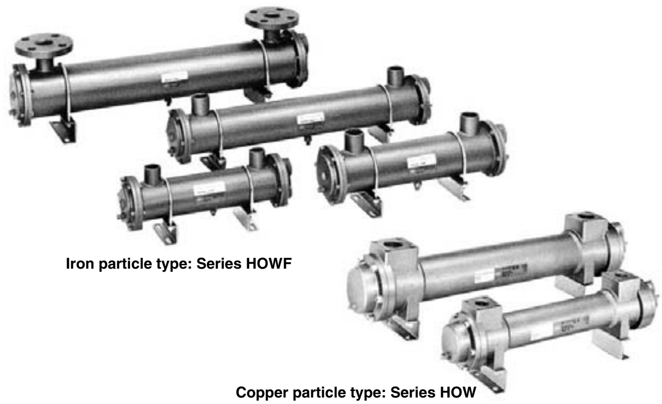
Water Cooled Oil Cooler

Series HOW□



Iron particle type: Series HOWF

Copper particle type: Series HOW

Series	Heat transfer area (Inside pipe) (m²)	Heat exchange volume (kW)	Flow rate (L/min)		Page
			Oil side	Cooling water side	
Oil Cooler: Iron particle type (Fixed pipe type) Series **HOWF**	0.077, 0.13, 0.21, 0.34 0.56, 0.83, 1.28	5.2 to 73	20 to 800	40 to 125	**1552**
Oil Cooler: Copper particle type (Floating pipe type) Series **HOW**	0.084, 0.13, 0.21, 0.32 0.50, 0.75	6.0 to 52	20 to 400	25 to 100	**1557**

Fixed Pipe Type Oil Cooler

Series HOWF

Water Cooled: Iron Particle Type

High heat transfer coefficient through the effects of turbulence

The metal particles reliably generate turbulence by agitating the fluid, resulting in effective cooling without unevenness.

Compact design requiring less installation space

The compact design is only 1/2 to 1/5 the size of conventional oil coolers. Installation requires very little space.

Large heat transfer area

The metal particles firmly welded to the outer surface of the heat transfer pipes provide several times the heat transfer performance of fin tube configurations.

Flexible installation orientation

U-bolts are used to mount the oil cooler, providing plenty of flexibility with regard to the mounting orientation and method.

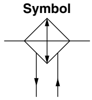
Simple structure

The baffle is also welded to a metal particle layer, a design that eliminates problems that previously tended to occur at the joins between the heat transfer pipes and baffles in conventional oil coolers.

Minimal pressure drop

The single-baffle structure increases the fluid path area, and the metal particles are 2 mm in diameter and pose no clogging danger.

Symbol



Specifications

Max. operating pressure	(Oil and Water sides) 1.0 MPa
Proof pressure	(Oil and Water sides) 1.5 MPa
Fluid temperature	Oil side: Max. 100°C/Water side: Max. 50°C
Cooling water	Industrial water, Tap water
Fluid cooled	General petroleum-based hydraulic fluid, Lubricating oil, Non-flammable oil (water-glycol)
Heat transfer medium	Copper tube and iron particles (iron particles surface treated with copper alloy)
Connection Note)	Oil side: Threaded or Flange/Water side: Threaded

Note) Refer to "Dimensions". Threads conform to JIS B 0203 parallel female thread (oil side) and tapered female thread (water side). Flanges conform to JIS B 2220 (JIS 1OK FF).

Model

Model	Heat transfer area (inside pipe) (m^2)	Heat exchange volume Note 1) (kW)	Oil side Note 3)	Cooling water side Note 2)		Weight (kg)
			Flow rate range (L/min)	Flow rate (L/min)	Pressure drop (MPa)	
HOWF7-06	0.077	5.2	20 to 100	40	0.02	7
HOWF11-06	0.13	8.4	30 to 150	40	0.02	9
HOWF22-08	0.21	14	40 to 250	55	0.02	12
HOWF37-08	0.34	21	60 to 300	55	0.02	17
HOWF55-10	0.56	32	70 to 300	75	0.03	27
HOWF75-10	0.83	43	80 to 400	75	0.03	40
HOWF110-16	1.28	73	200 to 800	125	0.03	75

Note 1) Conditions: Turbine oil Class 1 (ISO VG32), oil outlet temperature 50°C, water inlet temperature 30°C

Note 2) Increasing the cooling water flow volume to greater than the rated flow volume will increase the heat transfer and provide better cooling, but should be avoided as the increased flow speed within the pipe can cause corrosion.

Note 3) Use an oil-side flow rate within the range indicated above. (The product cannot be used with flow rates exceeding this range.)

How to Order

HOWF 7 – 06

Oil side port size

06	Rp (PS) 3/4
08	Rp (PS) 1
10	1 1/4B flange
16	2B flange

Basic size (Equivalent hydraulic motor kW)

7	7.5
11	11
22	22
37	37
55	55
75	75
110	110

Conditions In case of 55% heat loss of hydraulic motor kW
Oil outlet temperature 50°C
Water inlet temperature 30°C
Turbine oil Class 1 (ISO VG32)

Model Selection

To select the appropriate model for your application, use the data at right and follow the steps below.

