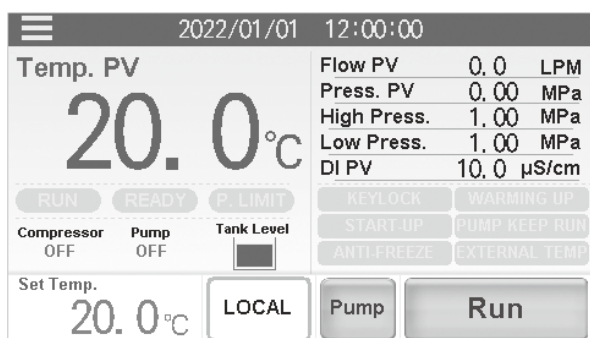


Air-cooled refrigeration

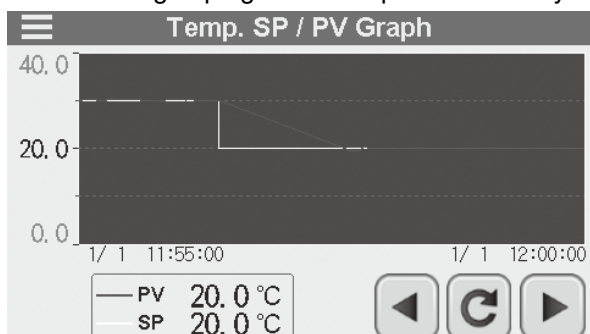
- Cooling capacity: 38 kW
- Power supply:
 - 3-phase 380 to 415 VAC (50/60 Hz)
 - 3-phase 460 to 480 VAC (60 Hz)
- Set temperature range: 5 to 35°C
- Max. ambient temperature: 45°C
- Temperature stability: $\pm 0.1^\circ\text{C}$
- With heating function
- Immersion pump (Mechanical sealless)
- Waterproof specification: IPX4
- Touch panel, Improved usability and visibility (For details, refer to page 166.)



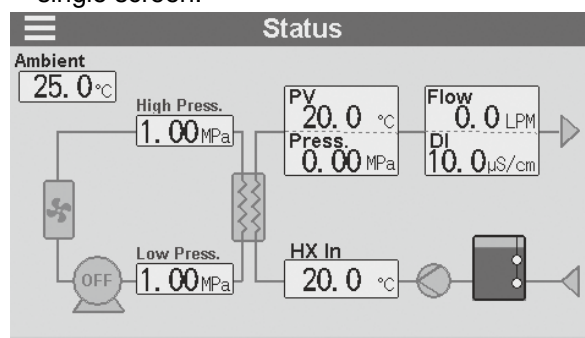
- Home screen



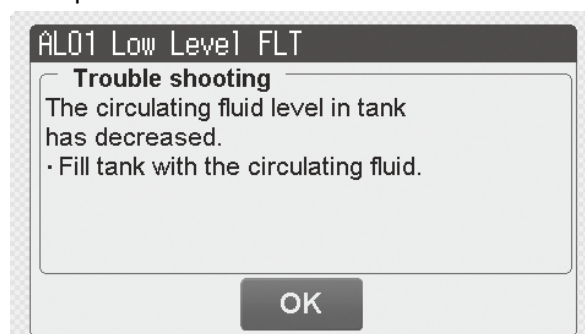
- Graphical representation of the temperature allows for grasping of the temperature history.



- Chiller operation status can be monitored on a single screen.



- Display of alarm details allows for quick response.



CONTENTS

HRS400 Series **Standard Type**



Thermo-chiller HRS400 Series

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Precautions on Cooling Capacity Calculation	p.174
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Thermo-chiller

Standard Type

Air-cooled 460 V Type

HRS400 Series



How to Order

HRS 400 - A - 46 -

Cooling capacity
400 38 kW

Cooling method
A Air-cooled refrigeration

Pipe thread type

Nil	Rc
F	G (With Rc-G conversion fitting)
N	NPT (With Rc-NPT conversion fitting)

Power supply

46	3-phase 380 to 415 VAC (50/60 Hz) 3-phase 460 to 480 VAC (60 Hz)
----	---

Option 1

Nil	None
A	With caster adjuster-foot
D	Electric conductivity control
K*1	With fluid fill port
M	Applicable to deionized water piping

*1 This is a manual fluid fill port that is different from the automatic fluid fill port. Fluid can be supplied manually into the tank without removing the side panel. (Fluid can be supplied manually for models without option K if the side panel is removed.)



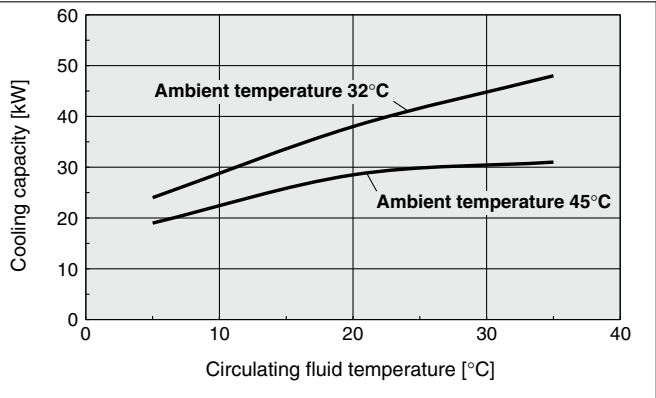
Specifications

Model			HRS400-A-46	
Cooling method			Air-cooled refrigeration	
Refrigerant			R410A (HFC)	
Refrigerant charge		kg	3.7	
Control method			PID control	
Ambient temperature/Altitude*1, 9, 11			°C Temperature: -5 to 45, Altitude: less than 3000 m	
Circulating fluid system	Circulating fluid*1, 2		Tap water, 15% Ethylene glycol aqueous solution, Deionized water	
	Set temperature range*1		°C 5 to 35	
	Cooling capacity*3, 9		kW 38	
	Heating capacity*4		kW 8	
	Temperature stability*5		°C ±0.1	
	Pump capacity	Rated flow (Outlet)*6	L/min	125 (0.45 MPa)
		Maximum flow rate	L/min	180
		Maximum pump head	m	68
	Settable pressure range*7		MPa 0.1 to 0.68	
	Minimum operating flow rate*8		L/min 40	
	Tank capacity		L 60	
	Circulating fluid outlet, circulating fluid return port			Rc1 (Symbol F: G1, Symbol N: NPTG1)
	Tank drain port			Rc3/4 (Symbol F: G3/4, Symbol N: NPTG3/4)
	Automatic fluid fill system (Standard)	Supply side pressure range	MPa	0.2 to 0.5
Supply side fluid temperature		°C	5 to 35	
Automatic fluid fill port		Rc1/2 (Symbol F: G1/2, Symbol N: NPTG1/2)		
Overflow port			Rc1 (Symbol F: G1, Symbol N: NPTG1)	
Fluid contact material		Metal	Stainless steel, Copper (Heat exchanger brazing), Brass, Bronze	
		Resin	PTFE, PU, FKM, EPDM, PVC, NBR, POM, PE, NR, PBT	
Electrical system	Power supply		3-phase 380 to 415 VAC (50/60 Hz) Allowable voltage range ±10% (No continuous voltage fluctuation) 3-phase 460 to 480 VAC (60 Hz) Allowable voltage range ±4%, -10% (Max. voltage less than 500 V and no continuous voltage fluctuation)	
	Applicable earth leakage breaker (Standard)	Rated current	A 40	
		Sensitivity of leak current	mA 30	
	Rated operating current*5		A 22	
	Rated power consumption*5		kW(kVA) 14.3 (15.2)	
	Noise level (Front 1 m/Height 1 m)*5		dB(A) 71	
Waterproof specification			IPX4	
Accessories			Operation Manual (for installation/operation) 1 pc. (English), Y-strainer (40 meshes) 25A, Barrel nipple 25A, Anchor bolt fixing brackets 2 pcs. (including 6 M8 bolts)*10	
Weight (drv state)		kg	Approx. 340	

- *1 When the ambient temperature or circulating fluid temperature is 10°C or below, refer to "Operation at low ambient temperature or low circulating fluid temperature" (page 176).
- *2 Use fluid in condition below as the circulating fluid.
Tap water: please refer to "Specific Product Precautions".
15% ethylene glycol aqueous solution: Diluted with clean water, without any additives such as antiseptics.
Deionized water: Electric conductivity 1 μS/cm or higher (Electric resistivity 1 MΩ·cm or lower)
- *3 ① Ambient temperature: 32°C, ② Circulating fluid: Tap water, ③ Circulating fluid temperature: 20°C, ④ Circulating fluid flow rate: Rated flow, ⑤ Power supply: 400 VAC
- *4 ① Ambient temperature: 32°C, ② Circulating fluid: Tap water, ③ Circulating fluid flow rate: Rated flow, ④ Power supply: 400 VAC
- *5 ① Ambient temperature: 32°C, ② Circulating fluid: Tap water, ③ Circulating fluid temperature: 20°C, ④ Load: Same as the cooling capacity, ⑤ Circulating fluid flow rate: Rated flow, ⑥ Power supply: 400 VAC, ⑦ Piping length: Shortest
- *6 The capacity at the thermo-chiller outlet when the circulating fluid temperature is 20°C
- *7 With the pressure control mode by inverter. If the pressure control mode is not necessary, use the flow control function or the pump output setting function.
- *8 Fluid flow rate to maintain the cooling capacity. If the actual flow rate is lower than this, install a bypass piping.
- *9 If the product is used at an altitude of 1000 m or higher, refer to "Operating Environment/Storage Environment" (page 175) Item 13 "For altitudes of 1000 m or higher."
- *10 The anchor bolt fixing brackets (including 6 M8 bolts) are used for fixing to wooden skids when packaging the thermo-chiller. No anchor bolt is included.
- *11 For the product operation in the UL compliant conditions, refer to "Operating Environment/Storage Environment" (page 175).

