



*Global Only 1. Company
for Professional Fluid Solution*

With DC motor

High Performance Air / Oil Cooler

● FD - Series



- CE Approval
- Optimized for Mobile Hydraulic System

FLOWFORCE CO., LTD.

Special benefits from the World-class of Air/Oil Cooler in FD Series



Maximum cooling capacity 27,520 Kcal/h

(at ETD 40°C)

The Best Optimal Solution for the Industrial Hydraulic Cooling System!

With 28 years of business background and experience aiming to be the No. 1 in the global hydraulic cooling system technology field, FLOWFORCE CO., LTD. will implement its guaranteed, created, and shared value for the customers with FD series.

- Increase customer value and profit
- Increase durability and extend life-cycle of oil
- Easy installation and maintenance
- Global technical engineering service

It is the key to prevent unnecessary losses with the ideal temperature.

Selection of the insufficient heat exchange cooler and improper operation management of oil result in a risk of excessing energy consumption and operating maintenance costs.

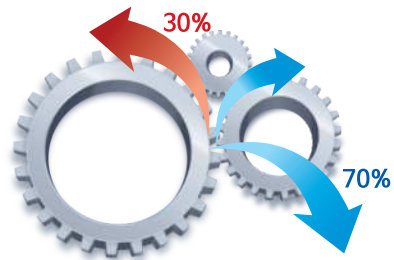
- Increase internal leakage
- High potential risk of cavitation
- Shorten the life-cycle of components



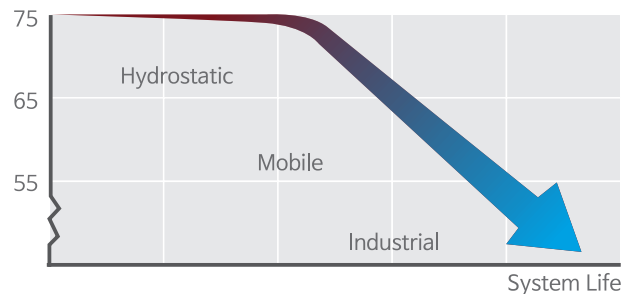
Consideration

30% energy loss in the hydraulic system is main cause raising the temperature of the operating oil.

- Friction loss occurred by hydraulic pump, control valve, etc...
- Heat generated due to the pressure drop, flow disturbance



Optimal temperature control based on the ideal of the hydraulic system



Technical consideration when selecting of oil cooler

- Hydrostatic System : 65°C
- Mobile Application : 55°C
- Industrial Application : 45°C

Remember!

- 1 ■ Oil service will be reduced by 50% when oil temperature increases 8°C based on 40°C.
- 2 ■ There is a risk of cavitation because operating oil has the air at atmospheric pressure.
- 3 ■ Hydraulic hose will have its life-time reduced by 50% when the oil temperature increases every 10°C from 60°C

Customer value-oriented product

(Clever Design + High durability components = Low operation and maintenance cost)

Product Features

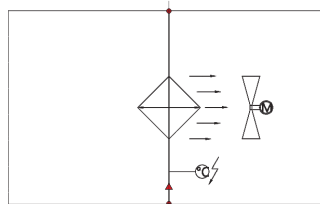
- Compact design with light weight
 - High efficiency DC motor
 - Cooler matrix: With low pressure drop and high cooling capacity
 - Low noise of fan & fan motor
 - Smart DC Motor available as an option.
- It can be equipped with multifunctional peripheral such as by-pass valve, thermo-switch, etc.

1 Environment friendly & Easy to maintenance



Main Parts

- 1 Motor / Fan, Fan Guard
- 2 Fan Housing
- 3 Cooler Matrix



Design Feature



Relay control unit

- Installed on DC Fan Cooler and works by thermo contact.
- Controls the DC Fan Motor automatically run on & off by the set temperature of the thermo contact.

