2016

- Other technical standards and specifications used :
  ASTM A240/A240M TYPE 304/304L/316/316L
  ASTM A276 TYPE 304/316, ASTM A351 Grade CF8
  JIS G4303/G4304/G4305/G4318 SUS 304/304L/316/316L

Module of conformity assessment applied : Module H
PED Certificate number : 01 202 TWN/Q-19 0358

TÜV Rheinland Industrie Service GmbH
Am Grauen Stein, 51105 Köln, Germany
Notified Body number: 0035

SIGNED ON BEHALF OF THE MANUFACTURER / *AUTHORIZED REPRESENTATIVE*
Name : Joe Chou
Position : Vice General Manager
Place : Taiwan
Signature :