POLIDORO Heat Exchangers

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Dhavex product range
Installation and operating manual



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1. Brazed plate heat exchangers (BPHE)

Introduction

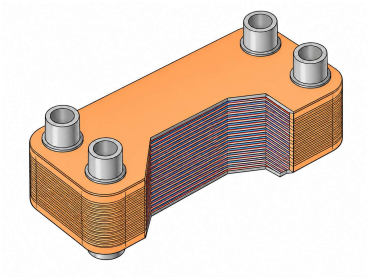
1.1 General information

POLIDORO spa. designs and manufactures brazed plate heat exchangers (hereinafter “BPHE” or “heat exchanger”) that are part of the “Dhavex” product range.

POLIDORO BPHEs are available in a wide range of sizes and can be used with different working fluids and pressures. Typical examples of working fluids are synthetic and mineral oils, water (excluding seawater), ethylene and propylene glycol solutions, and refrigerants (excluding natural refrigerants - ammonia and carbon dioxide - as well as use in transcritical cycles).

The heat exchanger is intended for a wide range of thermal applications, including refrigeration, residential heating, industrial heating and air conditioning, and the process industry.

The designations used in this manual refer to the entire Davhex heat exchanger range. The order specifications of each individual heat exchanger must also be taken into account.



The brazed plate heat exchanger consists of an assembly of corrugated plates forming two independent circuits, each with an inlet and an outlet identifiable on the BPHE end plates, as schematically shown in the following figure.

This manual is the reference for the use, installation and maintenance of the heat exchanger.

The installation and operation of brazed plate heat exchangers must be carried out by specifically trained specialist personnel, in compliance with all national and international regulations concerning safety and accident prevention.

Personnel using the heat exchanger must be familiar with the precautions relating to the fluids used and to the pressures and temperatures at which the heat exchanger operates. They must also be familiar with any precautions specific to the process of which the heat exchanger is a part.

Installation, commissioning and maintenance of the heat exchanger require the necessary authorisations in accordance with local regulations.

POLIDORO produces different types of plates that allow BPHEs to be used for different applications. The selection of the heat exchanger and plate type is determined by the inlet and outlet temperatures of each BPHE channel and by the allowable pressure drop.

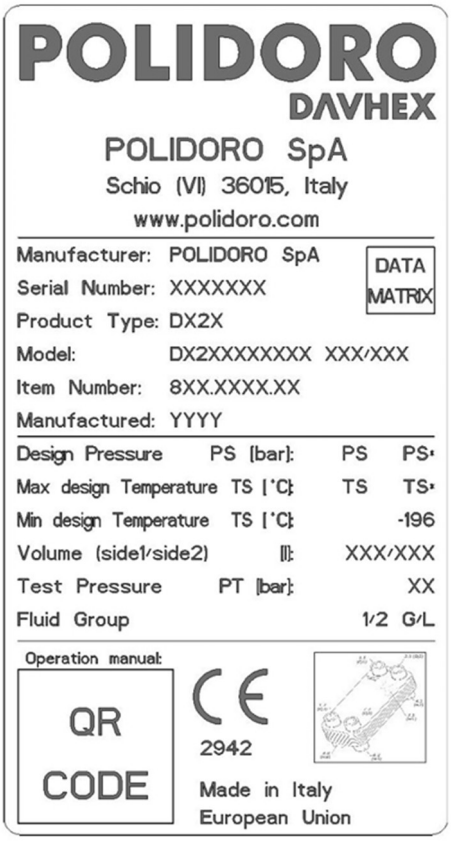
In particular, the maximum allowable temperature “TM” and the maximum allowable pressure “PS” are technical data indicated on the nameplate. The temperature refers to the temperature reached by the plate.

The heat exchanger is supplied without pressure protection devices, which are the responsibility of the end user.

Davhex heat exchangers are classified as pressure equipment pursuant to Directive 2014/68/EU of the European Parliament and of the Council.

Manufacturer information relating to BPHE type, model, manufacturing date, serial number, manufacturer and technical parameters is shown on the label applied to each BPHE.

The model coding is described in greater detail in the following section.



The nameplate will be set out according to the following example for PED category I, II, III and IV equipment.

Nameplate example

The PS and TS indications are interpreted as described below.

As shown, the “Design pressure PS” field and the “Max design temperature TS” field each contain two values. This designation means that pressure PS is constant and equal to PS up to temperature TS.

For temperatures above TS and up to TS*, pressure PS is calculated by linear interpolation between PS and PS* over the TS-TS* range.

Pressure PS and PS* and temperature TS and TS* refer to both circuits unless otherwise specified.

1.2 Heat exchanger coding and PED categorisation

The complete heat exchanger model identification code identifies some of its main characteristics, as shown in the following table.