Main Applications

- Mobile hydraulic system
- Rock drill equipment
- Lubrication system
- Special purposed vehicle / Heavy equipment vehicle
- Closed hydraulic system
- Concrete pump car
- Marine Hydraulics
- Brake system

2 How to select FD Air / Oil Cooler / Ordering code

1 2 3 4 5 6 7
FD - 060 - 2 - 00 - 0 - 0 - 0

1 FD = DC Fan Motor		2 Cooler size		3 Voltage	
FA	=AC Motor	010, 020, 040		0	=Without motor
FD	=DC Motor	050, 060, 070, 080, 090, 100		1	=12V
FH	=Hydraulic Motor			2	=24V
FC	=Circulation Pump Type(Off-Line)				
FTC	=Chiller				

4 Thermo contact		5 Cooler matrix		6 Matrix protect guard (option)	
00	=Without thermo contact	0	=Without matrix	0	=Without guard
40	=40°C -WIRE TYPE	1	=Standard	S	=Stone guard
50	=50°C -WIRE TYPE	2	=Two pass	D	=Dust guard
60	=60°C -WIRE TYPE	X	=Special	T	=Dust and Stone guard
41	=40°C -DIN CONNECTER TYPE	(※ Refer to page 5&8)			
51	=50°C -DIN CONNECTER TYPE				
61	=60°C -DIN CONNECTER TYPE				
XX	=Special				

(※ Refer to page 8)

7 Standard / Special	
0	=Standard
Z	=Special

3 General Technical Specification



■ FLUID COMBINATIONS

- Mineral oil HL/HLP according to DIN 51524
- Oil/Water emulsion HFA, HFB according to CETOP RP 77 H
- Water glycol HFC according to CETOP RP 77 H
- Phosphate ester HFD-R according to CETOP RP 77 H

■ MATERIAL / SURFACE PROTECTION

- Cooler matrix : Aluminum powder coated
- Fan blades : Fiber-glass reinforced polypropylene
- Cooler housing : Steel
- Fan guard : Steel / Zinc plating
- Others : Steel
- Surface treatment : Electro statically powder-coated

■ TECHNICAL DATA for COOLER MATRIX

- Maximum test pressure : 21bar
- Dynamic operating pressure : 14bar
- Heat transfer tolerance : ±6%
- Maximum operating oil temperature : 120°C
- Ambient temperature : -20°C ~ 40°C(standard)
- Painting specification : Epoxy RAL 9005
- Testing standard : ISO/DIS 10771-1

■ TECHNICAL DATA for DC MOTOR

- FD 015~020 / 040 / 050 ~ 070 / 080 ~ 100
- RPM : 3000 / 3350 / 3060
- Protection class : IP 68
- Insulation class : H
- Ambient temperature : -30 ~ 80°C
- Current consumption : (A) 12V 1.05 / 8 / 20 / 20x2
(A) 24V 0.6 / 4 / 10 / 10x2

■ COOLING CAPACITY CURVE

The cooling capacity curves in this technical data sheet are based on tests in accordance with EN 1048 and have been produced using oil type ISO VG46 at 60°C.

■ CONTACT FLOWFORCE for Special Order

- Oil Temperature > 120 °C
- Oil Viscosity > 100 cSt
- High-altitude and harsh environment

※ Caution

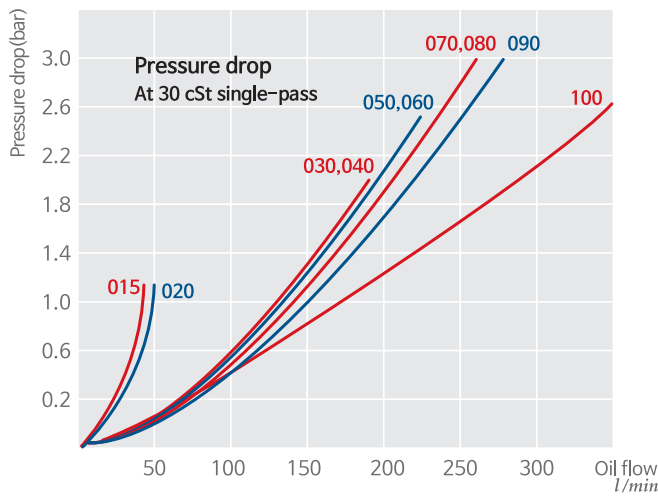
Please contact FLOWFORCE if the temperature difference is more than 50°C between inlet oil temperature and the ambient temperature.