Item		Fluid cooled	Cooling water
Type (brand)		Turbine oil Class 1 (VG56)	—
Flow rate		130 L/min	(40) L/min
Temperature	Inlet	—	25°C
	Outlet	50°C	—
Heat exchange volume		15 kW	

Step Ⓐ: No Cooling Water Flow Rate Specified

① From Data Ⓐ, calculate the oil type–heat volume correction coefficient.
— Example: A = 0.97

② From Data Ⓑ, calculate the water temperature–heat volume correction coefficient.
— Example: B = 1.3

③ Using the correction coefficients obtained in ① and ②, calculate the converted heat exchange volume.
— Example: $Q = \frac{15}{0.97 \times 1.3} = 11.9$ kW

④ Select the appropriate model from the model performance graph.
— Example: Oil outlet temperature 50°C, selected model **HOWF22**
In this case, the oil pressure drop can be calculated as follows.

⑤ From the model performance graph, determine the oil pressure drop.
— Example: △P = 0.04 MPa

⑥ From Data Ⓓ, calculate the oil type–pressure drop correction coefficient.
— Example: D = 1.4

⑦ Using ⑤ and ⑥, calculate the corrected oil pressure drop.
— Example: △P = 0.4 x 1.4 = 0.056 MPa

(Result) Model: HOWF22, Oil pressure drop: △P = 0.056 MPa,
Cooling water volume: 55 L/min

Step Ⓑ: Cooling Water Flow Rate Specified

① From Data Ⓐ, calculate the oil type–heat volume correction coefficient.
— Example: A = 0.97

② From Data Ⓑ, calculate the water temperature–heat volume correction coefficient.
— Example: B = 1.3

③ From the model performance graph, locate the intersection of the oil flow rate and heat exchange volume lines to make a provisional model selection. Note that the rated water volume for the selected model can be determined from the specifications.
— Oil outlet temperature 50°C, provisional model selection HOWF37, rated water volume 55 L/min.

④ Divide the actual water volume by the rated water volume from ③. If the calculated water volume is 1 or greater, treat it as 1.
— Example: $\frac{40}{55} = 0.72$

⑤ From Data Ⓒ, calculate the water volume–heat volume correction coefficient.
— Example: C = 0.85

⑥ Using the correction coefficients obtained in ①, ②, and ⑤, calculate the converted heat exchange volume.
— Example: $Q = \frac{15}{0.97 \times 1.3 \times 0.85} = 14$ kW

⑦ Select the appropriate model from the model performance graph.
— Example: Oil outlet temperature 50°C, selected model **HOWF37**
In this case, the oil pressure drop can be calculated as follows.

⑧ From the model performance graph, calculate the oil pressure drop.
— Example: △P = 0.035 MPa

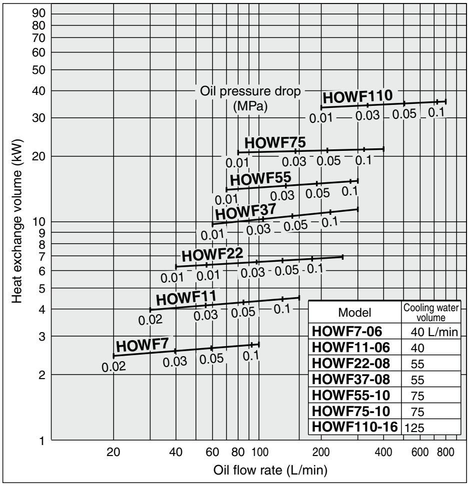
⑨ From Data Ⓓ, calculate the oil type–pressure drop correction coefficient.
— Example: D = 1.4

⑩ Using ⑧ and ⑨, calculate the corrected oil pressure drop.
— Example: △P = 0.35 x 1.4 = 0.049 MPa

(Result) Model: HOWF37, Oil pressure drop: △P = 0.049 MPa,
Cooling water volume: 40 L/min

Model Performance Graph ①: Oil Outlet Temperature 40°C

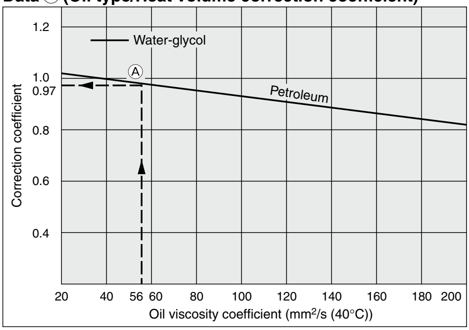
Conditions Oil outlet temperature: 40°C
Water inlet temperature: 30°C
Fluid: Turbine oil Class 1 (ISO VG32)
Oil side pressure drop: 0.01, 0.03, 0.05, 0.1 MPa indicated