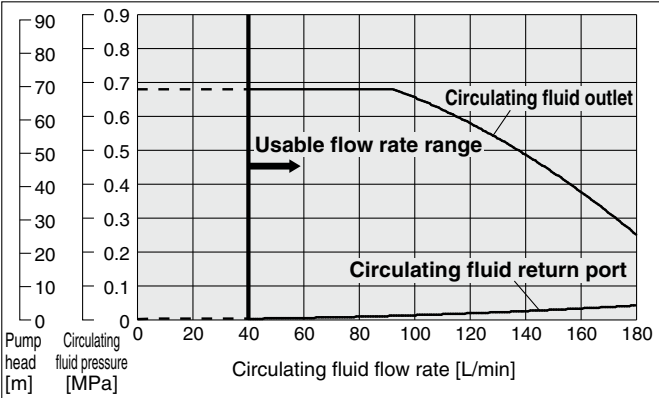
Cooling Capacity

HRS400-A□-46-□



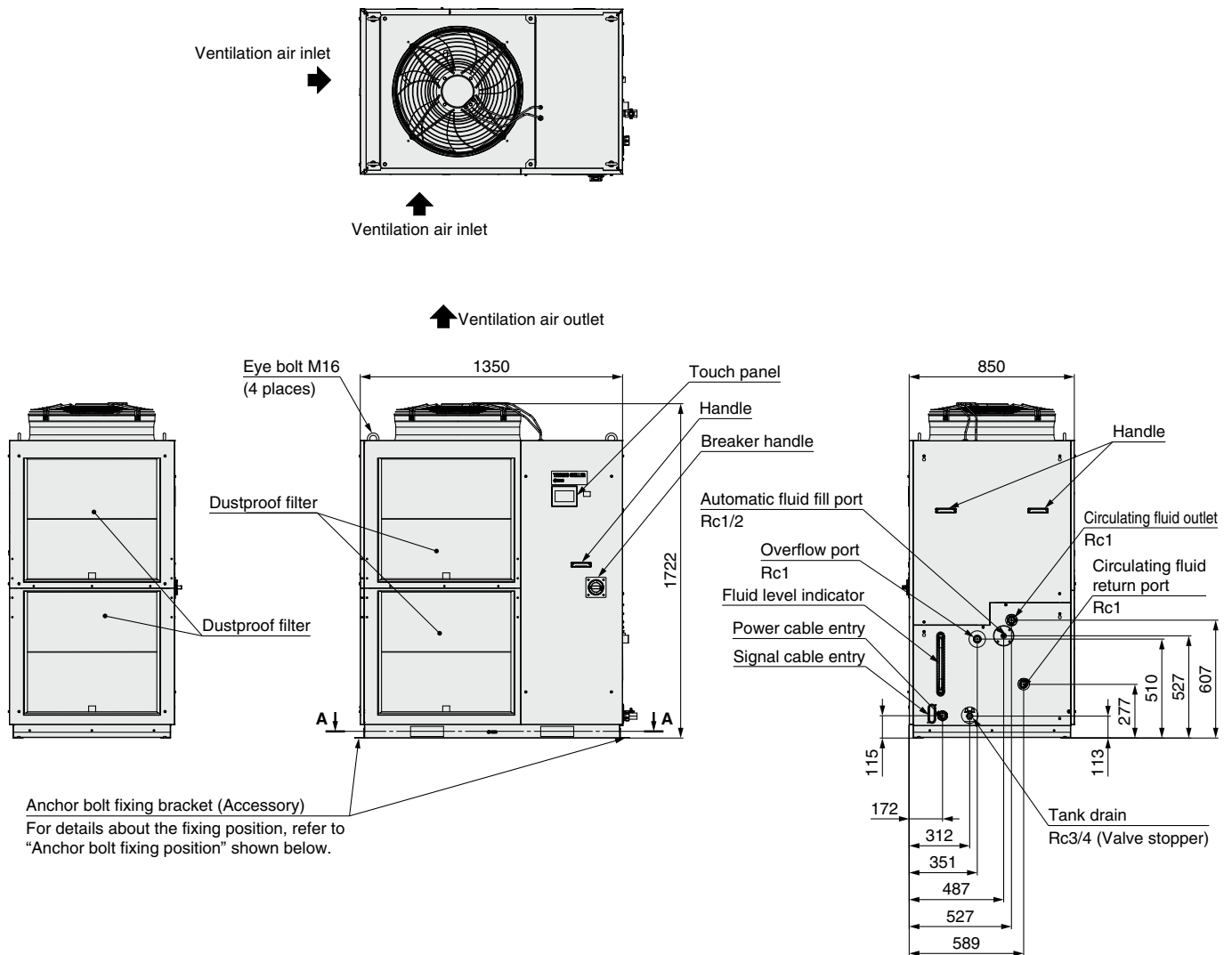
Pump Capacity

HRS400-A□-46-□

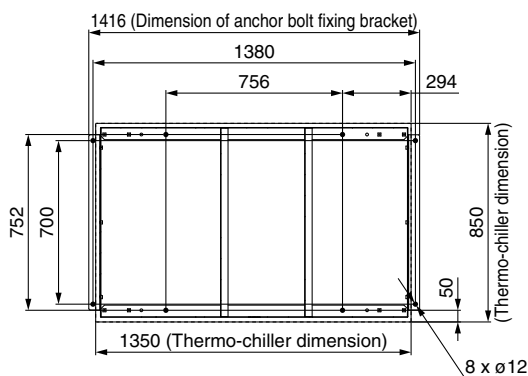


Dimensions

HRS400-A□-46-□

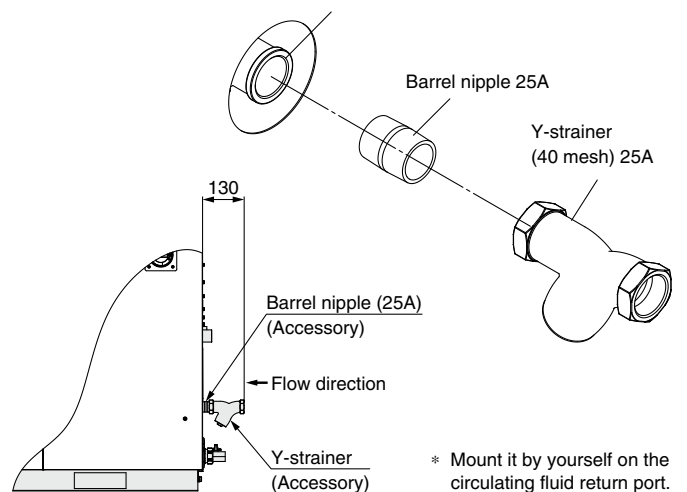


Anchor bolt fixing position



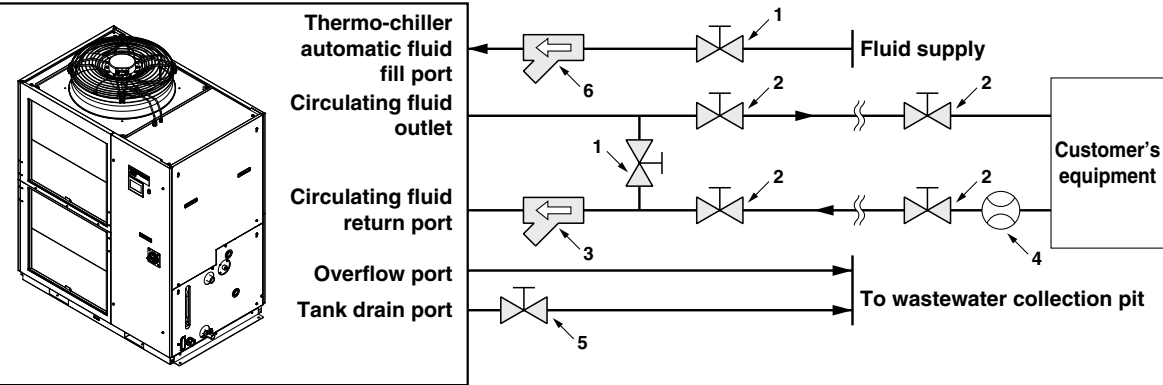
View A-A

Accessory: Y-strainer mounting view



Recommended External Piping Flow

External piping circuit is recommended as shown below.



* Ensure that the overflow port is connected to the wastewater collection pit in order to avoid damage to the tank of the thermo-chiller.

No.	Description	Size	Recommended part no.	Note
1	Valve	Rc1/2	—	—
2	Valve	Rc1	—	—
3	Y-strainer	Rc1 #40	Accessory	Install either the strainer or filter. If foreign matter with a size of 20 μm or more are likely to enter, install the particle filter. For the recommended filter, refer to the optional accessory HRS-PF005 (page 172).
	Filter	Rc1	HRS-PF005*1	
4	Flow meter	—	—	Prepare a flow meter with an appropriate flow range.
5	Valve (Part of thermo-chiller)	Rc3/4	—	—
6	Y-strainer	Rc1/2 #40	—	Install either the strainer or filter. If foreign matter with a size of 20 μm or more are likely to enter, select and prepare a particle filter.
	Filter	Rc1/2 20 μm	—	

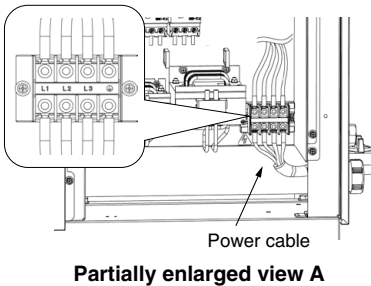
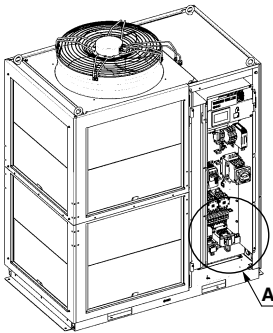
*1 The filter shown above cannot be directly connected to the thermo-chiller. Install it in the customer's piping system.