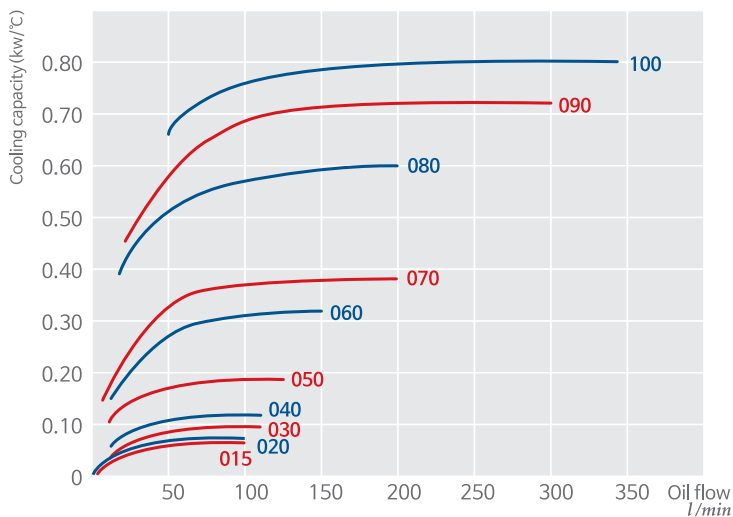
1. FD 010 - 100 Series Air Oil Cooler



The following performance curves are based on the inlet oil temperature at 60°C and the ambient temperature at 20°C.



The curves are based on the average viscosity at 30 cSt.



1 Temperature/Viscosity table

Type of oil	at 50°C (cSt)	at 60°C (cSt)	at 70°C (cSt)
VG 16	9.4	5.6	3.3
VG 22	15	11	8
VG 32	21	15	11
VG 46	29	20	14
VG 68	43	29	20
VG 120	68	44	31
VG 220	126	77	51
VG 320	180	108	69

※ Note : Optimal management viscosity - 30 cSt

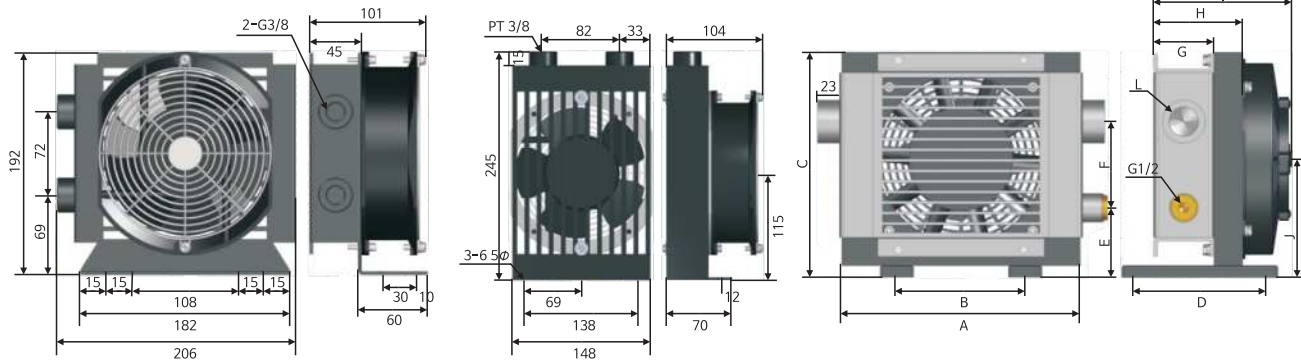
2 Correction factor K

Viscosity (cSt)	K	Viscosity (cSt)	K
10	0.6	60	1.6
20	0.8	80	2.14
30	1.0	100	2.7
40	1.2	150	4.2
50	1.4		

Technical Comments

- Cooling capacity (kw) / $\Delta T(^{\circ}C)$
- The performance curves are based on ETD at 40°C (Inlet oil temperature=60°C, ambient temperature =20°C)
- 1KW = 860 Kcal/h
- The performance curves are based on the suction flow type.