PRODUCT SERIES/application		MAXIMUM OPERATING PRESSURE		MODEL	NO. OF PLATES	ANGOLO CHEVRON DELLE plates		INTERNAL FLOW	Connection identification number
DM	Heat exchange without phase change (e.g. water-to-water)	**1**	16 bar	**A**	*Il numero massimo di plates varia in base al modello.* *Esempio: scambiatore con 50 plates* *050*	**L**	Low	*Main flow arrangements*	
				B					
				C					
				D					
				F					
				G				**S**	
DBE	Evaporator for refrigerant applications	**2**	31 bar	**A**		**M**	Medium	**Z**	
				B					
				C					
				D					
				F				**X**	
			27 bar	**G**					
DBC	Condenser for refrigerant applications	**3**	45 bar	**A**		**H**	High		
				B					
				C					
				D					
				F					
				G					
DS	Steam applications								
DP	With protective internal coating for water-to-water applications (increased corrosion resistance and use with potable water)								

The application field identifies the intended use, while the other fields describe certain geometric characteristics and flow arrangements. Contact POLIDORO for further information on the product range.

For the BPHE range, DX identifies the generic application (DM, DS, DP, DBC, DBE). Accordingly, DX1X, DX2X and DX3X refer to BPHE subfamilies with pressure levels 1, 2 and 3, respectively. For a subfamily with a specific plate model, for example plate model A, the designation becomes DX1A at pressure level 1. Subfamilies with other pressure levels and plate models are designated in the same manner.

The following table gives the PED categories for heat exchangers in the DX2X family, considering a Group 1 fluid in the gaseous state.

For applications with a Group 1 liquid or a Group 2 fluid (for example, the DM product series), the PED category is lower. The end user is responsible for determining the applicable PED category for the specific installation (in accordance with Guideline C-16).

DX2X heat exchanger family

Plate model		A	B	C	D	F	G
Product code		DX2A	DX2B	DX2C	DX2D	DX2F	DX2G
PS [bar]		31	31	31	31	31	27
PS* [bar]		24	24	24	24	24	21
Design temperature TS		-196°C/+135°C	-196°C/+135°C	-196°C/+135°C	-196°C/+135°C	-196°C/+135°C	-196°C/+135°C
Temperature TS*		225°C	225°C	225°C	225°C	225°C	225°C
PT (test pressure) [bar]		46	46	46	46	46	40
PED fluid group		1 / 2	1 / 2	1 / 2	1 / 2	1 / 2	1 / 2
Physical state [V/L]		V / L	V / L	V / L	V / L	V / L	V / L
Single-channel volume [l]		0,039	0,055	0,078	0,082	0,116	0,279
Minimum number of plates		6	6	6	10	10	10
Maximum number of plates		60	60	60	140	200	250
Maximum number of channels		29+30	29+30	29+30	69+70	99+100	124+125
Maximum circuit volume [l]		1,180	1,660	2,350	5,758	11,618	34,981
Number of plates	Article 4,3	**6-50**	**6-36**	**6-24**	**10-22**	**10-16**	
	Category I	**52-60**	**38-58**	**26-40**	**24-38**	**18-26**	**10-12**
	Category II		**60**	**42-60**	**40-140**	**28-110**	**14-52**
	Category III					**112-200**	**54-250**
	Category IV						

Where the fluid group and physical state differ from the Group 1/gas conditions under which the equipment was certified, the following information may be used to facilitate the assessment of the equipment category.

PS [bar]	Plate model	Volume singolo canale [l]	Minimum number of plates	Maximum number of plates	Maximum circuit volume [l]	PED CATEGORIES – PLATE RANGES AND MAXIMUM CIRCUIT VOLUME FOR CHANGES IN PED CATEGORY			
						Gruppo fluido 1 Vapore	Gruppo fluido 1 Liquido	Gruppo fluido 2 Vapore	Gruppo fluido 2 Liquido
31	A	0,039	6	60	1,180	Art. 4(3): 6-50 plates | V max 0,985 L Cat. I: 52-60 plates | V max 1,180 L	Art. 4(3): 6-60 plates | V max 1,180 L	Art. 4(3): 6-60 plates | V max 1,180 L	Art. 4(3): 6-60 plates | V max 1,180 L
	B	0,055	6	60	1,660	Art. 4(3): 6-36 plates | V max 1,000 L Cat. I: 38-58 plates | V max 1,605 L Cat. II: 60 plate | V max 1,660 L	Art. 4(3): 6-60 plates | V max 1,660 L	Art. 4(3): 6-58 plates | V max 1,605 L Cat. I: 60 plate | V max 1,660 L	Art. 4(3): 6-60 plates | V max 1,660 L
	C	0,078	6	60	2,350	Art. 4(3): 6-24 plates | V max 0,946 L Cat. I: 26-40 plates | V max 1,570 L Cat. II: 42-60 plates | V max 2,350 L	Art. 4(3): 6-60 plates | V max 2,350 L	Art. 4(3): 6-40 plates | V max 1,570 L Cat. I: 42-60 plates | V max 2,350 L	Art. 4(3): 6-60 plates | V max 2,350 L
	D	0,082	10	140	5,758	Art. 4(3): 10-22 plates | V max 0,920 L Cat. I: 24-38 plates | V max 1,576 L Cat. II: 40-140 plates | V max 5,758 L	Art. 4(3): 10-140 plates | V max 5,758 L	Art. 4(3): 10-38 plates | V max 1,576 L Cat. I: 40-140 plates | V max 5,758 L	Art. 4(3): 10-140 plates | V max 5,758 L
	F	0,116	10	200	11,618	Art. 4(3): 10-16 plates | V max 0,946 L Cat. I: 18-26 plates | V max 1,526 L Cat. II: 28-110 plates | V max 6,398 L Cat. III: 112-200 plates | V max 11,618 L	Art. 4(3): 10-110 plates | V max 6,398 L Cat. II: 112-200 plates | V max 11,618 L	Art. 4(3): 10-26 plates | V max 1,526 L Cat. I: 28-110 plates | V max 6,398 L Cat. II: 112-200 plates | V max 11,618 L	Art. 4(3): 10-200 plates | V max 11,618 L
27	G	0,279	10	250	34,981	Cat. I: 10 -12plate | V max 1,501 L Cat. II: 14-52 plates | V max 6,244 L Cat. III: 54-250 plates | V max 34,981 L	Art. 4(3): 10-52 plates | V max 6,244 L Cat. II: 54-250 plates | V max 34,981 L	Art. 4(3): 10-12 plate | V max 1,501 L Cat. I: 14-52 plates | V max 6,244 L Cat. II: 54-250 plates | V max 34.981 L	Art. 4(3): 10-250 plates | V max 34,981 L