Cable Specifications

Power Cable Specifications

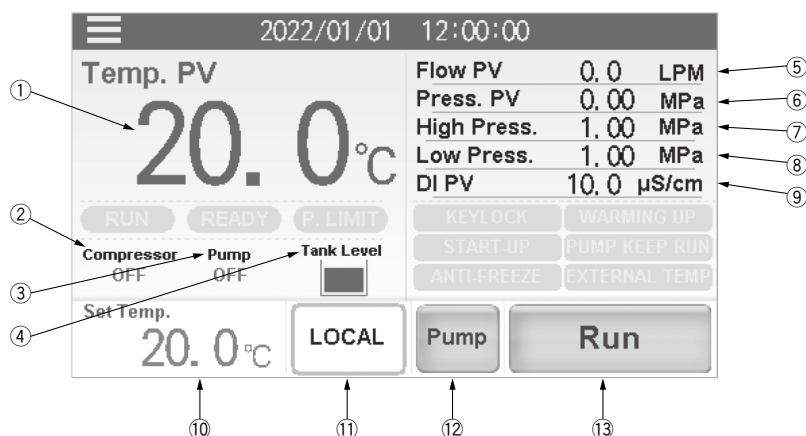
Rated value for thermo-chiller			Power cable examples	
Power supply	Applicable breaker rated current	Terminal block thread size	Cable size	Crimped terminal on the thermo-chiller side
3-phase 380 to 415 VAC (50/60 Hz) 3-phase 460 to 480 VAC (60 Hz)	40 A	M5	4 cores x 8 mm ² (4 cores x AWG8) * Including grounding cable	R8-5

* An example of the cable specifications is when two kinds of vinyl insulated wires with a continuous allowable operating temperature of 70°C at 600 V, are used at an ambient temperature of 30°C. Select the proper size of cable according to an actual condition.






Operation Display Panel

The basic operation of this unit is controlled through the operation display panel on the front of the product.



Home Screen and Setting Items

No.	Classification	Item	Explanation
①	Displayed value	Circulating fluid temperature	Indicates the current temperature
②		Compressor	Displays the operation and stop state of the compressor
③		Pump	Displays the operation and stop status of the pump
④		Tank fluid level	Indicates the tank fluid level with 3 levels: "Sufficient," "Low," or "Insufficient" <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  "Sufficient" Blue </div> <div style="text-align: center;">  "Low" Yellow </div> <div style="text-align: center;">  "Insufficient" Red </div> </div>
⑤		Circulating fluid flow rate	Indicates the fluid flow rate This value is not measured by a flow meter. It should be used as a reference value (rough indication).
⑥		Circulating fluid discharge pressure	Indicates the discharge pressure
⑦		Pressure gauge on the high-pressure side of the refrigeration circuit	Displays the pressure gauge on the high-pressure side of the refrigeration circuit
⑧		Pressure gauge on the low-pressure side of the refrigeration circuit	Displays the pressure gauge on the low-pressure side of the refrigeration circuit
⑨		Circulating fluid electric conductivity	Indicates the electric conductivity*1
⑩		Circulating fluid set temperature	Indicates the current temperature
⑪	Button	Operation mode	To select an operation mode from the touch panel (LOCAL mode), an operation mode from the contact input (DIO mode), or an operation mode from the serial communication (SERIAL mode)
⑫		Independent pump operation	Operates the pump independently while the button is pressed
⑬		Run/Stop	To run/stop the product

*1 When option "D" (Electric conductivity control) is purchased, a numerical value is displayed.

Alarm

This product may display the alarm messages shown in the table below.

Alarm code	Explanation
AL01	Abnormally low tank fluid level
AL02	Low tank fluid level
AL06	Fan failure
AL09	Abnormal rise of circulating fluid temperature
AL10	Circulating fluid temperature rise
AL11	Circulating fluid temperature drop
AL12	TEMP READY alarm
AL17	Abnormal rise in heat exchanger inlet temperature
AL18	Failure of circulating fluid discharge pressure sensor
AL19	Circulating fluid discharge pressure rise
AL20	Circulating fluid discharge pressure drop
AL28 (Option "D" only)	Electric conductivity increase
AL29	Power supply failure

Alarm code	Explanation
AL30	Contact input 1 signal detection
AL31	Contact input 2 signal detection
AL34	Communication error
AL35	Outside of the ambient temperature range
AL36	Maintenance alarm
AL37	Compressor circuit failure
AL38	Sensor failure
AL39	Controller failure
AL40	Compressor inverter error
AL41	Compressor inverter communication error
AL42	Pump inverter error
AL43	Pump inverter communication error

Communication Functions

Contact Input/Output

Contact Input/Output, Analog Output Communication Specifications

Item		Specifications	
Contact input signal 1, 2, 3	Insulation method	Photocoupler	
	Rated input voltage	24 VDC	
	Operating voltage range	21.6 to 26.4 VDC	
	Rated input current	5 mA TYP	
	Input impedance	4.7 kΩ	
Contact output signal 1, 2, 3, 4, 5, 6	Rated load voltage	48 VAC or less/30 VDC or less	
	Maximum load current	800 mA AC/DC or less*1	
	Minimum load current	5 VDC 10 mA	
	Output voltage range	0 to +10 V	
Analog output signal 1, 2	Maximum output current	10 mA	
	Output accuracy	±0.4% F.S. or less	
Output voltage		24 VDC ±10% 200 mA MAX*1 (No inductive load)	

Circuit diagram

When using this product's power supply, connect pin 1 to pin 2 and the COM side of each contact input signal to pin 14. (Example 1)

When using a customer's power supply, connect the 24 VDC + side to pin 2 and the COM side of each contact input signal to the customer's power COM. (Example 2)

Power supply usage example

This product's power supply usage example (Example 1)

Customer's power supply usage example (Example 2)

*1 Make sure that the total load current is 800 mA or less. When using the power supply of this product, make sure that the total load current is 200 mA or less.

Communication Functions

Contact Input/Output, Analog Output Pin Nos.

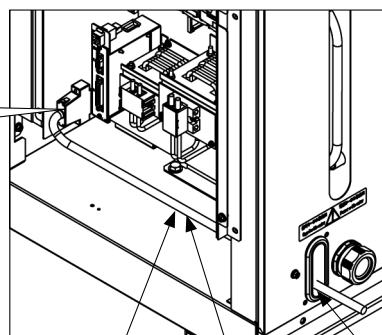
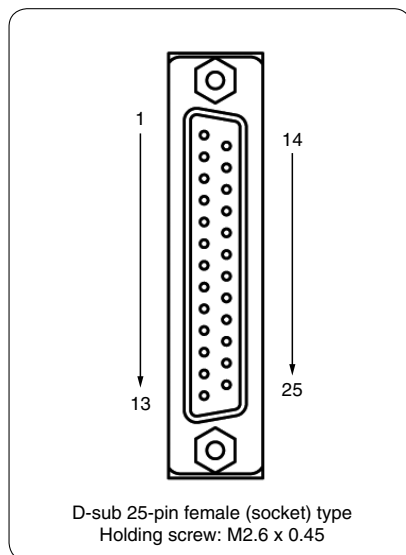
Pin no.	Application	Division	Default setting
1	24 VDC output	Output	—
2	24 VDC input	Input	—
3	Contact input signal 1	Input	Run/Stop* ¹
4	Contact input signal 3	Input	Operation mode request signal (fixed)* ²
5	Contact output signal 6	Output	OFF* ¹
6	Contact output signal 1	Output	Run status signal [N.O. type] (fixed)* ²
7	Contact output signal 3	Output	Operation continuation "WRN" alarm signal [N.C. type] (fixed)* ²
8	Contact output signal 5	Output	OFF* ¹
9	None	—	Cannot be connected* ³
10	Analog output signal 2	Output	Circulating fluid discharge temperature signal* ⁴
11	Analog output signal 1	Output	Circulating fluid discharge temperature signal* ⁴
12	None	—	Cannot be connected* ³
13	None	—	Cannot be connected* ³
14	24 COM output (Common of contact input signal)	Output	—
15	Common of contact output signals 1, 2, 3, 4, 5	Output	—
16	Contact input signal 2	Input	External switch signal* ¹
17	None	—	Cannot be connected* ³
18	Common of contact output signal 6	Output	—
19	Contact output signal 2	Output	Operation stop "FLT" alarm signal [N.C. type] (fixed)* ²
20	Contact output signal 4	Output	OFF* ¹
21	None	—	Cannot be connected* ³
22	Common of analog output signal 2	Output	—
23	Common of analog output signal 1	Output	—
24	None	—	Cannot be connected* ³
25	None	—	Cannot be connected* ³

*¹ It is possible to change the setting.

*² It is not possible to change the setting. ("N.O. type/N.C. type" can be changed.)

*³ Do not connect wiring.

*⁴ When option "D" (With electrical conductivity control) is selected, the setting can be changed.



* Prepare a cable tie. Fasten the signal cable to the mount on the base with the cable tie.