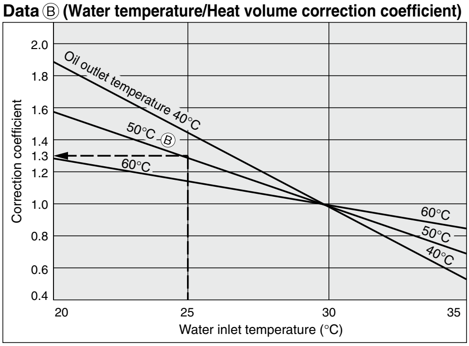
Model	Cooling water volume
HOWF7-06	40 L/min
HOWF11-06	40
HOWF22-08	55
HOWF37-08	55
HOWF55-10	75
HOWF75-10	75
HOWF110-16	125

Model performance values include an allowance (approx. 25%) for water deposits.

Data Ⓐ (Oil type/Heat volume correction coefficient)



Data Ⓑ (Water temperature/Heat volume correction coefficient)



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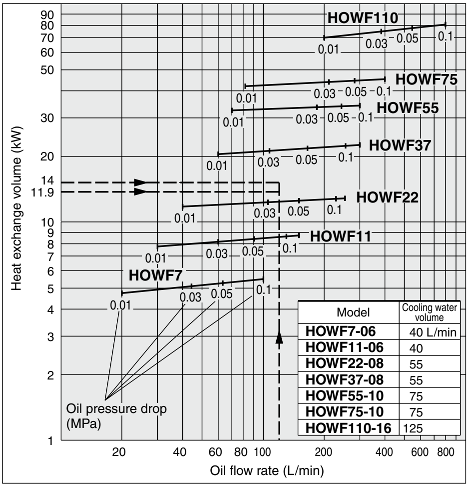
Model Performance Graph ②: Oil Outlet Temperature 50°C

Conditions Oil outlet temperature: 50°C
Water inlet temperature: 30°C
Fluid: Turbine oil Class 1 (ISO VG32)
Oil side pressure drop: 0.01, 0.03, 0.05, 0.1 MPa indicated

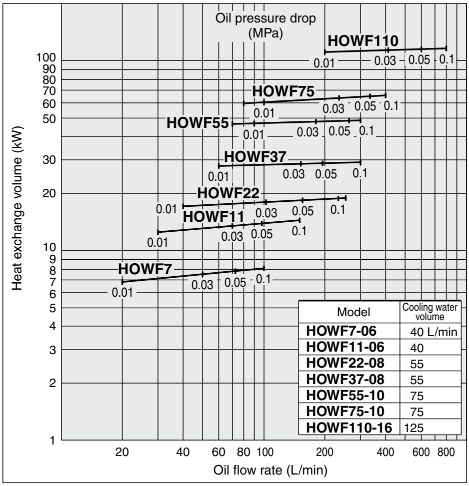


Model	Cooling water volume
HOWF7-06	40 L/min
HOWF11-06	40
HOWF22-08	55
HOWF37-08	55
HOWF55-10	75
HOWF75-10	75
HOWF110-16	125

Model performance values include an allowance (approx. 25%) for water deposits.

Model Performance Graph ③: Oil Outlet Temperature 60°C

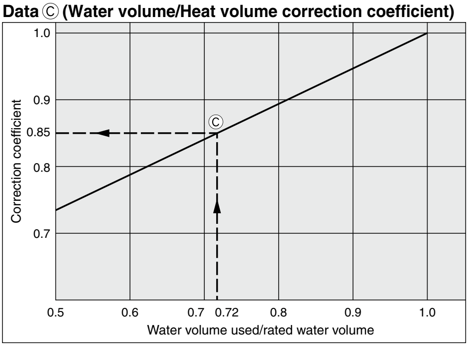
Conditions Oil outlet temperature: 60°C
Water inlet temperature: 30°C
Fluid: Turbine oil Class 1 (ISO VG32)
Oil side pressure drop: 0.01, 0.03, 0.05, 0.1 MPa indicated



Model	Cooling water volume
HOWF7-06	40 L/min
HOWF11-06	40
HOWF22-08	55
HOWF37-08	55
HOWF55-10	75
HOWF75-10	75
HOWF110-16	125

Model performance values include an allowance (approx. 25%) for water deposits.