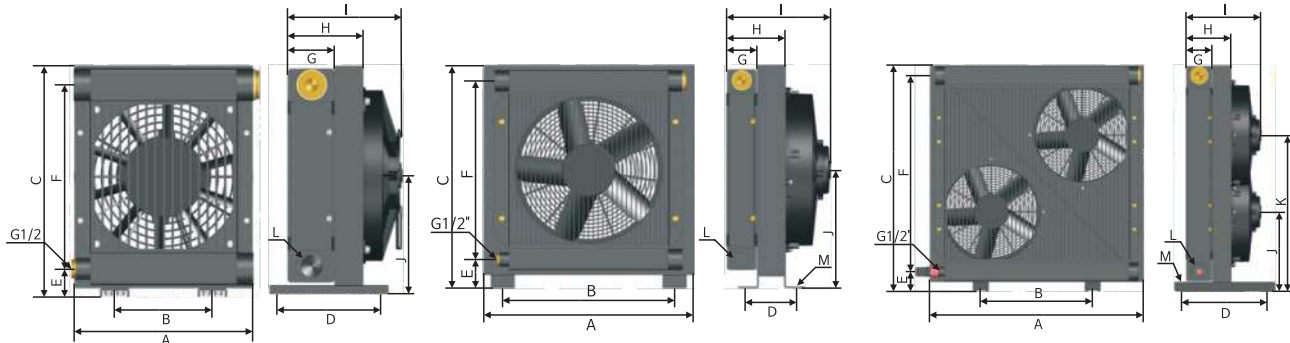
3 Dimension



FD 015

FD 020

FD 030



FD 040

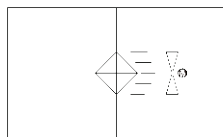
FD 050~070

FD 080~100

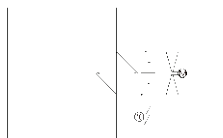
TYPE	A	B	C	D	E	F	G	H	I	J	K	L	M
FD 030	254	134	235	133	72.5	90	63	93	144	124		G1	SLOT 10X20
FD 040	245	134	317	133	38.5	252	65	105	160	165		G1	SLOT 10X20
FD 050	365	300	395	90	60	305	65	105	200	213		G1	SLOT 12X22
FD 060	440	360	468	101	60	375	65	125	220	247		G1	SLOT 12X24
FD 070	496	416	528	101	60	439	65	125	220	280		G1	SLOT 12X24
FD 080	615	356	645	280	75	525	63	123	218	210	465	G1	SLOT 12X22
FD 090	680	356	720	280	68	615	65	125	220	253	497	G1 1/4	SLOT 12X22
FD 100	680	356	720	280	63	625	85	145	240	253	497	G1 1/2	SLOT 12X22

Model	Fan RPM	Protection Class	Insulation Class	Ambient Temperature	Current Consumption	Acoustic Pressure Level dB(A) 1m	Weight/Kg (Approx...)
FD 015-12V	2800	IP44	A	-10°C~+80°C	1.05A	49	2
FD 015-24V	3000	IP44	A	-10°C~+80°C	0.60A	52	2
FD 020-12V	2800	IP44	A	-10°C~+80°C	1.05A	49	3
FD 020-24V	3000	IP44	A	-10°C~+80°C	0.60A	52	3
FD 030-12V	3350	IP68	H	-30°C~+80°C	8A	68	4.5
FD 030-24V	3350	IP68	H	-30°C~+80°C	4A	68	4.5
FD 040-12V	3350	IP68	H	-30°C~+80°C	8A	68	6
FD 040-24V	3350	IP68	H	-30°C~+80°C	4A	68	6
FD 050-12V	3060	IP68	H	-30°C~+80°C	20A	71	9
FD 050-24V	3060	IP68	H	-30°C~+80°C	10A	71	9
FD 060-12V	3060	IP68	H	-30°C~+80°C	20A	74	12
FD 060-24V	3060	IP68	H	-30°C~+80°C	10A	74	12
FD 070-12V	3060	IP68	H	-30°C~+80°C	20A	74	15
FD 070-24V	3060	IP68	H	-30°C~+80°C	10A	74	15
FD 080-12V	3060	IP68	H	-30°C~+80°C	2x20A	77	25
FD 080-24V	3060	IP68	H	-30°C~+80°C	2x10A	77	25
FD 090-12V	3060	IP68	H	-30°C~+80°C	2x20A	77	30
FD 090-24V	3060	IP68	H	-30°C~+80°C	2x10A	77	30
FD 100-12V	3060	IP68	H	-30°C~+80°C	2x20A	77	40
FD 100-24V	3060	IP68	H	-30°C~+80°C	2x10A	77	40