Mount for cable tie

Inlet of the signal cable

Communication Functions

Serial Communication

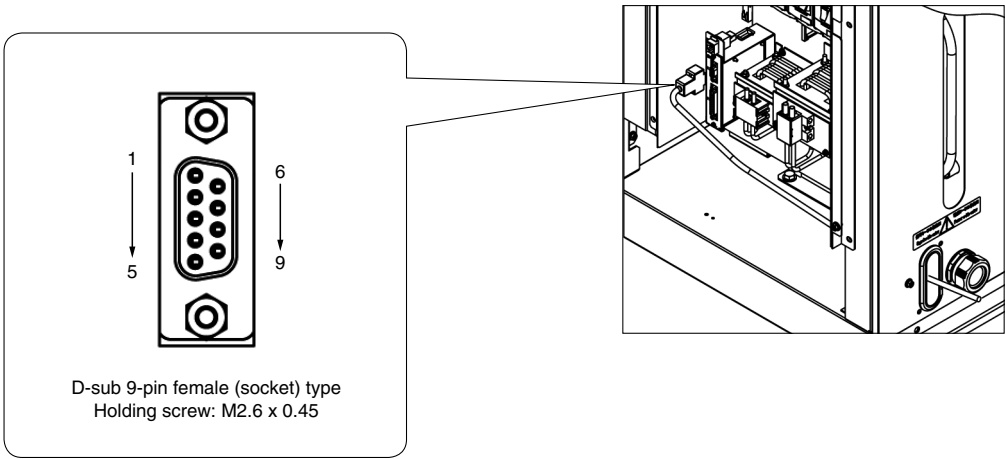
The following operations can be performed by the serial communication RS-232C/RS-485.

Writing	Readout
To run/stop the product To change the set value of circulating fluid temperature	To readout the circulating fluid temperature, pressure, flow rate and electrical conductivity*1 To readout the status of respective parts of the product (e.g., operation status and content of alarm)

*1 For Option D (With electric conductivity control)

Wiring of Interface Cable for Serial Communication

Item	Specifications
Connector type	D-sub 9-pin female (socket) type
Configuration of connection	RS-485
Circuit diagram	<p>One thermo-chiller for one host computer, or multiple thermo-chillers for one host computer. (31 thermo-chillers can be connected at maximum.)</p>
Standards	RS-232C
Circuit diagram	<p>One thermo-chiller for one controller</p>



HRS400 Series

Options

* Options have to be selected when ordering the thermo-chiller. It is not possible to add them after purchasing the unit.

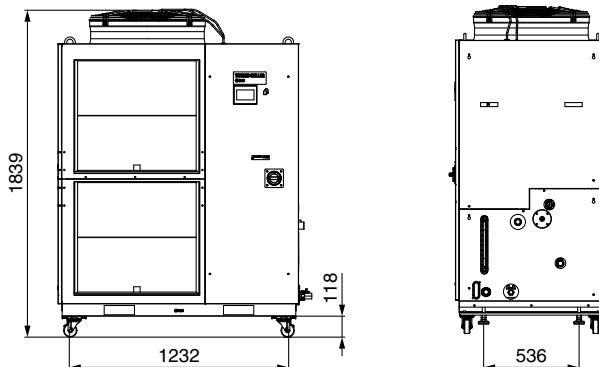
A Option symbol

With Caster Adjuster-foot

HRS400-A□-46-A

• With caster adjuster-foot

Unfixed casters and adjuster feet stops are mounted



D Option symbol

Electric Conductivity Control

HRS400-A□-46-D

• Electric conductivity control

This set can be used to display and control the electric conductivity of the circulating fluid. Refer to the Operation Manual for details.

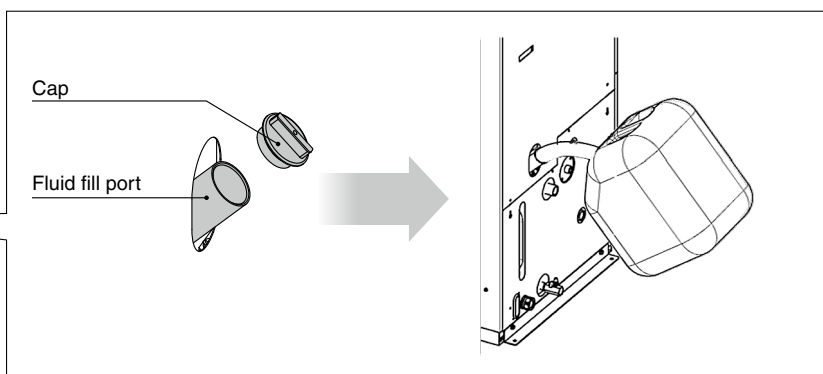
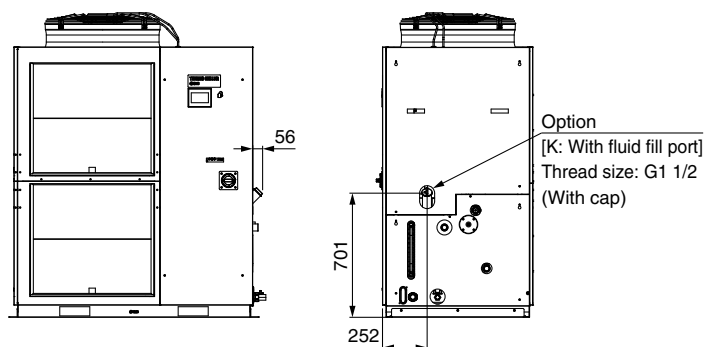
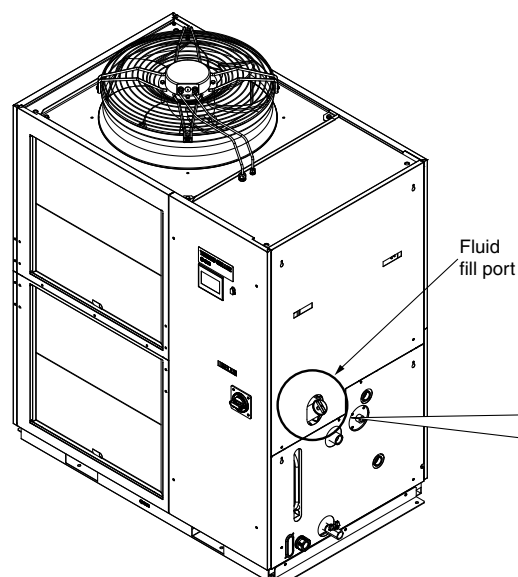
K Option symbol

With Fluid Fill Port

HRS400-A□-46-K

• With Fluid Fill Port

When the automatic fluid fill in port is not used, water can be supplied manually without removing the panel.



M Option symbol

Deionized Water (Pure Water) Piping

HRS400-A□-46-M

• Deionized water (Pure water) piping

The contact materials of the circulating fluid circuit are made from non-copper materials. Select this when using deionized water with a conductivity of 1 MΩ-cm or more (1 μs/cm or less).

Applicable model	HRS400-A□-46-M
Contact materials of circulating fluid	Stainless steel (including heat exchanger brazing), PE, POM, FKM, NBR, EPDM, PVC, PU, PBT

HRS400 Series

Optional Accessories

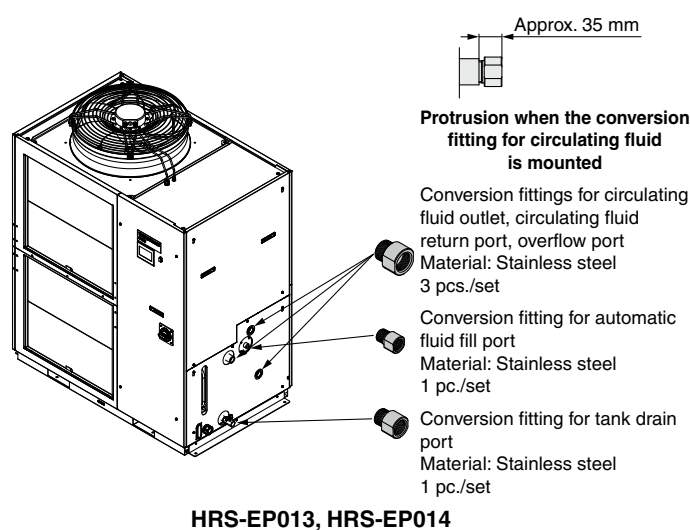
① Piping Conversion Fitting

This is a fitting to change the port from Rc to G or NPT.

- Circulating fluid outlet, Circulating fluid return port, Overflow port Rc1 → NPT1 or G1
- Drain port Rc3/4 → NPT3/4 or G3/4
- Automatic fluid fill port Rc1/2 → NPT1/2 or G1/2

(It is not necessary to purchase this when pipe thread type F or N is selected in "How to Order" since it is included in the product.)

Part no.	Contents	Applicable model
HRS-EP013	NPT thread conversion fitting set	HRS400-A□-46-□
HRS-EP014	G thread conversion fitting set	



② Caster Adjuster-foot Kit

This is a set of unfixed casters and adjuster feet stop.

When installed by customer, it is necessary to lift the thermo-chiller by a forklift or sling work. Carefully read the procedure manual included with this kit before performing the installation.

Part no.	Applicable model
HRS-KS004	HRS400-A□-46-□

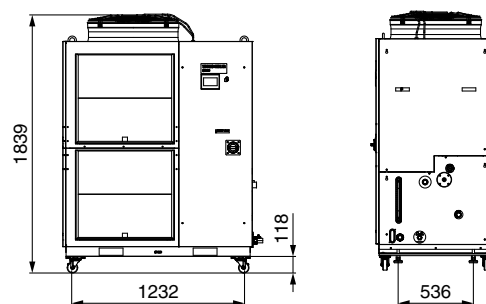


Fig. 1 Mounting view

Parts List

Description
Procedure manual
Caster adjuster-foot bracket (2 pcs.)
Fixing bolt (M8) (8 pcs.)

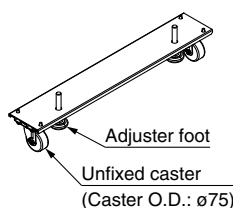


Fig. 2 Caster adjuster-foot bracket (2 pcs.)

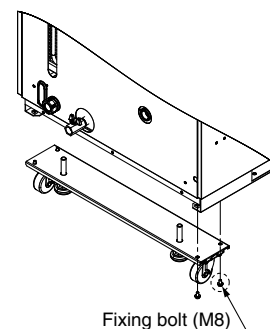


Fig. 3 Fixing bolt (8 pcs.)