Data Ⓒ (Water volume/Heat volume correction coefficient)



Data Ⓓ (Oil type/Pressure drop correction coefficient)

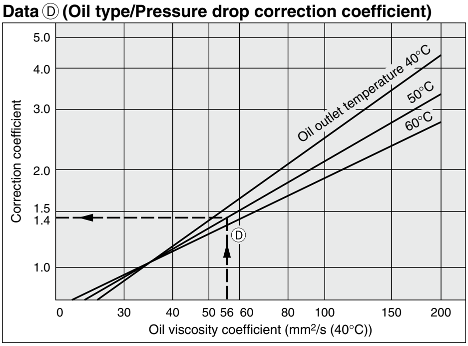
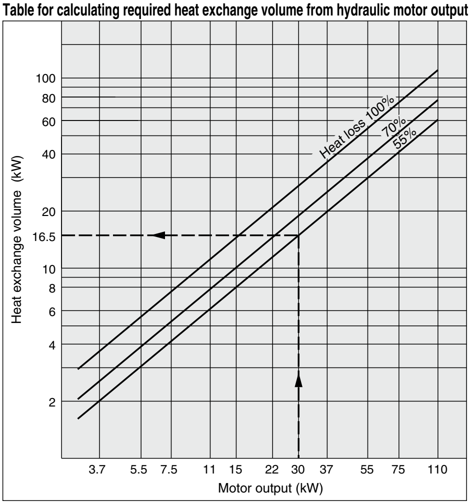
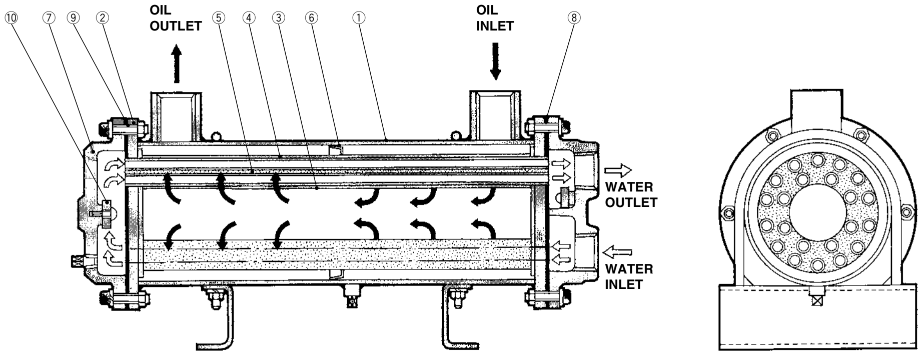


Table for calculating required heat exchange volume from hydraulic motor output



Note) If the hydraulic pump motor output is 30 kW and the heat loss is 55%, the required conversion volume is 16.5 kW. (Select the heat loss percentage based on the hydraulic circuit.)

Construction/Component Parts



The series HOWF employs a multi-pipe design with the heat transfer pipes arranged in a circular pattern. The area between the pipes is filled with porous metal particles. Cooling water flows through the heat transfer pipes. Fluid flows in through the inlet on the side of the cooler and passes among the metal particles outside the heat transfer pipes, finally reaching the open cavity in the center. It then flows axially though the center cavity, once again passes among the metal particles, and flows out through the outlet. The cooling water inlet and outlet may be reversed, and the oil inlet and outlet may be reversed as well. It is not possible to switch the cooling water and oil flow paths, however.

Component Part Materials

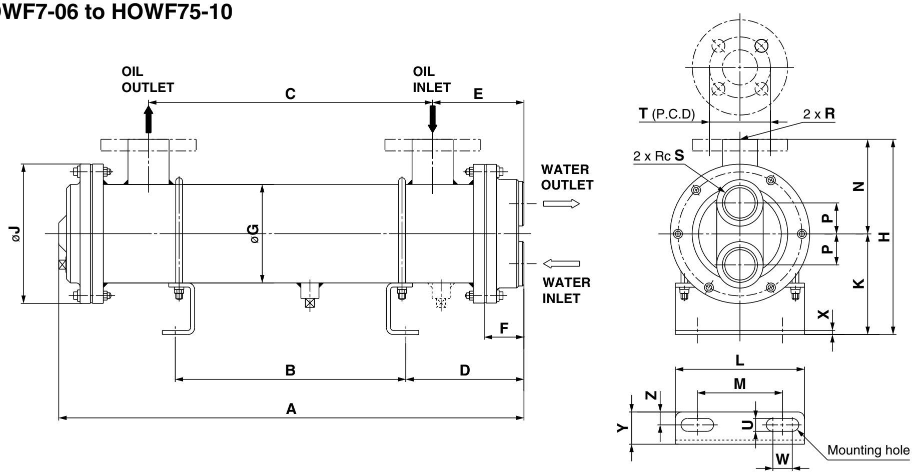
No.	Description	Material	Note
①	Body	STK	
②	Pipe plate A	SS400	
③	Metal particle cover	Stainless steel 304	
④	Heat transfer pipe	C1220T	
⑤	Metal particles	SS	Copper-plated
⑥	Baffle	Stainless steel 304	
⑦	Water chamber cover	FC200	