For the DX1X and DX3X families, use is considered only with Group 2 liquids. The operating conditions are given below.

DX1X family

Plate model	A	B	C	D	F	G
Product code	DX1A	DX1B	DX1C	DX1D	DX1F	DX1G
PS [bar]	16	16	16	16	16	16
Design temperature TS	-196°C/+95°C	-196°C/+95°C	-196°C/+95°C	-196°C/+95°C	-196°C/+95°C	-196°C/+95°C
PT (test pressure) [bar]	23	23	23	23	23	23
PED fluid group	2	2	2	2	2	2
Physical state [V/L]	L	L	L	L	L	L
Single-channel volume [l]	0,039	0,055	0,078	0,082	0,116	0,279
Minimum number of plates	6	6	6	10	10	10
Maximum number of plates	60	60	60	140	200	250
Maximum number of channels	29+30	29+30	29+30	69+70	99+100	124+125
Maximum circuit volume [l]	1,180	1,660	2,350	5,758	11,618	34,981
Number of plates Article 4,3	**6-60**	**6-60**	**6-60**	**10-140**	**10-200**	**10-250**

DX3X family

Plate model	A	B	C	D	F	G
Product code	DX3A	DX3B	DX3C	DX3D	DX3F	DX3G
PS [bar]	45	45	45	45	45	45
Design temperature TS	-196°C/+95°C	-196°C/+95°C	-196°C/+95°C	-196°C/+95°C	-196°C/+95°C	-196°C/+95°C
PT (test pressure) [bar]	65	65	65	65	65	65
PED fluid group	2	2	2	2	2	2
Physical state [V/L]	L	L	L	L	L	L
Single-channel volume [l]	0,039	0,055	0,078	0,082	0,116	0,279
Minimum number of plates	6	6	6	10	10	10
Maximum number of plates	60	60	60	140	200	250
Maximum number of channels	29+30	29+30	29+30	69+70	99+100	124+125
Maximum circuit volume [l]	1,180	1,660	2,350	5,758	11,618	34,981
Number of plates Article 4,3	**6-60**	**6-60**	**6-60**	**10-140**	**10-200**	**10-250**

1.3 Environmental compliance

Installation, operation, maintenance and disposal of the heat exchanger must be carried out in compliance with applicable environmental regulations and with the aim of reducing environmental impact.

Packaging materials such as cardboard, plastic, wood and any metal straps must be reused, recycled or sent for energy recovery in accordance with local regulations.

The heat exchanger consists of stainless steel plates brazed with copper. Any studs and fastening screws are made of stainless steel.

At the end of its service life, the heat exchanger must be sent to authorised centres for recovery or disposal in accordance with local regulations.

Any residues of process fluids, detergents or hazardous substances must be drained, collected and treated separately in a safe manner and in compliance with applicable regulations.

2. Safety instructions

The heat exchanger must be used in accordance with the instructions described in this manual. Otherwise, use of the heat exchanger may result in serious injury.

Upon receipt of the BPHE delivery, any claim concerning external damage or incomplete delivery must be reported in writing to the logistics company.

The following sections identify WARNING ⚠ to be observed in order to avoid incorrect behaviour that could lead to potentially hazardous situations for people and property.

These Operating Instructions must be kept in good condition and in a place that is easily accessible to the personnel concerned.

These Operating Instructions do not exempt the user from compliance with current safety and accident-prevention legislation.

POLIDORO spa. declines all liability in the event of:

- improper use of the pressure equipment or modification of the pressure equipment

- failure to comply with current safety and accident-prevention regulations;

- failure to comply with the contents of these Operating Instructions.

⚠WARNING: Read the entire manual carefully before installation and commissioning. Failure to do so may result in personal injury or damage to the equipment.

⚠WARNING: The BPHE structure may have sharp edges. Always wear safety gloves and handle with care.