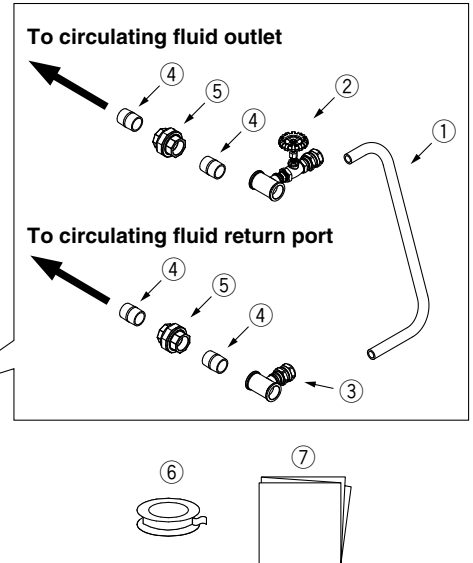
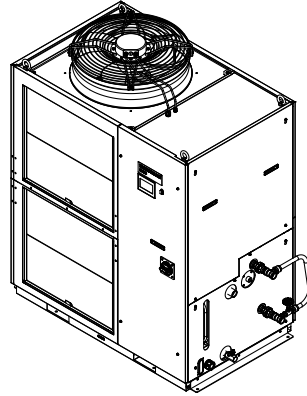
③ Bypass Piping Set

When the circulating fluid goes below the minimum operating flow rate (as shown below), cooling capacity will be reduced and the temperature stability will be badly affected. Use the bypass piping set to ensure a circulating fluid flow rate of the minimum operating flow rate or more.

Part no.	Applicable model	Minimum operating flow rate [L/min]
HRS-BP005	HRS400-A□-46-□	40

Parts List

No.	Description	Fluid contact material	Qty.
①	Hose (I.D.: 15 mm)	PVC	1 (Approx. 700 mm)
②	Outlet piping assembly (With globe valve)	Stainless steel, Brass, Bronze	1
③	Return piping assembly	Stainless steel, Brass	1
④	Nipple (Size: 1 inch)	Stainless steel	4
⑤	Union (Size: 1 inch)	Stainless steel	2
⑥	Sealant tape	PTFE	1
⑦	Operation Manual	—	1



④ Particle Filter Set

Removes foreign matter in the circulating fluid. This set cannot be directly connected to the thermo-chiller. Install it in the customer's piping system. Refer to the Operation Manual for details.

Particle Filter Set

HRS-PF005-H

•Accessory

Symbol	Accessory
Nil	None
H	With handle

Fluid	Tap water
Max. operating pressure	0.65 MPa
Operating temperature range	5 to 35°C
Nominal filtration accuracy	5 μm
Installation environment	Indoors

Parts List

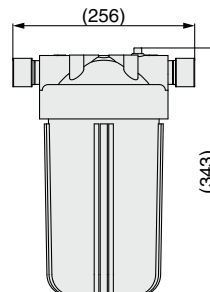
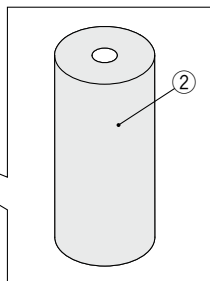
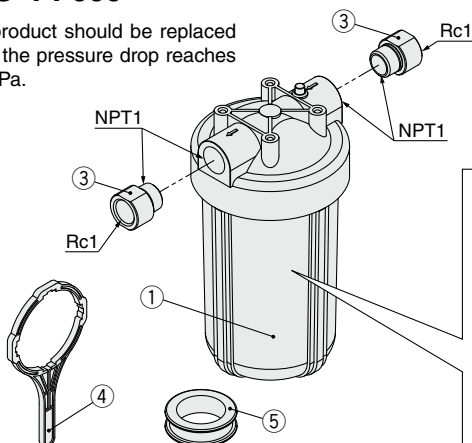
No.	Description	Material	Qty.	Note
①	Body	PC, PP	1	—
②	Element*1	PP	1	—
③	Extension piece	Stainless steel	2	Conversion from NPT to Rc
④	Handle	—	1	When -H is selected
⑤	Sealant tape	PTFE	1	—

*1 The product should be replaced when the pressure drop reaches 0.1 MPa.

Replacement Element

HRS-PF006

The product should be replaced when the pressure drop reaches 0.1 MPa.

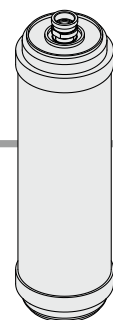


⑤ DI Filter Replacement Cartridge

DI filter cartridge for replacement for Option D [Electric conductivity control type]

DI Filter Replacement Cartridge

HRR-DF002



HRS400 Series

Cooling Capacity Calculation

Required Cooling Capacity Calculation

Example 1: When the heat generation amount in the customer's equipment is known.

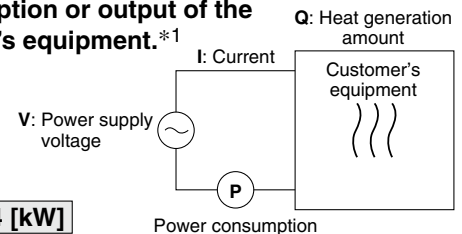
The heat generation amount can be determined based on the power consumption or output of the heat generating area — i.e. the area requiring cooling — within the customer's equipment.*1

① Derive the heat generation amount from the power consumption.

Power consumption **P**: 20 [kW]

$$Q = P = 20 \text{ [kW]}$$

Cooling capacity = Considering a safety factor of 20%, $20 \text{ [kW]} \times 1.2 = \boxed{24 \text{ [kW]}}$



② Derive the heat generation amount from the power supply output.

Power supply output **VI**: 20 [kVA]

$$Q = P = V \times I \times \text{Power factor}$$

In this example, using a power factor of 0.85:

$$= 20 \text{ [kVA]} \times 0.85 = 17 \text{ [kW]}$$

Cooling capacity = Considering a safety factor of 20%,

$$17 \text{ [kW]} \times 1.2 = \boxed{20.4 \text{ [kW]}}$$

③ Derive the heat generation amount from the output.

Output (shaft power, etc.) **W**: 13 [kW]

$$Q = P = \frac{W}{\text{Efficiency}}$$

In this example, using an efficiency of 0.7:

$$= \frac{13}{0.7} = 18.6 \text{ [kW]}$$

Cooling capacity = Considering a safety factor of 20%,

$$18.6 \text{ [kW]} \times 1.2 = \boxed{22.3 \text{ [kW]}}$$

*1 The examples above calculate the heat generation amount based on the power consumption.
The actual heat generation amount may differ due to the structure of the customer's equipment.
Be sure to check it carefully.

Example 2: When the heat generation amount in the customer's equipment is not known.

Obtain the temperature difference between inlet and outlet by circulating the circulating fluid inside the customer's equipment.

Heat generation amount by customer's equipment **Q**: Unknown [W] ([J/s])
 Circulating fluid : Tap water*1
 Circulating fluid mass flow rate **qm** : (= $\rho \times qv \div 60$) [kg/s]
 Circulating fluid density ρ : 1 [kg/L]
 Circulating fluid (volume) flow rate **qv** : 70 [L/min]
 Circulating fluid specific heat **C** : 4.186×10^3 [J/(kg·K)]
 Circulating fluid outlet temperature **T1** : 293 [K] (20 [°C])
 Circulating fluid return temperature **T2** : 297 [K] (24 [°C])
 Circulating fluid temperature difference ΔT : 4 [K] (= $T_2 - T_1$)
 Conversion factor: minutes to seconds (SI units) : 60 [s/min]

*1 Refer to the next page for the typical physical property value of tap water or other circulating fluids.

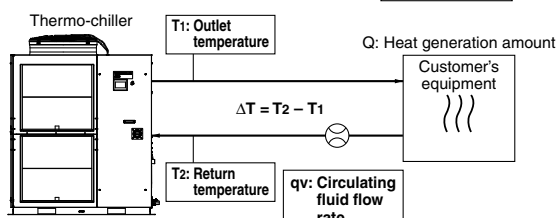
$$Q = qm \times C \times (T_2 - T_1)$$

$$= \frac{\rho \times qv \times C \times \Delta T}{60} = \frac{1 \times 70 \times 4.186 \times 10^3 \times 4.0}{60}$$

$$= 19535 \text{ [J/s]} \approx 19535 \text{ [W]} = 19.5 \text{ [kW]}$$

Cooling capacity = Considering a safety factor of 20%,

$$19.5 \text{ [kW]} \times 1.2 = \boxed{23.4 \text{ [kW]}}$$



Example of conventional units (Reference)

Heat generation amount by customer's equipment **Q**: Unknown [cal/h] → [W]
 Circulating fluid : Tap water*1
 Circulating fluid weight flow rate **qm** : (= $\rho \times qv \times 60$) [kgf/h]
 Circulating fluid weight volume ratio γ : 1 [kgf/L]
 Circulating fluid (volume) flow rate **qv** : 70 [L/min]
 Circulating fluid specific heat **C** : 1.0×10^3 [cal/(kgf·°C)]
 Circulating fluid outlet temperature **T1** : 20 [°C]
 Circulating fluid return temperature **T2** : 24 [°C]
 Circulating fluid temperature difference ΔT : 4 [°C] (= $T_2 - T_1$)
 Conversion factor: hours to minutes : 60 [min/h]
 Conversion factor: kcal/h to kW : 860 [(cal/h)/W]

$$Q = \frac{qm \times C \times (T_2 - T_1)}{860}$$

$$= \frac{\gamma \times qv \times 60 \times C \times \Delta T}{860}$$

$$= \frac{1 \times 70 \times 60 \times 1.0 \times 10^3 \times 4.0}{860}$$

$$= \frac{16800000 \text{ [cal/h]}}{860}$$

$$\approx 19534 \text{ [W]} = 19.5 \text{ [kW]}$$

Cooling capacity = Considering a safety factor of 20%,

$$19.5 \text{ [kW]} \times 1.2 = \boxed{23.4 \text{ [kW]}}$$

Required Cooling Capacity Calculation**Example 3: When there is no heat generation, and when cooling the object below a certain temperature and period of time.**