Component Parts

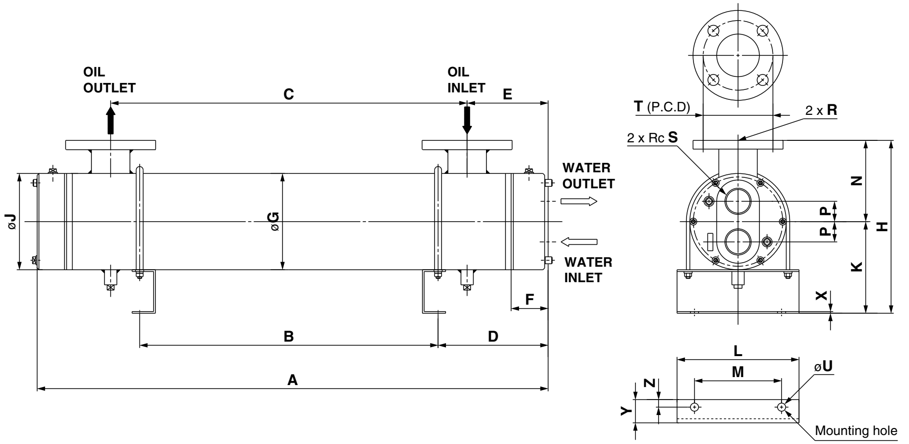
No.	⑧	⑨	⑩
Description	Gasket A	Gasket B	Corrosion-resistant zinc
Material	NBR	NBR	Zn
Model / Quantity	1	1	3
HOWF7-06	P1751411	P1751412	P1751427
HOWF11-06			
HOWF22-08	P1751611	P1751612	
HOWF37-08			
HOWF55-10	P1751810	P1751811	
HOWF75-10			
HOWF110-16	P175126	P175127	P175067

Dimensions

HOWF7-06 to HOWF75-10



HOWF110-16



(mm)

Model	A	B	C	D	E	F	øG	H	øJ	K	L	M	N	P	R	S
HOWF7-06	246	60	105	93	72	30	76	151	108	78	100	66	73	24	Rp (PS) 3/4	3/4
HOWF11-06	361	175	220	95	72	30	76	151	108	78	100	66	73	24	Rp (PS) 3/4	3/4
HOWF22-08	429	210	270	113	83	33	89	169	121	84	113	79	85	28	Rp (PS) 1	1
HOWF37-08	639	420	480	113	83	33	89	169	121	84	113	79	85	28	Rp (PS) 1	1
HOWF55-10	742	500	570	125	90	35	114	229	146	107	143	103	122	34	1 1/4^{B} flange	1 1/4
HOWF75-10	1057	815	885	125	90	35	114	229	146	107	143	103	122	34	1 1/4^{B} flange	1 1/4
HOWF110-16	1313	950	1050	189	139	64	165	298	166	158	210	150	140	35	2^{B} flange	1 1/2

Model	T	U	W	X	Y	Z
HOWF7-06	—	10	15	3.2	25	10
HOWF11-06	—	10	15	3.2	25	10
HOWF22-08	—	10	15	3.2	25	10
HOWF37-08	—	10	15	3.2	25	10
HOWF55-10	100	12	13	3.2	30	12
HOWF75-10	100	12	13	3.2	30	12
HOWF110-16	120	ø14	—	7	40	13

Note) Threads conform to JIS B 0203 parallel female thread (oil side) and tapered female thread (water side). Flanges conform to JIS B 2220 (JIS 1OK FF). B dimensions are maximum values.
The HOWF7-06 only is equipped with a fluid drain plug directly below the OIL INLET. Since foot and U-bolts are not pre-mounted, they should be mounted during installation.

Floating Pipe Type Oil Cooler
Series HOW
Water Cooled: Copper Particle Type

Large heat transfer area
The porous nature of the metal particles welded to the outer surface of the heat transfer pipes provide several times the heat transfer area of fin tube configurations.

High heat conductivity
The highly heat-conductive metal particles are firmly welded, so they provide effective cooling even when attached to a surface separated from the heat transfer pipes.

Compact design requiring less installation space
The compact design is only 1/2 to 1/5 the size of conventional oil coolers. Installation requires very little space.

High heat exchange effectiveness due to turbulence
The layer of metal particles reliably generates turbulence by agitating the fluid, resulting in effective cooling without unevenness.

Minimal pressure loss
The single-baffle structure increases the fluid path area. The metal particles are 2 mm in diameter, so they produce little pressure loss and will not create clogging that degrades performance.

Simple structure
The single baffle is welded to the metal particle layer for increased rigidity, a design that eliminates problems that previously tended to occur at the joins between the heat transfer pipes and baffles in conventional oil coolers.

Easy maintenance
The floating pipe type makes interior cleaning and inspection easy. The compact pipe bundle makes for easy handling.

Specifications

Max. operating pressure	(Oil and Water sides) 1.0 MPa
Proof pressure	(Oil and Water sides) 1.5 MPa
Fluid temperature	Oil side: Max. 100°C/Water side: Max. 50°C
Cooling water	Industrial water, Tap water
Fluid cooled	General petroleum-based hydraulic fluid, Lubricating oil Note 1)
Heat transfer medium	Copper tube and copper particles
Connection	Threaded Note 2)

Note 1) Not suitable for use with non-flammable fluid (water-glycol) or phosphoric ester hydraulic fluid.
Note 2) Thread connection is standard for the oil side, but flange connection is possible using a (custom) companion flange.