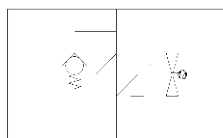
2. Cooler installation / Piping Diagram



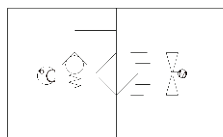
Standard Suction type Model A, B



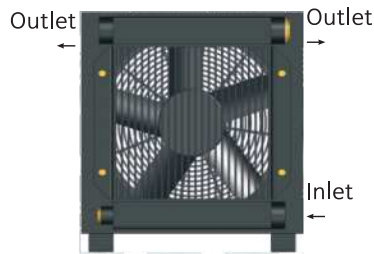
With thermo-switch Model C, D



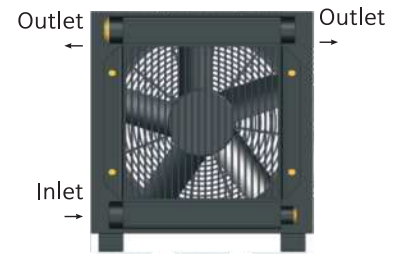
With by-pass valve Model E, F



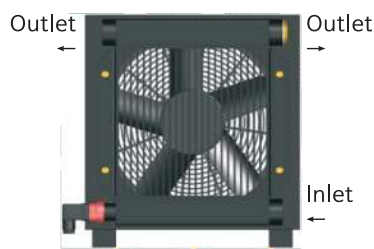
With temperature operated by-pass valve Model E, F



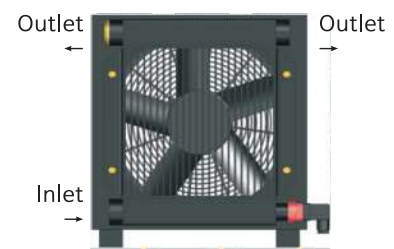
Model A



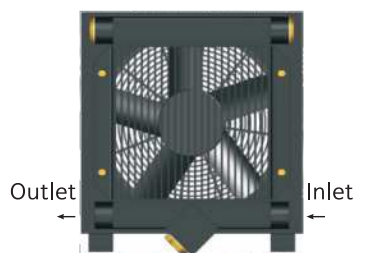
Model B



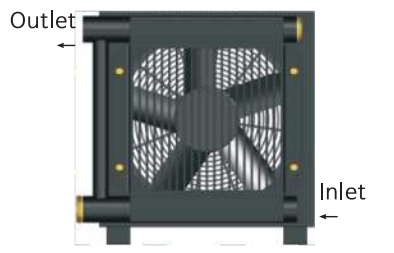
Model C



Model D



Model E

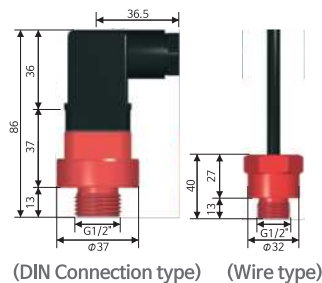


Model F

1 Thermo contact

Responsive to the temperature to operate the oil cooler in the desired temperature by sensing the motor signal.

- Type : Bi-metal control system
- Switching capacity : 24VDC 5A (In the case of inductive loads, the relay controller should be used)
- Max working Temp : 120°C
- Set temperature : Refer to the specification
- Protection : IP65



※Caution※ Please be sure to use within the allowable voltage and current ranges. When using the motor directly in inductive loads will cause damage to the contacts.

1-1 Types of thermo contacts

Model	Temperature	Connection
T40-W	40	Wire
T40-C	40	Connector
T50-W	50	Wire
T50-C	50	Connector
T60-W	60	Wire
T60-C	60	Connector

ex:T40-W : 45°C ± 5°C (ON), 35°C ± 5°C (OFF)
(In the case of inductive loads, the relay controller should be used)

1-2 Relay control box

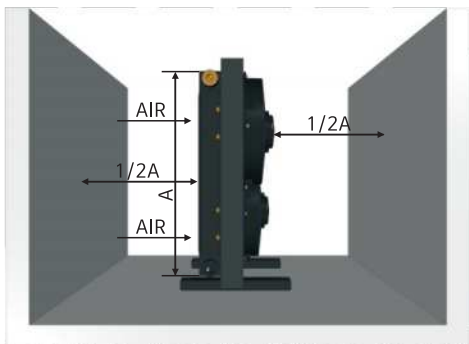
In case of controlling the coolers by using the temperature sensors, it is good to protect the cooler motors from the excessive current and also battery and other components when the cooler motors are damaged.