⚠WARNING: Beware of hot surfaces. During operation, BPHE surfaces may reach high temperatures.



⚠WARNING: Work and repairs on heat exchangers are permitted only when the unit is not under pressure and its surface temperature is below 40 °C.

⚠WARNING: When the heat exchanger is used at high temperature, provide suitable thermal insulation. Exercise caution near the heat exchanger to avoid burns.

⚠WARNING: If the heat exchanger is used in environments containing hazardous liquids and gases with a fire risk, comply with mandatory safety requirements and use suitable safety accessories. A fire in the BPHE operating environment may cause the allowable limits of the heat exchanger to be exceeded.

⚠WARNING: Do not drop the brazed plate heat exchanger from a height. Protect it from impacts during installation.

⚠WARNING: Before installation, check that the unit has not been damaged during transport and storage and that the components meet the specified requirements.

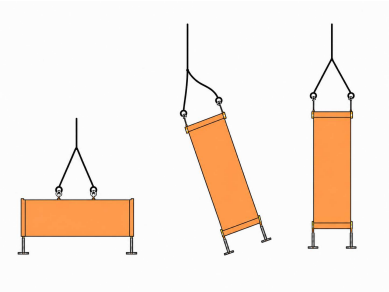
⚠WARNING: Use personal protective equipment: safety footwear, protective helmet, safety goggles and protective gloves.

3. Installation and mounting

Lifting

For heavier heat exchangers, lifting eyes or brackets may be required for handling. Contact POLIDORO for available solutions.

⚠WARNING: Do not lift the heat exchanger directly by the connections or studs.



⚠WARNING: Keep personnel at a safe distance from the heat exchanger during lifting to prevent injury.

Mounting

The BPHE mounting position must provide sufficient space around the unit to allow maintenance and servicing.

For operation with phase-change fluids, the BPHE must always be installed in a vertical position (evaporator, condenser).

On request, base supports are available for models F and G for mounting the heat exchanger on a fixing base.

During heat exchanger installation, the maximum loads on the fastening bolts must not be exceeded.

Stud	Tensile force Ft [N]	Torque Mt [Nm]
M8x20 (external thread)	2000	6
M10x25 (external thread)	3200	12
M12x25 (external thread)	4700	21

Table 3.1 Allowable loads on studs during mounting

Installation

⚠WARNING: The heat exchanger must be installed with devices protecting it against pressures and temperatures outside the limits shown on the nameplate. Safety valves must be installed in accordance with the applicable regulations for pressure equipment.

⚠WARNING: Make sure that the BPHE is not exposed to severe vibrations or pulsations. To prevent this, vibration absorbers must be installed in the piping system or heat exchanger mounting system, or between the BPHE and other equipment. BPHE service life is significantly reduced if system and flow control is inadequate.

⚠WARNING: Before connecting the BPHE to new or renewed piping, make sure that the piping is free from debris and/or coarse particles that could clog the BPHE channels.

⚠WARNING: To increase BPHE operating safety, filters are recommended at the fluid inlets to prevent particles from entering the channels, as these may clog the heat exchanger, reduce efficiency, increase pressure drop and increase the risk of freezing.

⚠WARNING: The installation must allow venting, draining and cleaning by means of suitable valves and access points.

⚠WARNING: Use mounting brackets to secure the BPHE or support it from the base. Supporting heat exchangers only by the piping, for example by the fittings or nearby pipes, is not recommended.

⚠WARNING: Perform a leak test before commissioning the heat exchanger.

Connections

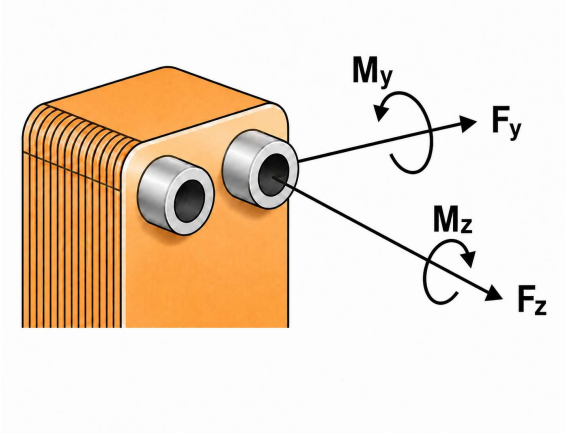
Different types of standard connections are available. Contact POLIDORO spa. for the available types.

During installation of a heat exchanger, the maximum forces and torques shown in the following table must not be exceeded.