Model

Model	Heat transfer area (inside pipe) (m^2)	Heat exchange volume (kW)	Oil side	Cooling water side		Weight (kg)
			Flow rate range (L/min)	Flow rate (L/min)	Pressure drop (MPa)	
HOW008M-06	0.084	6	20 to 130	25	0.02	7
HOW013M-06	0.13	8.5	30 to 160	25	0.02	8
HOW021M-12	0.21	14	35 to 200	65	0.03	14
HOW032M-12	0.32	21	40 to 250	65	0.03	18
HOW050M-12	0.50	30	50 to 300	65	0.03	24
HOW075M-14	0.75	52	60 to 400	100	0.05	42

Note 1) Conditions: Turbine oil Class 1 (ISO VG32), oil outlet temperature 50°C, water inlet temperature 30°C
Note 2) Increasing the cooling water flow volume to greater than the rated flow volume will increase the heat transfer and provide better cooling, but should be avoided as the increased flow speed within the pipe can cause corrosion.

How to Order

H O W 021 M − 12

- **H** — Heat exchanger series
- **O** — Oil cooler
- **W** — Water cooled
- **021** — Heat transfer area (m^2)

008	0.084
013	0.13
021	0.21
032	0.32
050	0.50
075	0.75

(Based on pipe interior)

- **M** — Sintered metal particle diameter

M	2 mm

- **12** — Connection

06	Rc3/4
12	Rc1 1/4
24	Rc1 1/2

Model Selection

To select the appropriate model for your application, use the data at right and follow the steps below. (Note that Data Ⓐ through Data Ⓓ are listed in the series HOWF section.)

Item		Fluid cooled	Cooling water
Type (brand)		Turbine oil Class 1 (VG56)	—
Flow rate		130 L/min	(47) L/min
Temperature	Inlet	—	25°C
	Outlet	50°C	—
Heat exchange volume		15 kW	

Step Ⓐ: No Cooling Water Flow Rate Specified

① From Data Ⓐ, calculate the oil type–heat volume correction coefficient.
— Example: A = 0.97
② From Data Ⓑ, calculate the water temperature–heat volume correction coefficient.
— Example: B = 1.3
③ Using the correction coefficients obtained in ① and ②, calculate the converted heat exchange volume.
— Example: $Q = \frac{15}{0.97 \times 1.3} = 11.9$ kW
④ Select the appropriate model from the model performance graph.
— Example: Oil outlet temperature 50°C, selected model **HOW021M**
In this case, the oil pressure drop can be calculated as follows.
⑤ From the model performance graph, determine the oil pressure drop.
— Example: $\triangle P = 0.06$ MPa
⑥ From Data Ⓓ, calculate the oil type–pressure drop correction coefficient.
— Example: D = 1.4
⑦ Using ⑤ and ⑥, calculate the corrected oil pressure drop.
— Example: $\triangle P = 0.6 \times 1.4 = 0.084$ MPa

(Result) Model: HOW021M, Oil pressure drop: △P = 0.084 MPa,
Rated water volume: 65 L/min

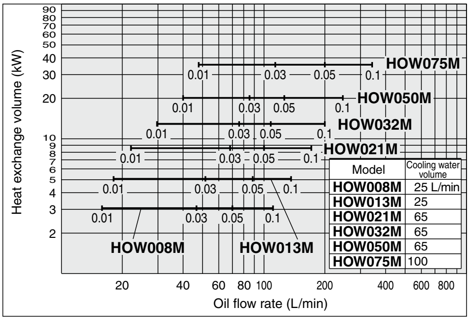
Step Ⓑ: Cooling Water Flow Rate Specified

① From Data Ⓐ, calculate the oil type–heat volume correction coefficient.
— Example: A = 0.97
② From Data Ⓑ, calculate the water temperature–heat volume correction coefficient.
— Example: B = 1.3
③ From the model performance graph, locate the intersection of the oil flow rate and heat exchange volume lines to make a provisional model selection. Note that the rated water volume for the selected model can be determined from the specifications.
— Oil outlet temperature 50°C, provisional model selection HOW021M, rated water volume 65 L/min.
④ Divide the actual water volume by the rated water volume from ③. If the calculated water volume is 1 or greater, treat it as 1.
— Example: $\frac{47}{65} = 0.72$
⑤ From Data Ⓒ, calculate the water volume–heat volume correction coefficient.
— Example: C = 0.85
⑥ Using the correction coefficients obtained in ①, ②, and ⑤, calculate the converted heat exchange volume.
— Example: $Q = \frac{15}{0.97 \times 1.3 \times 0.85} = 14$ kW
⑦ Select the appropriate model from the model performance graph.
— Example: Oil outlet temperature 50°C, selected model **HOW021M**
In this case, the oil pressure drop can be calculated as follows.
⑧ From the model performance graph, determine the oil pressure drop.
— Example: $\triangle P = 0.06$ MPa
⑨ From Data Ⓓ, calculate the oil type–pressure drop correction coefficient.
— Example: D = 1.4
⑩ Using ⑧ and ⑨, calculate the corrected oil pressure drop.
— Example: $\triangle P = 0.6 \times 1.4 = 0.084$ MPa