Heat quantity by cooled substance (per unit time) **Q** : Unknown [W] ([J/s])
 Cooled substance : Water
 Cooled substance mass **m** : (= $\rho \times V$) [kg]
 Cooled substance density ρ : 1 [kg/L]
 Cooled substance total volume **V** : 300 [L]
 Cooled substance specific heat **C** : 4.186×10^3 [J/(kg·K)]
 Cooled substance temperature when cooling begins **T₀** : 305 [K] (32 [°C])
 Cooled substance temperature after t hour **T_t** : 293 [K] (20 [°C])
 Cooling temperature difference ΔT : 12 [K] (= $T_0 - T_t$)
 Cooling time Δt : 900 [s] (= 15 [min])

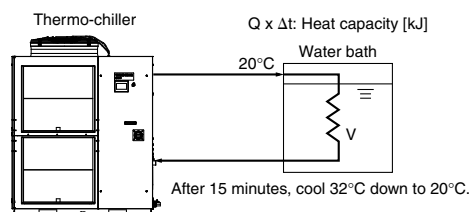
* Refer to the following for the typical physical property values by circulating fluid.

$$Q = \frac{m \times C \times (T_0 - T_t)}{\Delta t} = \frac{\rho \times V \times C \times \Delta T}{\Delta t}$$

$$= \frac{1 \times 300 \times 4.186 \times 10^3 \times 12}{900} = 16744 \text{ [J/s]} \approx 16.7 \text{ [kW]}$$

Cooling capacity = Considering a safety factor of 20%,

$$16.7 \text{ [kW]} \times 1.2 = 20 \text{ [kW]}$$

**Example of conventional units (Reference)**

Heat quantity by cooled substance (per unit time) **Q** : Unknown [cal/h] → [W]
 Cooled substance : Water
 Cooled substance weight **m** : (= $\rho \times V$) [kgf]
 Cooled substance weight volume ratio γ : 1 [kgf/L]
 Cooled substance total volume **V** : 300 [L]
 Cooled substance specific heat **C** : 1.0×10^3 [cal/(kgf·°C)]
 Cooled substance temperature when cooling begins **T₀** : 32 [°C]
 Cooled substance temperature after t hour **T_t** : 20 [°C]
 Cooling temperature difference ΔT : 12 [°C] (= $T_0 - T_t$)
 Cooling time Δt : 15 [min]
 Conversion factor: hours to minutes : 60 [min/h]
 Conversion factor: kcal/h to kW : 860 [(cal/h)/W]

$$Q = \frac{m \times C \times (T_0 - T_t)}{\Delta t \times 860} = \frac{\gamma \times V \times 60 \times C \times \Delta T}{\Delta t \times 860}$$

$$= \frac{1 \times 300 \times 60 \times 1.0 \times 10^3 \times 12}{15 \times 860}$$

$$\approx 16744 \text{ [W]} = 16.7 \text{ [kW]}$$

Cooling capacity = Considering a safety factor of 20%,

$$16.7 \text{ [kW]} \times 1.2 = 20 \text{ [kW]}$$

* This is the calculated value by changing the fluid temperature only. Thus, it varies substantially depending on the water bath or piping shape.

Precautions on Cooling Capacity Calculation**1. Heating capacity**

When the circulating fluid temperature is set above room temperature, it needs to be heated by the thermo-chiller. The heating capacity depends on the circulating fluid temperature. Consider the radiation rate and heat capacity of the customer's equipment and check beforehand if the required heating capacity is provided.

2. Pump capacity**<Circulating fluid flow rate>**

Circulating fluid flow rate varies depending on the circulating fluid discharge pressure. Consider the installation height difference between the thermo-chiller and the customer's equipment, and the piping resistance such as circulating fluid pipings, or piping size, or piping curves in the machine. Check beforehand if the required flow is achieved, using the pump capacity curves.

<Circulating fluid discharge pressure>

Circulating fluid discharge pressure has the possibility to increase up to the maximum pressure in the pump capacity curves.

Check beforehand if the circulating fluid pipings or circulating fluid circuit of the customer's equipment are fully durable against this pressure.

Circulating Fluid Typical Physical Property Values**1. This catalog uses the following values for density and specific heat in calculating the required cooling capacity.**

Density ρ : 1 [kg/L] (or, using conventional units, weight volume ratio $\gamma = 1$ [kgf/L])

Specific heat **C**: 4.19×10^3 [J/(kg·K)] (or, using conventional units, 1×10^3 [cal/(kgf·°C)])

2. Values for density and specific heat change slightly according to temperature shown below. Use this as a reference.**Water**

Physical property value Temperature	Density ρ [kg/L]	Specific heat C [J/(kg·K)]	Conventional units	
			Weight volume ratio γ [kgf/L]	Specific heat C [cal/(kgf·°C)]
5°C	1.00	4.2×10^3	1.00	1×10^3
10°C	1.00	4.19×10^3	1.00	1×10^3
15°C	1.00	4.19×10^3	1.00	1×10^3
20°C	1.00	4.18×10^3	1.00	1×10^3
25°C	1.00	4.18×10^3	1.00	1×10^3
30°C	1.00	4.18×10^3	1.00	1×10^3
35°C	0.99	4.18×10^3	0.99	1×10^3
40°C	0.99	4.18×10^3	0.99	1×10^3

15% Ethylene Glycol Aqueous Solution

Physical property value Temperature	Density ρ [kg/L]	Specific heat C [J/(kg·K)]	Conventional units	
			Weight volume ratio γ [kgf/L]	Specific heat C [cal/(kgf·°C)]
5°C	1.02	3.91×10^3	1.02	0.93×10^3
10°C	1.02	3.91×10^3	1.02	0.93×10^3
15°C	1.02	3.91×10^3	1.02	0.93×10^3
20°C	1.01	3.91×10^3	1.01	0.93×10^3
25°C	1.01	3.91×10^3	1.01	0.93×10^3
30°C	1.01	3.91×10^3	1.01	0.94×10^3
35°C	1.01	3.91×10^3	1.01	0.94×10^3
40°C	1.01	3.92×10^3	1.01	0.94×10^3

* Shown above are reference values.



HRS400 Series

Specific Product Precautions 1

Be sure to read this before handling the products. For safety instructions and temperature control equipment precautions, refer to the "Handling Precautions for SMC Products" and the "Operation Manual" on the SMC website: <https://www.smcworld.com>

Design

Warning

1. This catalog shows the specifications of a single unit.

- 1) Check the specifications of the single unit (contents of this catalog) and thoroughly consider the adaptability between the customer's system and this unit.
- 2) Although a protection circuit as a single unit is installed, prepare a drain pan, water leakage sensor, discharge air facility, and emergency stop equipment, depending on the customer's operating conditions. Also, the customer is requested to carry out a safety design for the whole system.

2. When attempting to cool areas that are open to the atmosphere (tanks, pipes), plan your piping system accordingly.

When cooling open-air external tanks, arrange the piping so that there are coil pipes for cooling inside the tanks and to carry back the entire flow volume of circulating fluid that is released.

3. Use non-corrosive material for circulating fluid contact parts.

Using corrosive materials such as aluminum or iron for fluid contact parts such as piping may cause clogging or leakage in the circulating fluid circuit. Provide protection against corrosion when you use the product.

Selection

Warning

Model selection

When selecting a thermo-chiller model, the amount of heat generation from the user's equipment must be known. Obtain this value, referring to "Cooling Capacity Calculation" on pages 173 and 174 before selecting a model.

Handling

Warning

Thoroughly read the operation manual.

Read the operation manual completely before operation, and keep the manual where it can be referred to as necessary.

Operating Environment/Storage Environment

Warning

1. Do not use in the following environment as it will lead to a breakdown.

- 1) In locations where water vapor, salt water, and oil may splash on the product.
- 2) In locations where there are dust and particles.
- 3) In locations where corrosive gases, organic solvents, chemical fluids, or flammable gases are present. (This product is not explosion proof.)
- 4) In locations where the ambient temperature exceeds the limits as mentioned below.

During transportation/storage: -15°C to 50°C (But as long as water or circulating fluid are not left inside the pipings)

Operating Environment/Storage Environment

Warning

During operation: -5°C to 45°C

- * When the ambient temperature or circulating fluid temperature is 10°C or below, use the circulating fluid specified in "Operation at low ambient temperature or low circulating fluid temperature".

- 5) In locations where condensation may occur.
- 6) In locations which receive direct sunlight or radiated heat.
- 7) In locations where there is a heat source nearby and the ventilation is poor.
- 8) In locations where temperature substantially changes.
- 9) In locations where strong magnetic noise occurs.
(In locations where strong electric fields, strong magnetic fields and surge voltage occur.)
- 10) In locations where static electricity occurs, or conditions which make the product discharge static electricity.
- 11) In locations where high frequency occurs.
- 12) In locations where damage is likely to occur due to lightning.
- 13) In locations at an altitude of 3000 m or higher (Except during storage and transportation)

- * For altitudes of 1000 m or higher

Because of lower air density, the heat radiation efficiencies of the devices in the product will be lower in the location at an altitude of 1000 m or higher. Therefore, the maximum ambient temperature to use and the cooling capacity will lower according to the descriptions in the table below.

Select the thermo-chiller considering the descriptions.

- ① Upper limit of ambient temperature: Use the product in ambient temperature of the described value or lower at each altitude.
- ② Cooling capacity coefficient: The product's cooling capacity will lower to one that multiplied by the described value at each altitude.