Connection outside diameter [mm]	*My [Nm]*	*Fy * [kN]*	*Fz [kN]*	*Mz [Nm]*
≥15 - <26	*5.5*	*1.8*	*1,1*	*25*
≥26 - <36	*15*	*4*	*2*	*110*
≥36 - <47	*25*	*10*	*2,5*	*150*
≥47 - ≤60	*50*	*13*	*3*	*230*

Table 3.2 Allowable loads on connections during installation

**The force Fy is considered to act at the base of the connection.*

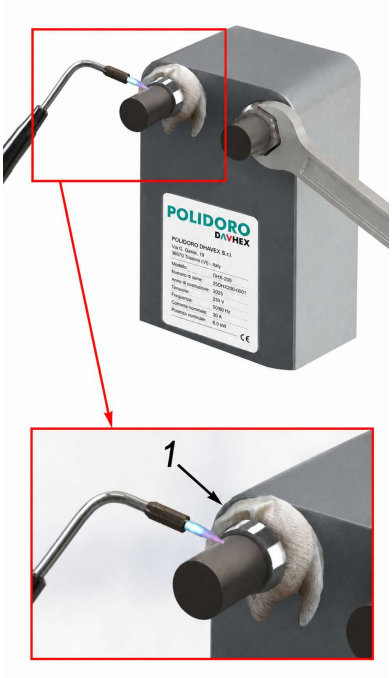


⚠WARNING: Piping must be adequately supported to prevent loads from being transferred to the connections and to the BPHE.

Brazed connections

Clean and degrease the surfaces to be brazed, both on the copper pipes and on the BPHE fittings. Polish the surfaces to remove oxides. Braze the surfaces. To prevent oxidation during brazing, fill the inside of the BPHE with nitrogen. Direct the flame towards the fittings. Do not direct the brazing torch flame towards the BPHE and do not exceed a process temperature of 650 °C (1200 °F).

Filler metal: silver content not less than 45%. Use a wet cloth to prevent overheating of the BPHE. Make sure that the BPHE and pipes remain stationary during brazing.



⚠WARNING: The use of a wet cloth is recommended to limit overheating during work on the fittings.

Welded connections

Use TIG (GTAW) welding.

Use a wet cloth to prevent overheating of the BPHE.

To prevent oxidation during the welding/brazing process, fill the inside of the BPHE with nitrogen.

Take suitable measures to prevent copper contamination in areas adjacent to the weld joint. The presence of copper could impair the weld.

⚠WARNING: Excessive heat may melt the copper and damage the BPHE.

Threaded connections

Install the BPHE first, then connect the piping using threaded fittings.

The BPHE supply piping must be installed so as to avoid stresses or tensile loads on the threaded fittings.

⚠WARNING: If the purchaser orders a fitting or flanged connection separately from the BPHE, POLIDORO spa. is not responsible for poor-quality brazing/welding of such fittings or for any resulting accidents.

4. Connections

In most standard BPHE applications, maximum thermal efficiency is achieved with counter-current flow, where the two fluids flow in opposite directions inside the BPHE.

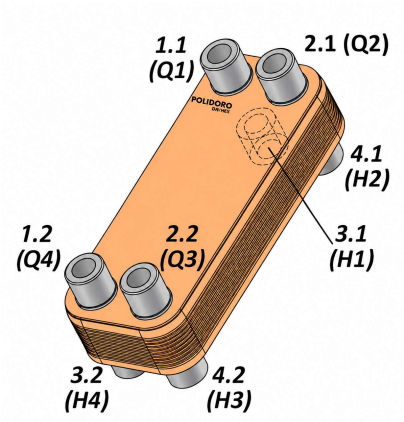
With reference to the following figure, two circuits can be identified:

Circuit 1 (primary channel), with connections 1.1 and 1.2, also identified respectively as Q1 and Q4 in the thermal calculation software

Circuit 2 (secondary channel), with connections 2.1 and 2.2, also identified respectively as Q2 and Q3 in the thermal calculation software

Circuit 1, the primary channel, consists of channels that are always adjacent on both sides to channels of the secondary circuit. Circuit 2 therefore always has one more channel than Circuit 1.

The heat exchanger orientation for identifying the connections and circuits is determined by the “Polidoro Dhavex” logo marking located near connection 1.1 (see figure).



BPHE connection numbering

With reference to the figure, connections 3.1 and 3.2 of the primary circuit and connections 4.1 and 4.2 of the secondary circuit can also be identified when they are present on the heat exchanger face opposite the side bearing the reference marking.

Heat exchange without fluid phase change

Normally, the circuit with the higher temperature and pressure must be connected to the primary circuit of the BPHE.

For example, for water-to-water heat exchangers, the heat exchanger must be connected in counter-current flow to achieve maximum operating efficiency, as follows:

1.1 (or 3.1): hot-water inlet from the heating system

1.2 (or 3.2): hot-water outlet to the heating system

2.2 (or 4.2): cold-water circuit inlet to be heated

2.1 (or 4.1): cold-water circuit outlet after heating

This configuration maximises heat-transfer efficiency and minimises heat losses because the hot-fluid channels are always located between the cold-fluid channels.

Heat exchange with phase-change fluids

Use of the BPHE in refrigeration units requires the refrigerant circuit to be the primary circuit, while water or water-glycol is connected to the secondary circuit. This makes the process more efficient both when used as an evaporator and as a condenser. Counter-current flow always provides the highest efficiency.

In addition, in applications with a phase-change fluid, the heat exchanger must be installed vertically for correct operation.

⚠WARNING: Failure to connect the refrigerant circuit to the primary channel as specified may result in a loss of efficiency.