(Result) Model: HOW021M, Oil pressure drop: △P = 0.084 MPa,
Cooling water volume: 47 L/min

Model Performance Graph ①: Oil Outlet Temperature 40°C

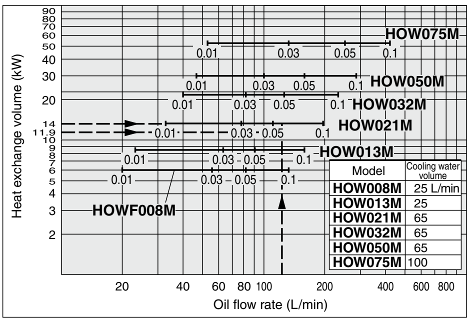
Conditions Oil outlet temperature: 40°C
Water inlet temperature: 30°C
Fluid: Turbine oil Class 1 (ISO VG32)
Oil side pressure drop: 0.01, 0.03, 0.05, 0.1 MPa indicated



Model performance values include an allowance (approx. 25%) for water deposits.

Model Performance Graph ②: Oil Outlet Temperature 50°C

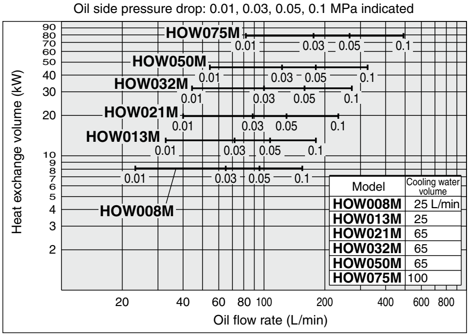
Conditions Oil outlet temperature: 50°C
Water inlet temperature: 30°C
Fluid: Turbine oil Class 1 (ISO VG32)
Oil side pressure drop: 0.01, 0.03, 0.05, 0.1 MPa indicated



Model performance values include an allowance (approx. 25%) for water deposits.

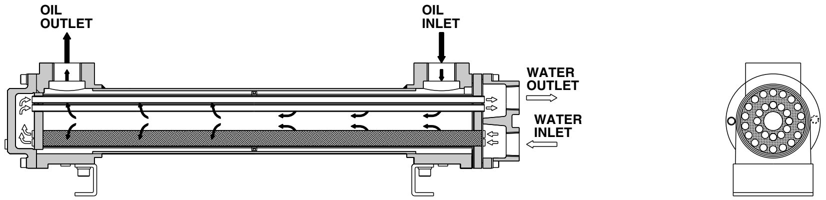
Model Performance Graph ③: Oil Outlet Temperature 60°C

Conditions Oil outlet temperature: 60°C
Water inlet temperature: 30°C
Fluid: Turbine oil Class 1 (ISO VG32)
Oil side pressure drop: 0.01, 0.03, 0.05, 0.1 MPa indicated



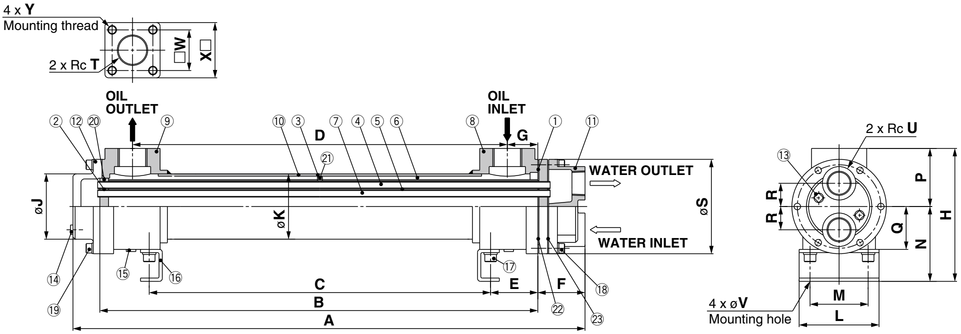
Model performance values include an allowance (approx. 25%) for water deposits.

Construction



Construction description

The series HOW employs a multi-pipe design with the heat transfer pipes arranged in a circular pattern. The area between the pipes is filled with porous metal particles. Cooling water flows through the heat transfer pipes. Fluid flows in through the inlet on the side of the shell and passes into the metal particle layer outside the heat transfer pipes, finally reaching the open cavity in the center. It then flows axially though the center cavity, once again passes through the metal particle layer, and flows out through the outlet. The cooling water inlet and outlet may be reversed, and the oil inlet and outlet may be reversed as well. It is not possible to switch the cooling water and oil flow paths, however.