Altitude [m]	① Upper limit of ambient temperature [$^{\circ}\text{C}$]	② Cooling capacity coefficient
Less than 1000 m	45	1.00
Less than 1500 m	42	0.85
Less than 2000 m	38	0.80
Less than 2500 m	35	0.75
Less than 3000 m	32	0.70

- 14) In locations where strong impacts or vibrations occur.
- 15) In locations where a massive force strong enough to deform the product is applied or a weight from a heavy object is applied.
- 16) In locations where there is not sufficient space for maintenance.
- 17) In locations where liquid that exceeds the conditions required for the degrees of protection IPX4 may splash on the product.
- 18) Insects or plants may enter the unit.

2. The product is not designed for clean room usage. It generates particles internally.

3. The product is not dust-proof.

If used in an environment with dust, it may accumulate inside the product and cause not only a malfunction but also a fire hazard.



HRS400 Series Specific Product Precautions 2

Be sure to read this before handling the products. For safety instructions and temperature control equipment precautions, refer to the “Handling Precautions for SMC Products” and the “Operation Manual” on the SMC website: <https://www.smcworld.com>

Operating Environment/Storage Environment

⚠ Caution

For the product operation in UL compliant conditions, use the product in the environment shown below:

- Environment at an altitude of 2000 meters or less
- Environment at an ambient temperature of 40°C or less
- Environment at a pollution degree of 2 or less
- Location where the ambient humidity is within the following range:
During transportation or storage: 15% to 85% (No condensation)
During operation: 30% to 70% (No condensation)

Operation at Low Ambient Temperature or Low Circulating Fluid Temperature

⚠ Caution

1. Circulating fluid

In order to avoid freezing of the circulating fluid, use aqueous solution of ethylene glycol.

Ambient temperature [°C]	Recommended circulating fluids
10 to 45	Tap water, ethylene glycol aqueous solution 15 (wt)%
-5 to 10	Ethylene glycol aqueous solution 15 (wt)%

Circulating fluid temperature [°C]	Recommended circulating fluids
10 to 35	Tap water, ethylene glycol aqueous solution 15 (wt)%
5 to 10	Ethylene glycol aqueous solution 15 (wt)%

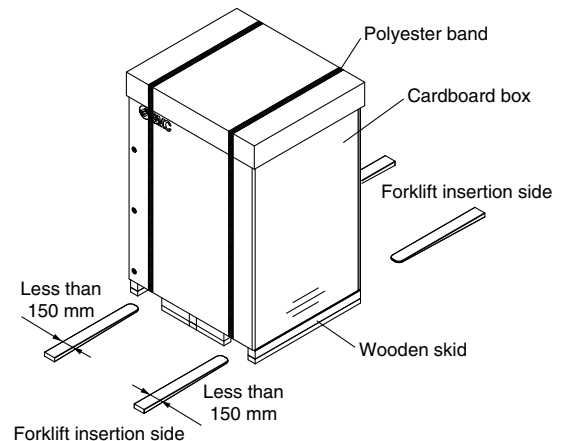
2. And following instructions must be executed. If following instructions are not executed, not only Thermo-chiller alarm will be generated, but also damage of the product can result.

- Power has to be supplied to the Thermo-chiller all the time.
- Turn on anti-freezing function all the time.
- When the power supply to the Thermo-chiller is stopped for a long period of time, discharge all the circulating fluid in the Thermo-chiller and customer's device and piping. When the Thermo-chiller is refilled with the circulating fluid, supply the fluid at normal temperature.

Transportation/Carriage/Movement

⚠ Warning

1. This product will require an acceptance with the product not unloaded from the truck, and the customer will need to unload the product by himself. Prepare a forklift.
The product will be delivered in the packaging shown below.



<When packaged>

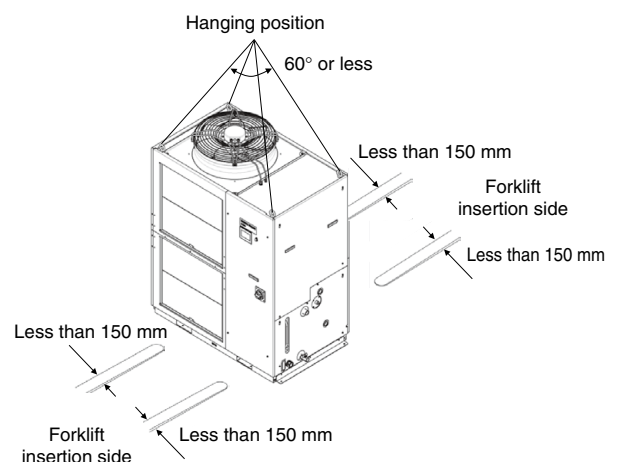
Model	Weight [kg]	Dimensions [mm]
HRS400-A□-46-□	410	Height 1650 x Width 1060 x Depth 2020
HRS400-A□-46-A	424	
HRS400-A□-46-D	411	
HRS400-A□-46-K		

2. Transporting with forklift

- 1) A licensed driver should drive the forklift.
- 2) The proper place to insert the tines of the forklift differs depending on the model of cooler. Check the insert position, and be sure to drive the fork in far enough for it to come out the other side.
- 3) Be careful not to bump the fork to the cover panel or piping ports.

3. Hanging transportation

- 1) Crane manipulation and slinging work should be done by an eligible person.
- 2) Do not grip the piping on the right side or the handles of the panel.
- 3) When hanging by the eye bolts, be sure to use a 4-point hanging method. For the hanging angle, use caution regarding the position of the center of gravity and hold it within 60°.





HRS400 Series

Specific Product Precautions 3

Be sure to read this before handling the products. For safety instructions and temperature control equipment precautions, refer to the “Handling Precautions for SMC Products” and the “Operation Manual” on the SMC website: <https://www.smcworld.com>

Transportation/Carriage/Movement

(When using option A/With caster adjuster-foot and optional accessories/Caster adjuster-foot kit KS004)

4. Transporting with casters

- 1) This product is heavy and should be moved by at least two people.
- 2) Do not grip the piping port on the right side or the handles of the panel.
- 3) When transporting using a forklift, be sure not to let it hit the casters or adjusters, and drive the fork all the way through until it comes out the other side.
- 4) Do not get across steps with casters.

⚠ Caution

If this product is to be transported after delivery, please use the original packaging the product was delivered in. If other packaging is to be used, carefully package the product so as to prevent the product from incurring any damage during transport.

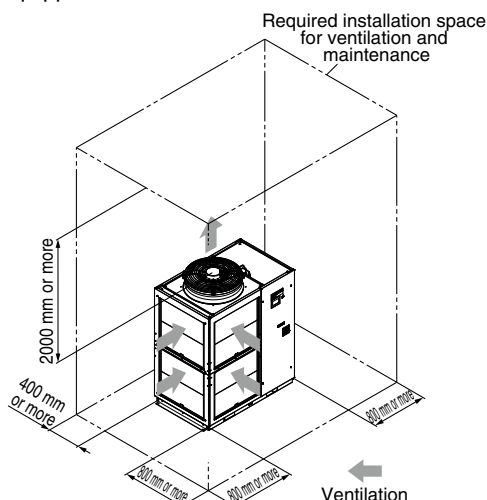
Mounting/Installation

⚠ Warning

Do not place heavy objects on top of this product, or step on it. The external panel can be deformed and danger can result.

⚠ Caution

1. Install on a rigid floor which can withstand this product's weight.
 2. Secure with bolts, anchor bolts, etc.
 3. Refer to the operation manual for this product, and secure an installation space that is necessary for the maintenance and ventilation.
1. The air-cooled type product exhausts heat using the fan that is mounted to the product. If the product is operated with insufficient ventilation, ambient temperature may exceed 45°C, and this will affect the performance and life of the product. To prevent this ensure that suitable ventilation is available (see below).
 2. For installation indoors, ventilation ports and a ventilation fan should be equipped as needed.



Mounting/Installation

⚠ Caution

3. If it is impossible to exhaust heat from the installation area indoors, or when the installation area is conditioned, provide a duct for heat exhaustion to the air outlet port of this product for ventilation. Do not mount the inlet of the duct (flange) directly to the air vent of the product, and keep a space larger than the diameter of the duct. Additionally, consider the resistance of the duct when making the air vent port for the duct.

<Heat radiation amount/Required ventilation rate>

Heat radiation amount [kW]	Required ventilation rate [m³/min]	
	Differential temp. of 3°C between inside and outside of installation area	Differential temp. of 6°C between inside and outside of installation area
Approx. 52	865	435

4. When using the product at a low ambient temperature (10°C or less), refer to “Operation at low ambient temperature or low circulating fluid temperature” (page 176).

Piping

⚠ Caution

1. Regarding the circulating fluid piping, consider carefully the suitability for temperature and circulating fluid.
If the operating performance is not sufficient, the pipings may burst during operation. Also, the use of corrosive materials such as aluminum or iron for fluid contact parts, such as piping, may not only lead to clogging or leakage in the circulating fluid circuit but also refrigerant leakage and other unexpected problems. Provide protection against corrosion when you use the product.
2. Select the piping port size which can exceed the rated flow.
For the rated flow, refer to the pump capacity table.
3. When tightening at the drain port of this product, use a pipe wrench to clamp the connection ports.
4. Supply water pressure to the automatic fluid fill port of this product should be 0.2 to 0.5 MPa.
This product has a built-in ball (float) tap. If you attach it to the faucet of a sink, etc. it will automatically supply water to the rated fluid level of the tank (halfway between HIGH and LOW.) If the water supply pressure is too high, the pipes may burst during use. Proceed with caution.
5. Ensure that piping is connected to the overflow port so that the circulating fluid can be exhausted to the drainage pit when the fluid level in the tank increases.
6. For the circulating fluid piping connection, install a drain pan and wastewater collection pit just in case the circulating fluid may leak.
7. This product series are constant-temperature fluid circulating machines with built-in tanks.
Do not install equipment on your system side such as pumps that forcibly return the circulating fluid to the unit. Also, if you attach an external tank that is open to the air, it may become impossible to circulate the circulating fluid. Proceed with caution.