Ordering code for Relay Control Unit

① FRC - ② 12 - ③ 1 - ④ L - ⑤ 15

- ① FLOWFORCE Relay Control
- ② Voltage
 - 12V DC 12
 - 24V DC 24
- ③ No. of Fan
 - 1EA 1
 - 2EA 2
- ④ Switch
 - Right R
 - Left L
- ⑤ Fuse Size
 - 15A 15
 - 20A 20
 - 25A 25

3. Service Instruction



■ **Installation**

FD Series Air / Oil Coolers can be installed and mounted in any position but an upright installation is recommended. Prior to the installation, please consider the enough space for the air-flow of the coolers. In order to keep the best performance of the coolers, please do not disturb air-flow.

■ **Cleaning**

- Cooler body: When cleaning exterior of the coolers by water, ensure to disconnect the power supply.
- Cooler matrix: Using the compressed air to clean the cooler matrix but no damages on the cooler matrix.
- Fan housing: Remove the cooler matrix, when cleaning the inside of the fan housing. Use compressed air to clean the fan housing and blow the compressed air from the electric motor to fan guard.

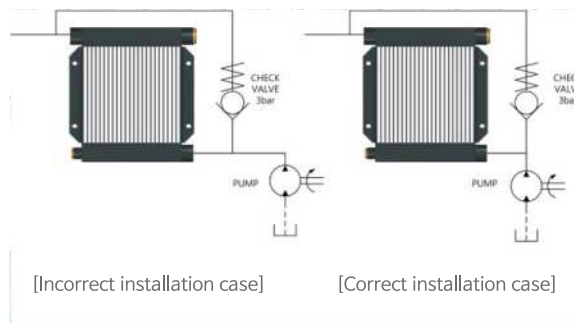
■ **Noise Level**

The noise level of the oil cooler might vary with depending on reflection from surrounding objects, natural frequency and interference sources.

■ **Connection of cooler matrix**

Using flexible hydraulic hoses to connect the cooler matrix. Make sure that all the hydraulic hoses and connections should be considered for the required pressure, flow and temperature of application. If there is a risk of pressure peaks or flow peaks the coolers should be mounted together with a filters in a separate cooling circuit.

■ **How to install an external by-pass**



Take the next step

Use the right accessories(options)



Pressure-controlled by-pass valve
Integrated type that allows the oil to bypass the cooler matrix if the pressure is too high and it reduces the risk of the cooler burst.



Temperature controlled by-pass valve
Integrated type and same function with pressure controlled by-pass valve but working by the temperature.



Thermo contact
Work by the sensor with fixed set point. Automatic switching on and off the fan motor.



Stone guard / Dust guard
Protect components and cooling system. Good to use under tough working condition

4. Model selection & Calculation

1 How to select the appropriate cooler

- Determination of cooler size and model
- Determination of expected pressure drop

Definition

■ T_{io} [°C]	Inlet oil temperature	■ P_1 [kw]	Total amount of heat exchange
■ T_{ia} [°C]	Inlet air temperature	■ Q [l /min]	Oil flowrate
■ Δt [°C]	Entrance Temperature Difference, $\Delta t = T_{io} - T_{ia}$	■ C_p	Specific heat capacity (2.08 kJ / kg °C)
■ P_a [kw/°C]	Corrected amount of heat exchange	■ S_g	Oil density (0.89 kg/dm ³)
■ P_2 [kw/°C]	Cooling capacity, $P_2 = P_1 / \Delta t$		

Example of Calculation

- Tank oil volume (V) 300Liter
- Oil temperature at start-up (T') 15°C
- The oil is heated up approx.
 - Oil temperature after 25 min (T'') 45°C
 - Inlet oil temperature (T_{io}) 55°C
 - Inlet air temperature (T_{ia}) 25°C
 - Oil flow rate (Q) 90 l /min

Calculation

1. Calculation of P_1

$$P_1 = \frac{300 \times 0.89 \times 2.08 \times (45 - 15)}{25 \times 60} = 11.11 \text{ kw}$$
2. $\Delta t = T_{io} - T_{ia} = 55^\circ\text{C} - 25^\circ\text{C} = 30^\circ\text{C}$
3. Required specific performance :

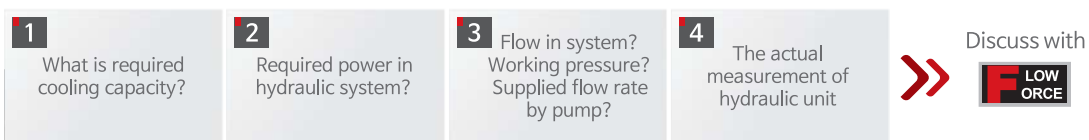
$$P_2 = P_1 / \Delta t = 11.11 \text{ kw} / 30^\circ\text{C} = 0.37 \text{ kw}/^\circ\text{C}$$
4. Corrected amount of heat exchange

$$P_a = P_2 \times 1.1 = 0.4 \text{ kw}/^\circ\text{C}$$
5. Using the performance curve, select the appropriate cooler at 90 l /min



Discuss with FLOWFORCE for better cooling solution that we, **FLOWFORCE** always stay with customers.