Model	A	B	C	D	E	F	G	H	øJ	øK	L	M	N	P	Q	R	øS	T	U	øV	□W	□X	Y (Mounting thread)
HOW008M-06	493	400	300	336	50	58	32	149	64	73	90	60	87	62	47	25	100	3/4	1/2	10	40	56	M8 x P1.25 x depth 14
HOW013M-06	693	600	500	536	50	58	32	149	64	73	90	60	87	62	47	25	100	3/4	1/2	10	40	56	M8 x P1.25 x depth 14
HOW021M-12	505	400	270	316	65	65	42	184	90	90	110	80	104	80	59	32	130	1 1/4	1	12	56	76	M12 x P1.75 x depth 20
HOW032M-12	705	600	470	516	65	65	42	184	90	90	110	80	104	80	59	32	130	1 1/4	1	12	56	76	M12 x P1.75 x depth 20
HOW050M-12	1055	950	820	866	65	65	42	184	90	90	110	80	104	80	59	32	130	1 1/4	1	12	56	76	M12 x P1.75 x depth 20
HOW075M-14	1077	950	780	842	85	77	54	230	118	120	150	100	130	100	75	40	168	1 1/2	1 1/4	14	65	92	M16 x P2 x depth 25

Component Parts

No.	Description	Material	Quantity
①	Tube sheet A	SS400	1
②	Tube sheet B	SS400	1
③	Baffle	SS400	1
④	Heat transfer pipes	C1220T	—
⑤	Metal particle layer	Cu	—
⑥	Metal particle cover A	Stainless steel 304	2
⑦	Metal particle cover B	Stainless steel 304	1
⑧	Shell flange A	AC4C	1
⑨	Shell flange B	AC4C	1
⑩	Shell pipe	A6063T	1
⑪	Water chamber cover A	FC200	1
⑫	Water chamber cover B	FC200	1

No.	Description	Material	Quantity
⑬	Corrosion-resistant plug	Zn, FCMB	2
⑭	Water drain plug	FCMB	1
⑮	Oil drain plug	FCMB	2
⑯	Foot	SS400	2
⑰	Foot bolt	S20C	4
⑱	Cap bolt	SCM3	6
⑲	Cap bolt	SCM3	6
⑳	O-ring A	NBR	1
㉑	O-ring B	NBR	1
㉒	Seal A	V#6500	1
㉓	Seal B	V#6500	1

- If you are unsure which model is suitable, please refer to the items at right and contact SMC.

Application			
Heat exchange volume		kW	
Item		Fluid to be cooled	Cooling water
Type (brand)			
Flow rate		L/min	L/min
Temperature	**Inlet**	°C	°C
	Outlet	°C	—
Allowable pressure drop		MPa	MPa
Max. operating pressure		MPa	MPa
Property values	**Weight volume ratio**	kgf/cm³	—
	Specific heat	kW/kg°C	—
	Viscosity	mm²/s	—
If hydraulic fluid, hydraulic motor output		kW	—

Series HOW/HOWF
Specific Product Precautions

Be sure to read before handling.
Refer to front matter 38 for Safety Instructions.

Design

⚠Caution

1. **Do not use at a pressure that exceeds the operating pressure range.**
2. **Do not use at a temperature that exceeds the operating temperature range.**
3. **Fluid**
   Do not use the product with gases.
4. **Fatigue damage**
   Under the following conditions, special measures are required:
   1) If the product will be subjected to pressure surges.
   2) If the product is not mounted securely and will be subject to friction or vibrations.
5. **Corrosion**
   The product may corrode depending on usage conditions and environment.

Selection

⚠Warning

1. **When selecting products, carefully consider the usage purpose, the required specifications, and the usage conditions (fluid, pressure, flow rate, temperature, environment), and ensure that the specification range is not exceeded.**
2. **The fluid used must not be heated to the boiling point.**
3. **Do not use the product with air or other gases under any circumstances.**
4. **Do not use the product in circumstances where it will be exposed to pressure that exceeds 1 MPa, such as with a water hammer or surge pressure.**

Fluid

⚠Warning

1. **Use tap water or industrial water as cooling water.**
   Do not use seawater.
2. **Do not use for cooling chemicals or food products.**

Piping

⚠Caution

1. **Make sure to allow sufficient space for maintenance when installing and piping.**
2. **Connections**
   Make sure no cutting chips from pipe threads or sealing material gets inside the piping. If sealant tape is used, leave 1.5 to 2 thread ridges exposed at the end of the male thread.
3. **Filter installation**
   Install #100 µm filters into the inlet pipes of the oil cooler on both the oil and cooling water sides.
4. **The cooling water inlet and outlet may be reversed, and the oil inlet and outlet may be reversed as well. It is not possible to switch the cooling water and oil flow paths, however.**

Operating Environment

⚠Caution

1. **If the product is used in an environment or location conducive to corrosion, discoloration or deterioration due to corrosion may occur.**
2. **Fatigue damage may occur if the product is used in a location subject to vibrations or impacts.**

Maintenance

⚠Caution

1. **Wash out the cooling water side once a year.**