When operating as an evaporator, incorrect connection involves the following risks:

- The pressure drop on the water side increases considerably
- The refrigerant does not achieve the required performance in terms of efficiency
- If the refrigerant is incorrectly connected to Circuit 2, ambient condensate may freeze on the heat exchanger, with the possibility of heat exchanger failure.

Use as a condenser

When the heat exchanger is used as a condenser, follow the instructions below for the circuit connections.

1.1 (or 3.1): refrigerant inlet
1.2 (or 3.2): refrigerant outlet
2.2 (or 4.2): water / water-glycol circuit inlet
2.1 (or 4.1): water / water-glycol circuit outlet

Use as an evaporator

When the heat exchanger is used as an evaporator, follow the instructions below for the circuit connections.
In this case, the refrigerant enters at the bottom at connection 2.2 (or 4.2).
In all cases, where a flow distribution system is present, it must always be located at the bottom at connection 1.2 (or 3.2).

1.1 (or 3.1): refrigerant outlet
1.2 (or 3.2): refrigerant inlet
2.2 (or 4.2): water / water-glycol circuit outlet
2.1 (or 4.1): water / water-glycol circuit inlet

The expansion control valve must be installed at a distance of 150-300 mm from the refrigerant inlet. The pipe connecting the expansion valve to the refrigerant inlet must be straight, without bends or elbows, and preferably horizontal. The valve should be selected with a capacity slightly higher than that of the heat exchanger.

For heat exchangers used in non-standard or special configurations, contact the manufacturer or company representative for further information.

5. Start-up

Before starting the BPHE, check that the maximum operating parameters indicated on the manufacturer's label are not exceeded.

Check for any leaks at all fluid connections.

Pumps supplying the BPHE must be fitted with shut-off valves.

To prevent water hammer, flow adjustment and valve opening or closing must be carried out slowly. Water hammer can cause pressure peaks and damage to the heat exchanger.

The system must be free of air to prevent BPHE malfunctions. Suitable vent valves must therefore be provided.

At start-up, the circuit drain valve and vent valve must be open while the suction valve is closed. Then start the pump and slowly open the suction valve. Close the vent valve once all the air has been released.

Residual air in the system and in the BPHE reduces operating efficiency and increases the risk of corrosion.

Make sure that pulsations and vibrations are not transmitted to the BPHE. The piping must be installed correctly to prevent damaging loads on the fittings.

⚠WARNING: To prevent water hammer, adjust the flow rate and operate the valve slowly and gradually.

6. Operation

The BPHE must not exceed the maximum pressures and temperatures indicated on the nameplate. The heat exchanger mounting must minimise loads on the connections and vibrations transmitted to the heat exchanger.

The heat exchanger is not designed or approved for operation under mechanical or thermal fatigue conditions.

Significant and sudden changes in temperature and pressure may therefore damage the heat exchanger.

It is therefore necessary to ensure that the heat exchanger operates without pressure and temperature fluctuations. For this reason, water hammer must be avoided, valves allowing gradual flow-rate changes must be used and operated (for example, avoid quick-closing valves), and the system in which the heat exchanger is installed must provide stable temperatures and pressures, with fluctuations having the lowest possible amplitude and frequency.

In addition, the temperature difference between the primary and secondary circuits must be limited.

Since the heat exchanger can operate at low or high temperatures, suitable insulation must be used. This prevents injuries due to excessively high or low heat exchanger temperatures in accordance with local regulations. Check that the insulation temperature limits are compatible with the operating temperatures.

⚠WARNING: During operation, the maximum allowable temperatures and pressures indicated on the BPHE label must not be exceeded.

⚠WARNING: The heat exchanger is not approved for mechanical or thermal fatigue loading. Operation of the BPHE with severe temperature fluctuations or pressure surges may damage the BPHE and is not permitted. If severe temperature fluctuations, pressure surges or water hammer occur, stop operation of the BPHE.

⚠WARNING: Use suitable control and regulation devices to ensure correct operation of the heat exchanger.

⚠WARNING: Make sure that the heat exchanger is suitably insulated to prevent injuries due to excessively high or low heat exchanger temperatures, in accordance with local regulations.

⚠WARNING: Check that there are no leaks from the connections during operation. If leaks are present, stop operation.

⚠WARNING: Make sure that the heat exchanger mounting minimises loads on the connections and vibrations.

⚠WARNING: During operation, avoid excessive temperature differences (greater than 40 °C) between the primary and secondary circuits. Avoid high rates of change of fluid temperature.

⚠WARNING: Aggressive fluids that may cause corrosion of BPHE materials must not be used. Check fluid compatibility with the heat exchanger materials.

Regularly check the efficiency of the control device and monitor the measured values. This allows timely identification of BPHE malfunctions, such as changes in the system hydraulic parameters or the need for cleaning.

During operation, make sure to avoid any operating condition that could exceed the system design limits and the operating instructions.

For non-standard applications not described in this manual, contact the manufacturer or company representatives for further information.

Shutdown

Before taking the BPHE out of service, gradually reduce the flow rate, slowly close the supply valves and stop the pump. The side at the higher pressure must be shut down first.