The process for the calculation of cooling capacity



Selection of the most appropriate oil cooler

5. Technical Questionnaire – Air Oil Cooler

Please contact FLOWFORCE by email(master@flowforce.co.kr) or fax(031-499-9886) after filling the blanks below.

Date :

Company / Dept.	/		Doc. No.	
Contact information	Person		Tel.	
	E-mail		Fax.	
System information	Name of system			
	Location	<input type="checkbox"/> Indoor	<input type="checkbox"/> Outdoor	<input type="checkbox"/> Etc. ()
Application				
Type of motor	<input type="checkbox"/> AC FAN Motor <input type="checkbox"/> DC FAN Motor <input type="checkbox"/> HYD Motor <input type="checkbox"/> Off-line <input type="checkbox"/> Other()			

▲ Working Condition

Working fluid		Temperature	Inlet temperature		°C
Max. Allowable pressure drop	bar		Ambient temperature		°C
Flow rate	ℓ /min		Outlet temperature		°C
Required cooling	KW		Max. Working temperature		°C
Capacity Viscosity	ISO VG		Material	House	<input type="checkbox"/> Steel(STD.) <input type="checkbox"/> SUS <input type="checkbox"/> other()
		Matrix		<input type="checkbox"/> Aluminum(STD.) <input type="checkbox"/> other()	
		Motor		<input type="checkbox"/> Standard <input type="checkbox"/> other()	

▲ Operation Condition

<input type="checkbox"/> AC FAN Motor		<input type="checkbox"/> DC FAN Motor		<input type="checkbox"/> HYD' Motor		<input type="checkbox"/> Off-line	
Motor	<input type="checkbox"/> 110V <input type="checkbox"/> 220V	Motor		Flow		Flow	<input type="checkbox"/> 20.7cc/rev
	<input type="checkbox"/> 220/380V						cc/rev()
<input type="checkbox"/> 440V	rpm()						<input type="checkbox"/> 29.0cc/rev
Hz	<input type="checkbox"/> 50Hz <input type="checkbox"/> 60Hz		°12v				<input type="checkbox"/> 42.0cc/rev
IP	<input type="checkbox"/> Standard		°24v				<input type="checkbox"/> 53.1cc/rev
	<input type="checkbox"/> Other()						<input type="checkbox"/> 40.8cc/rev
							<input type="checkbox"/> 61.2cc/rev

▲ Options

Themo contact	<input type="checkbox"/> T40 <input type="checkbox"/> T50 <input type="checkbox"/> T60
	<input type="checkbox"/> DIN-TYPE <input type="checkbox"/> WIRE-TYPE
By-pass valve integrated type	<input type="checkbox"/> SINGLE PASS <input type="checkbox"/> TWO PASS
	<input type="checkbox"/> By temperature <input type="checkbox"/> By pressure
Temperature sensor	Temperature()°C, Pressure()bar <input type="checkbox"/> PT100 <input type="checkbox"/> Temperature Transmitter(4~20mA)
Temperature controler	<input type="checkbox"/> Simple ON/OFF <input type="checkbox"/> Inverter PID
Filter unit	<input type="checkbox"/> 5μm <input type="checkbox"/> 10μm
Protective guard	<input type="checkbox"/> STONE GUARD <input type="checkbox"/> DUST GUARD
Adapter(PF->PT)	<input type="checkbox"/> 1" <input type="checkbox"/> 1"1/4 <input type="checkbox"/> 1"1/2 <input type="checkbox"/> 2"

▲ Additional Specification

Nameplate	<input type="checkbox"/> Standard	Manufacturer's standard
	<input type="checkbox"/> Other	English/Other :
Paint	<input type="checkbox"/> Manufacturer's standard (RAL 9005)	
	Request	
Internal cleanliness	<input type="checkbox"/> Manufacturer's standard	
	<input type="checkbox"/> ISO4406	
Motor approval	<input type="checkbox"/> CE <input type="checkbox"/> UL <input type="checkbox"/> ATEX <input type="checkbox"/> Other()	
Certificaiton	<input type="checkbox"/> CE <input type="checkbox"/> ASME <input type="checkbox"/> CLASS() <input type="checkbox"/> Other()	
Other specification		

※ Please feel free to write below blanks.

