Fluidcontrol

Oil/air cooler BLK

Drives and hydraulic aggregates are used in machine construction, raw material production, maritime and many other areas.

In hydraulic systems oil transfers power and motion, in drives it's a vital lubricant. Both as a power transfer medium and lubricant oil is heated by friction losses during operation.

Since the viscosity of the oil changes along with the temperature, precise temperature stabilisation using coolers is a vital requirement for systems and drives for consistent power. The temperature further affects the ageing behaviour and the life of oils.

Due to the unlimited supply, ambient as air as the coolant for heat dissipation. However, since the air temperature fluctuates throughout the year and oil flow can also fluctuate, the heat exchanger required to stabilise the oil temperature must be carefully configured.

The BLK series features efficient cooling matrixes, an easy to maintain design and energy-efficient fan motors.

- Easy to maintain design
- Compact installation dimensions
- Low noise emission
- Broad performance range
- Rugged cooling matrix
- Extensive accessories

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Introduction and description

Why coolers?

There are basically two main concepts in developing fluid power systems.

One is to design systems without using a cooler, and if operational conditions show that the system needs a cooler, install it later at additional costs. This understandably then often calls for compromises, making the system more expensive.

The other concept recognizes that a system originally designed with an integrated cooler needs less installation space and is a better choice with respect to construction and system costs.

Why Bühler?

If you plan to cool with an oil/air cooler, it needs to have a simple and compact design, low noise emissions, and be easy and quick to maintain.

When we developed the BLK series we incorporated our years of experience in designing and selling oil/air coolers. Especially the fatigue life of the cooling matrix was a focus during development, since in some cases the matrix has to withstand considerable pressure peaks in the return line.

The cooling matrix can easily be removed from the fan case for maintenance without uninstalling the fan or motor.

If our comprehensive standard range of products does not include the right solution for your application, we will gladly develop a custom solution for you.

Use the data in this leaflet to determine a suitable cooler for your application.

Construction and application

The BLK series consist of the following components:

- Cooling matrix
- Fan case with mounting rails
- Blower, consisting of AC motor, fan and protective/mounting grate
- The cooling matrix and fan can individually be removed from the fan case without the need to uninstall other components

BLK series cooling matrixes are made from aluminum. The coolers are designed for use in hydraulic circuits - including return lines. They are not suitable for pure water.

We also offer cooling matrixes with bypass (see type code).

Depending on the application or system requirements, off-line filtration is often required. In these cases we recommend combining them with an off-line circuit. Please refer to our BNK series for suitable models. These units are also suitable for upgrading existing systems.

Planning information

Set-up

The cooler must be set up so it does not interfere with the air supply and exhaust. The distance to air obstacles behind the cooler should be at least half the cooler height (dimension B).

Ensure adequate ventilation. During set-up, avoid exiting hot air or noise emission from causing problems.

If the ambient air is dirty, excess deposit on the cooling matrix must be expected. This will reduce the cooling capacity. In this case, particularly in the case of air loaded with oil mist, the air ducts must be cleaned regularly.

For outdoor setup, adequately protect the motor from the weather.

Ensure easy access for inspection and maintenance.

Mount

The coolers are secured to the mounting rails with four screws. Be sure the support structure is adequately sized. Install in any position.

Connecting the oil circuit

The connection between the system and the cooling matrix should be stress and vibration free, which can be achieved by using conduit.

Follow the appropriate safety regulations to prevent environmental damage due to possible oil leaks (e.g. collection pans).

Model key

BLK 4.6- IBx - T50

Number of motor contacts
Frame size

Including a bypass and/or thermal contact will be indicated by the addition to the type designation:

BLK 4.6- IBx - T50

Bypass version	AB	(BLK 2-10)	external bypass
	IB	(BLK 3-9)	internal bypass
	ITB	(BLK 3-9)	internal temperature-dependent bypass 29 PSI / 113 °F
	ATB	(BLK 2-9)	external temperature-dependent bypass 29 PSI / 113 °F
	x		bypass value 29 PSI, 72.5 PSI, 116 PSI
Temperature switch	T50, T60 T70, T80		Temperature in °F, specifications see separate data sheet

Technical Data

Technical Data	
Materials / surface protection	
Cooling battery:	Aluminium, painted
ventilation box, safety guard and motor brackets:	Steel, powder-coated
Colour:	RAL 7001 / Motor: RAL 7024/7030
Operating fluids:	Mineral oils according to DIN 51524 Gear lubricant according to DIN 51517-3 Oil/water emulsions HFA and HFB according to CETOP RP 77 H Water glycol HFC according to CETOP RF 77 H Phosphoric ester HFD-R according to CETOP RP 77 H
Operating pressure	
static	
BLK 1.2:	max. 232 psi
BLK 2.2 – BLK 10.8:	max. 305 psi
dynamic	
BLK 1.2:	160 psi (at 5 M load cycle, 3 Hz)
BLK 2.2 – BLK 10.8:	218 psi (at 5 M load cycle, 3 Hz)
Operating oil temperature:	max. 176 °F (higher upon request)
Ambient temperature:	5 to 104 °F