During BPHE shutdown, stop the primary circuit first and only then the secondary circuit. On restart, start the secondary circuit first and only then the other circuit, in order to reduce the possibility of overheating the heat exchanger.

After a long period of system shutdown, the BPHE must be completely drained and cleaned. This is required because of the risk of freezing and also when hazardous or harmful liquids are used in the BPHE, as failure to complete these operations may lead to biological contamination.

7. Freeze protection

Freezing can cause severe damage to the BPHE due to ice formation. If the operating fluid temperatures approach the freezing point, antifreeze agents such as glycol solutions must be used.

In particular, the risk of freezing is present when the heat exchanger is used in refrigerant applications and as an evaporator.

This can occur if the refrigerant evaporation temperature (or bubble-point temperature if the refrigerant is a mixture) is below the freezing temperature of the fluid in the secondary circuit.

⚠WARNING: During system start-up and shutdown, the temperature of the secondary-circuit fluid must not fall below its freezing temperature.

⚠WARNING: Use an antifreeze protection thermostat and a flow switch to ensure that water or water-antifreeze solution flows in the secondary circuit for at least 1 minute before and during compressor start-up. Use a low-pressure switch to ensure that the primary-circuit pressure does not fall below the specified values.

⚠WARNING: After shutdown of the system or compressor, maintain flow in the secondary circuit until the evaporator pressure rises to a value at which the temperature of the primary-circuit fluid is above the freezing temperature of the secondary-circuit fluid.

⚠WARNING: Do not empty the heat exchanger by running the compressor after shutdown (pump-down function). The temperature could fall below the freezing point of the fluid in the secondary circuit.

⚠WARNING: When the BPHE is used as an evaporator in refrigeration units, carefully check the BPHE parameters using suitable thermal verifications. Use only appropriate control devices.

⚠WARNING: Use suitable insulation on the BPHE to prevent injury and to prevent ambient moisture from freezing on the heat exchanger.

⚠WARNING: To prevent small particles from entering and depositing inside the BPHE (> 1 mm), install suitable filters at the heat exchanger inlets (100 µm). These particles may increase the risk of freezing.

8. Overheating protection

⚠WARNING: If the primary circuit is supplied with hot fluids or gases, for example when used as a condenser, make sure that flow in the secondary circuit is active before supplying the primary circuit.

⚠WARNING: Make sure that the pressure in the secondary circuit is sufficient to prevent boiling during operation.

9. Fouling, scaling and clogging

BPHE clogging and scale formation may depend on several factors, such as flow velocity, temperature and water quality.

To prevent small particles from entering and depositing inside the BPHE (> 1 mm), install suitable filters at the heat exchanger inlets (100 µm). Otherwise, the plate channels may become clogged, causing reduced efficiency, increased pressure drop or freezing of the heat exchanger when operating as an evaporator.

The deposition of small particles can be prevented by ensuring high flow turbulence.

Factors contributing to scale formation and other deposits in domestic hot-water systems include:

- Water quality (see Table 11.1);
- Low water velocity and higher fluid temperatures promote calcium deposits. An excessively low hot-water flow rate in certain systems reduces flow turbulence. This is a common cause of reduced self-cleaning action; in this case, precipitated calcium is deposited on the plates. This is particularly relevant in domestic hot-water systems;
- In regions with a high calcium content in the water and a high risk of small-particle deposits, demineralising and softening the water is recommended;
- High plate temperature in hot-water systems increases the possibility of scale formation and the risk of small-particle deposits. For BPHE wall temperatures above 70°, the risk of deposit formation increases.

Scale formation results in reduced performance, which may appear as an increase in pressure drop and a reduction in heat-transfer capacity.

10. Cleaning

The BPHE must be cleaned regularly to prevent deposits from forming in the heat exchanger channels. Cleaning must be carried out in counter-current flow using specific detergents and weak acids. The compatibility of chemicals and detergents with copper and stainless steel must be checked. After cleaning, the BPHE must be rinsed with clean water.

Complete information on the substances must be obtained from the detergent manufacturers to determine whether they may affect the BPHE materials. Cleaning must be carried out in accordance with safety and accident-prevention instructions and with the detergent manufacturer's recommendations.

Failure to comply with these conditions may damage the BPHE.

⚠WARNING: Use appropriate personal protective equipment when using cleaning detergents. Detergents may be corrosive and cause injury.

⚠WARNING: Cleaning residues must be disposed of in accordance with local regulations.

11. Corrosion

⚠WARNING: The brazed plate heat exchanger consists of corrugated stainless steel plates brazed with copper. It is important to avoid factors that contribute to corrosion of stainless steel and copper, as well as copper dissolution during operation. Failure to comply with these conditions may damage the BPHE.

The main water properties that cause metal corrosion are electrical conductivity, pH, water hardness, alkalinity, chloride and sulfate ion concentration, and dissolved oxygen. A high chloride and sulfate content significantly increases the likelihood of corrosion.

Avoid ammonia and other liquids that are particularly aggressive towards copper. Sulfides are also particularly aggressive towards copper.