Type / Series		Product model	
Q'ty		Requested delivery date	

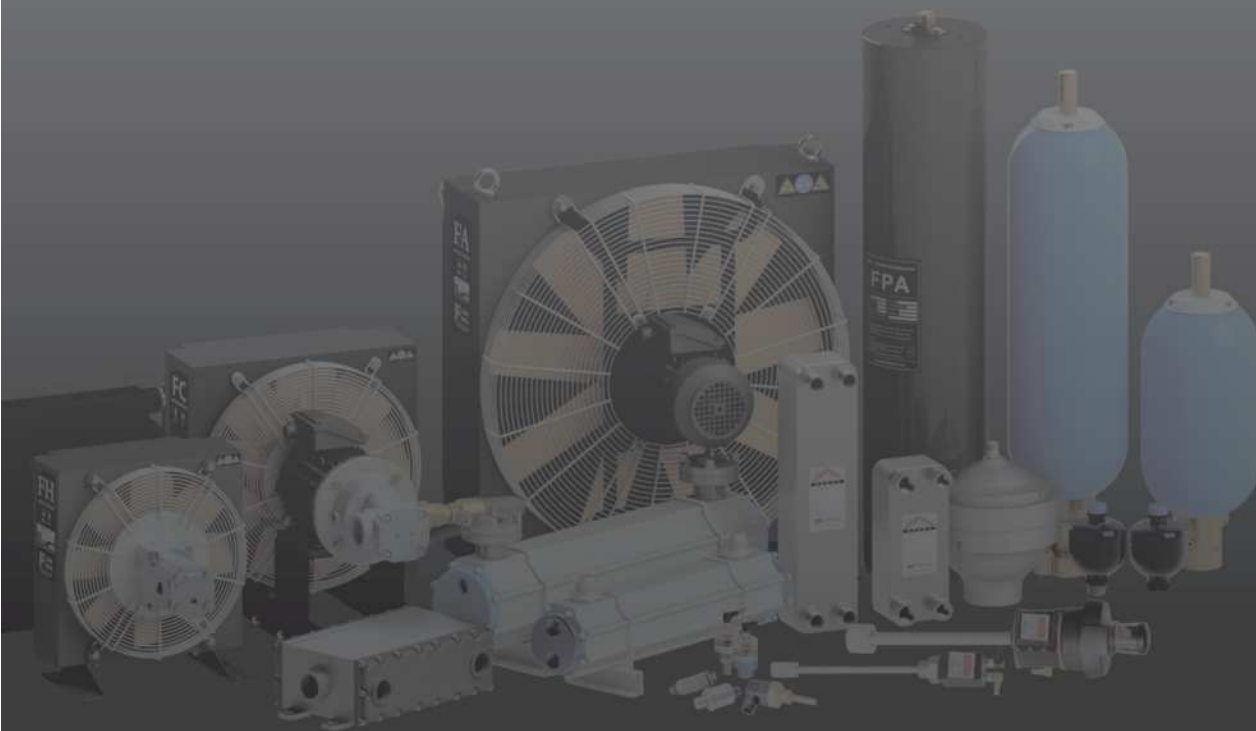
The faith and belief in technology with new CI, FLOWFORCE is a hydraulic system accessory manufacturer with

28 years of business background and experience aiming to be the Global Only 1. Company in the hydraulic accessories and cooling solution technology.

FLOWFORCE also implements energy-saving on its site and lead the market with new technology by supplying the most efficient eco-friendly and next-generation products as its guaranteed, created and shared value for the customers.

By the experience together with next-generation technologies that we, FLOWFORCE will exert efforts to improve customer problems with differentiated engineering solutions and leading the market.

Thank you.



FLOW **ORCE** (주)플로우포스
Flowforce. Co., Ltd.

경기도 화성시 서신면 공평항로 1686-7
Tel. 031-499-9885 | Fax. 031-355-4175

1686-7, Gungpyeonghang-ro, Seosin-myeon,
Hwaseong-si, Gyeonggi-do, Korea
www.flowforce.co.kr

master@flowforce.co.kr