HRS400 Series

Specific Product Precautions 4

Be sure to read this before handling the products. For safety instructions and temperature control equipment precautions, refer to the "Handling Precautions for SMC Products" and the "Operation Manual" on the SMC website: <https://www.smcworld.com>

Electrical Wiring

Warning

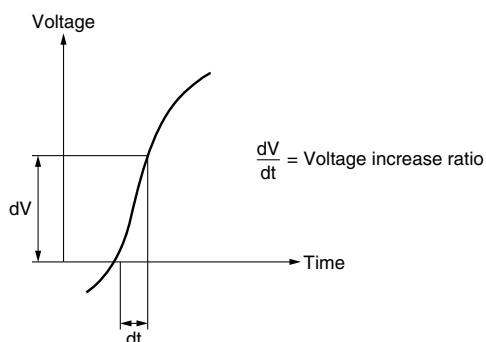
Grounding should never be connected to a water line, gas line or lightning rod.

Caution

1. Power supply and communication cables should be prepared by customer.

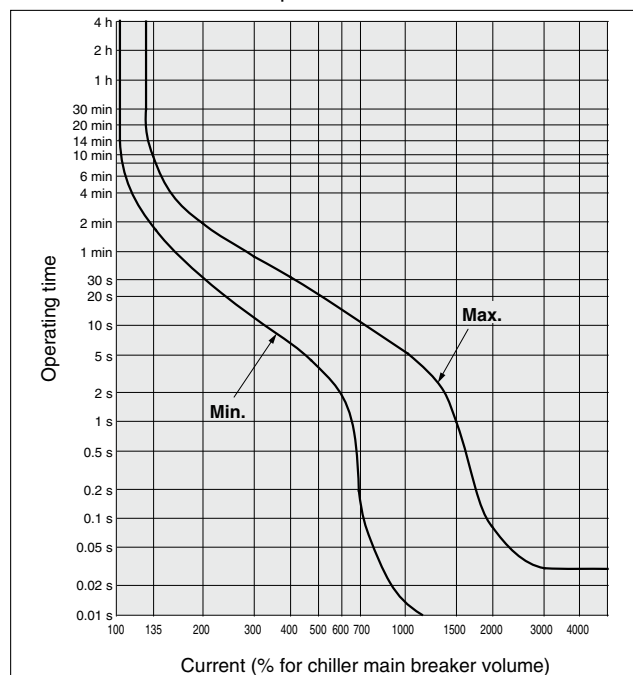
2. Provide a stable power supply which is not affected by surge or distortion.

If the voltage increase ratio (dV/dt) at the zero cross should exceed 40 V/200 μ sec., it may result in malfunction.



3. This product is installed with a breaker with the following operating characteristics.

For the customer's equipment (inlet side), use a breaker whose operating time is equal to or longer than the breaker of this product. If a breaker with shorter operating time is connected, the customer's equipment could be cut off due to the inrush current of the motor of this product.



Electrical Wiring

Caution

4. For the product operation in the UL compliant conditions, the conditions shown below must be satisfied:

- Use power supply of overvoltage category 2*
- For power supply cable, it is to be properly prepared by the customer in accordance with National Electrical Code and Canadian Electrical Code.
- Bending radius of the power supply cable must be 38.1 mm or more.

* When using a power supply in the overvoltage category 3, take measures such as mounting an isolation transformer between the product and the power supply or keep the transient overvoltage of the power supply to 2200 V or less by using a varistor, etc.

Circulating Fluid

Caution

1. Avoid oil or other foreign matter entering the circulating fluid.

2. When water is used as a circulating fluid, SMC recommends the water quality shown in the following table as reference.

- Including water used for dilution of ethylene glycol aqueous solutions.
- In most areas, tap water can be used. However, if the tap water in the area is hard, there is a possibility of failure or performance decline due to limescale build-up. To soften the water and avoid problems, consider using water hardness filters.

Tap Water (as a Circulating Fluid) Quality Standards

The Japan Refrigeration and Air Conditioning Industry Association
JRA GL-02-1994 "Cooling water system - Circulation type - Make-up water"

	Item	Unit	Standard value	Influence	
				Corrosion	Scale generation
Standard item	pH (at 25°C)	—	6.0 to 8.0	○	○
	Electric conductivity (25°C)	[μ S/cm]	100*1 to 300*1	○	○
	Chloride ion (Cl^-)	[mg/L]	50 or less	○	
	Sulfuric acid ion (SO_4^{2-})	[mg/L]	50 or less	○	
	Acid consumption amount (at pH4.8)	[mg/L]	50 or less		○
	Total hardness	[mg/L]	70 or less		○
	Calcium hardness ($CaCO_3$)	[mg/L]	50 or less		○
	Ionic state silica (SiO_2)	[mg/L]	30 or less		○
Reference item	Iron (Fe)	[mg/L]	0.3 or less	○	○
	Copper (Cu)	[mg/L]	0.1 or less	○	
	Sulfide ion (S_2^{2-})	[mg/L]	Should not be detected.	○	
	Ammonium ion (NH_4^+)	[mg/L]	0.1 or less	○	
	Residual chlorine (Cl)	[mg/L]	0.3 or less	○	
	Free carbon (CO_2)	[mg/L]	4.0 or less	○	

*1 In the case of [$M\Omega \cdot cm$], it will be 0.003 to 0.01.

- ○: Factors that have an effect on corrosion or scale generation.
- Even if the water quality standards are met, complete prevention of corrosion is not guaranteed.

3. Use an ethylene glycol aqueous solution that does not contain additives such as preservatives.

4. Refer to "Operation at low ambient temperature or low circulating fluid temperature" (page 176) for the concentration of the ethylene glycol aqueous solution.

5. When deionized water is used, the electric conductivity should be 1 μ S/cm or higher (Electric resistivity: 1 $M\Omega \cdot cm$ or lower).



HRS400 Series

Specific Product Precautions 5

Be sure to read this before handling the products. For safety instructions and temperature control equipment precautions, refer to the “Handling Precautions for SMC Products” and the “Operation Manual” on the SMC website: <https://www.smcworld.com>

Operation

⚠ Warning

1. Confirmation before operation

- 1) The fluid level of a tank should be within the specified range of “HIGH” and “LOW.” When exceeding the specified level, the circulating fluid will overflow.
- 2) Remove the air.
Conduct a trial operation, looking at the fluid level. Since the fluid level will go down when the air is removed from the customer's piping system, supply water once again when the fluid level is reduced. When there is no reduction in the fluid level, the job of removing the air is completed. Pump can be operated independently.

2. Confirmation during operation

- Check the circulating fluid temperature.
The operating temperature range of the circulating fluid is between 5 and 35°C.
When the amount of heat generated from the customer's equipment is greater than the product's capability, the circulating fluid temperature may exceed this range. Use caution regarding this matter.

3. Emergency stop method

- When an abnormality is confirmed, stop the machine immediately. After the machine has stopped, make sure to turn off the breaker of the customer's equipment (on the upstream side).

Operation Restart Time/Operation and Suspension Frequency

⚠ Caution

1. Wait five minutes or more before restarting operation after it has been stopped. If the operation is restarted within five minutes, the protection circuit may activate and the operation may not start properly.
2. Operation and suspension frequency should not exceed 10 times per day. Frequently switching between operation and suspension may result in the malfunction of the refrigeration circuit.

Protection Circuit

⚠ Caution

If operating in the below conditions, the protection circuit will activate and an operation may not be performed or will stop.

- Power supply voltage is not within the rated voltage range of $\pm 10\%$.
- In case the water level inside the tank is reduced abnormally.
- Circulating fluid temperature is too high.
- Compared to the cooling capacity, the heat generation amount of the customer's equipment is too high.
- Ambient temperature is over 45°C.
- Ventilation hole is clogged with dust or dirt

Maintenance

⚠ Caution

<Periodical inspection every one month>

Clean the ventilation hole.

If the dustproof filter of water-cooled type product becomes clogged with dust or debris, a decline in cooling performance can result. In order to avoid deforming or damaging the dustproof filter, clean it with a long-haired brush or air gun.

Maintenance

⚠ Caution

<Periodical inspection every three months>

Inspect the circulating fluid.

1. When using tap water or deionized water
 - Replacement of circulating fluid
Failure to replace the circulating fluid can lead to the development of bacteria or algae. Replace it regularly depending on your usage conditions.
2. When using ethylene glycol aqueous solution
Use a concentration meter to confirm that the concentration does not exceed 15%.
Dilute or add as needed to adjust the concentration.

<Periodical inspection during the winter season>

1. Make water-removal arrangements beforehand.

If there is a risk of the circulating fluid freezing when the product is stopped, release the circulating fluid in advance.

■ Refrigerant with GWP reference

Refrigerant	Global Warming Potential (GWP)		
	Regulation (EU) 2024/573, AIM Act 40 CFR Part 84	Fluorocarbon Emissions Control Act (Japan) GWP value labeled on products	GWP value to be used for reporting the calculated amount of leakage
R134a	1,430	1,430	1,300
R404A	3,922	3,920	3,940
R407C	1,774	1,770	1,620
R410A	2,088	2,090	1,920
R448A	1,386	1,390	1,270
R454C	146	145	146

* This product is hermetically sealed and contains fluorinated greenhouse gases (HFC). When this product is sold on the market in the EU after January 1, 2017, it needs to be compliant with the quota system of the F-Gas Regulation in the EU.

* See specification table for refrigerant used in the product.