Stainless steel is particularly susceptible to corrosion in the presence of chlorides. Chlorides attack the passive layer of the steel, compromising the protection mechanism typical of these steels. The severity of the attack also depends on temperature as well as on all other factors.

Table 11.1 provides guidance but cannot be considered definitive due to the complexity of corrosion phenomena.

To prevent electrochemical corrosion:

1. The heat exchanger must be earthed. The electrical potential between the heat exchanger and earth must be 0. The earth impedance must be R < 4 Ω.
2. Galvanic corrosion caused by the use of dissimilar metals cannot be tolerated. Measures must be taken to separate galvanic couples, for example by using bronze or stainless steel adapters and fittings.
3. Follow the manufacturer's recommendations for allowable concentrations of impurities in the water (see Table 11.1).

Recommended values for water properties and impurities for BPHEs:

Chemical species / property	Concentration [mg/l]	Chemical species / property	Concentration [mg/l]
Electrical conductivity	10-500 µS cm-1	Aluminium (Al)	< 0,2 mg/l
pH	7,5 - 9,0	Iron (Fe)	< 0,2 mg/l
Hardness (°dH)	4 – 8.5	Manganese (Mn)	< 0,1 mg/l
Bicarbonates (HCO3-)	70 - 300 mg/l	Ammonia (NH3)	< 0.5 mg/l
Sulphates (SO42-)	< 70* mg/l	Nitrates (NO3)	< 100 mg/l
Ratio (HCO3-)/(SO42-)	> 1,5	Free carbon dioxide (CO2)	< 5,0 mg/l
Free chlorine (Cl2)	< 1,0 mg/l	Hydrogen sulphide (H2S)	< 0,05 mg/l
Chlorides (Cl-), depending on temperature	< 25 ppm (130 °C) < 100 ppm (80 °C) < 300 ppm (50 °C)	Copper	<2,0 mg/l
Oxygen (O2)	<0.02		

Table 11.1. Guideline values for preventing corrosion of heat exchanger materials.

⚠WARNING: Copper may trigger corrosion in systems containing different types of materials. Do not use the heat exchanger in installations using galvanised pipes.

12. POLIDORO BPHE dimensions

The internal volume of the BPHE can be determined using the formula Vmax = Vch × N, where Vmax is the internal volume of the heat exchanger, Vch is the channel volume and N is the number of channels. The number of channels is Nplates/2 for circuit 2 and Nplates/2 − 1 for circuit 1.

Model	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	L [mm]	Empty weight [kg]
A	90	228	43	182	22	DX1A – DX2A: 5,95 + 2,25*N DX3A: 10,25 + 2,3*N	DX1A – DX2A: 0,876 + 0,061*N DX3A: 1,578 + 0,070*N
B	90	325	43	279	22	DX1B – DX2B: 5,95 + 2,25*N DX3B: 10,25 + 2,3*N	DX1B – DX2B: 1,16 + 0,088*N DX3B: 2,159 + 0,097*N
C	94	463	43	415	22	DX1C – DX2C: 10,2 + 2,20*N DX3C: 14,5 + 2,3*N	DX1C – DX2C: 1,65 + 0,128*N DX3C: 3,069 + 0,137*N
D	123	380	64	320	27	DX1D – DX2D: 12,5 + 2,18*N DX3D: 14,5 + 2,25*N	DX1D – DX2D: 2,154 + 0,136*N DX3D: 3,706 + 0,155*N
F	125	535	64	471	27	DX1E – DX2E: 12,5 + 2,25*N DX3E: 16,8 + 2,25*N	DX1E – DX2E: 2,99 + 0,19*N DX3E: 5,056 + 0,210*N
G	264	547	174	456	27	DX1F – DX2F: 18,2 + 2,13*N DX3F: 23,2 + 2,3*N	DX1F – DX2F: 10,21 + 0,382*N DX3F: 15,036 + 0,447*N - 1

13. Insulation

On request, Polidoro can supply an insulation kit for the heat exchanger.

Thermal insulation must be installed after brazing and welding work has been completed and once the equipment has cooled down.

Before installing the insulation kit, make sure that the appropriate size has been selected and that it matches the BPHE dimensions.

14. Warranty

POLIDORO provides a 24-month warranty for its products from the date of delivery, unless otherwise agreed with the customer. The warranty covers material and product defects arising during the manufacturing process. The warranty does not cover defects or damage resulting from installation and operation, including corrosion and freezing of the heat exchanger.

The operating performance of POLIDORO BPHEs is based on correct installation, maintenance and the operating conditions described in this manual. POLIDORO is not responsible for losses resulting from failure to comply with these conditions.

⚠WARNING: BPHE installation and maintenance must be carried out in accordance with this manual. If this condition is not met, POLIDORO is not responsible for BPHE operation.

For further information, contact the manufacturer or its representatives.

Standards, manufacturing site and contacts

The products and manufacturing processes comply with the requirements of the following standards:

- EN ISO 9001:2015 (ISO 9001:2015)
- EN ISO 14001:2015 (ISO 14001:2015)
- PED - 2014/68/EU

Manufacturing site

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