Electric motors (others available upon request)	
Voltage / frequency:	
BLK 1.2:	230 V - 50 Hz
BLK 2.2 – BLK 10.8:	220/380 – 245/420V 50Hz 220/380 – 280/480V 60Hz
Thermal stability:	Insulation class F, utilisation per Class B
Protection class:	
BLK 1.2:	IP44
BLK 2.2 – BLK 10.8:	IP55
The motors comply with standards IEC 60034, IEC 60072, IEC 60085	

Basic data (at 60 Hz frequency)

Item no.	Cooler type	Motor power Number of poles Rated current at 460 V	Weight (lb)	Capacity (fl. oz.)	Noise level db(A)*
3501200	BLK 1.2	0.1 hp / 2 / 0.24 A (230 V)	15	27.1	68
3502200IE3	BLK 2.2	0.75 hp / 2 / 1.1 A	55	44	84
3502400IE3	BLK 2.4	0.25 hp / 4 / 0,5 A	51	44	69
3503200IE3	BLK 3.2	1.5 hp / 2 / 1.9 A	75	60.9	90
3503400IE3	BLK 3.4	0.35 hp / 4 / 0.6 A	64	60.9	74
3504400IE3	BLK 4.4	0.5 hp / 4 / 0,9 A	73	77.8	76
3504600IE3	BLK 4.6	0.25 hp / 6 / 0.6 A	68	77.8	66
3505400IE3	BLK 5.4	1 hp / 4 / 1.3 A	106	104.8	82
3505600IE3	BLK 5.6	0.35 hp / 6 / 0,8 A	88	104.8	71
3506420IE3	BLK 6.4	3 hp / 4 / 3.5 A	170	138.6	89
3506620IE3	BLK 6.6	0.75 hp / 6 / 1.3 A	141	138.6	77
3507420IE3	BLK 7.4	3 hp / 4 / 3.5 A	194	182.6	92
3507620IE3	BLK 7.6	0.75 hp / 6 / 1.3 A	159	182.6	78
3508620IE3	BLK 8.6	2 hp / 6 / 2.4 A	229	213	82
3508820IE3	BLK 8.8	0.75 hp / 8 / 1.6 A	198	213	76
3509620IE3	BLK 9.6	3 hp / 6 / 3.5 A	348	277.3	89
3509820IE3	BLK 9.8	1.5 hp / 8 / 3.2 A	311	277.3	82
3510620IE3	BLK 10.6	7.5 hp / 6 / 8.5 A	569	642.5	93
3510820IE3	BLK 10.8	3 hp / 8 / 6.0 A	542	642.5	87

*DIN EN ISO 3744, Class 3

Calculation example and nomenclature

Determination

An oil/air cooler is determined in two steps:

1. Determining or selecting the cooler size
2. Determining the actual pressure loss

$t_{ÖE}$ [°F]	Inlet oil temperature
t_{LE} [°F]	Inlet air temperature
ETD [°F]	Temperature differential: $ETD = t_{ÖE} - t_{LE}$
P_{spec} [hp / °F]	specific cooling performance (see performance curves): $P_{spec} = P / ETD$
P [hp]	Cooling performance in hp
Q [gpm]	Oil flow rate
C_{Oil} [BTU/lb·°F]	Specific heat capacity of the oil (approx. 0,48 BTU/lb·°F)
ς [lb/gal]	Gravity of oil ≈ 7,51 lb/gal

Calculation example

Assumptions:

Tank capacity	(V)	approx. 52.8 gal
Start up temperature of oil	(T_1)	59 °F (≈ 288 K)
Oil heats up in approx. t = 25 min. (1500 s) to	(T_2)	113 °F (≈ 318 K)
Required oil temperature	($t_{ÖE}$)	140 °F
Inlet air temperature	(t_{LE})	86 °F

Calculation

1. Calculating P from the tank warming

$$P = \frac{V \cdot \varsigma \cdot c_{Oil} \, (T_2 - T_1)}{t} = \frac{52.8 \text{ gal} \cdot 0.9 \, \frac{\text{kg}}{\text{l}} \cdot 2 \, \frac{\text{kJ}}{\text{kg} \cdot \text{K}} \cdot (318 \text{ K} - 288 \text{ K})}{1500 \text{ s}} = 7.2 \text{ kW}$$

2. ETD = $t_{ÖE}$ - t_{LE} = 140 °F - 86 °F = 30 K
3. Determining the cooler size: P_{spec} = P / ETD = 7.2 kW / 30 K = 0.24 kW/K
4. In the graph, select a cooler at 80 L/min with P_{spec} 0.24 kW/K. There are two options: BLK 2.2 or the larger but quieter BLK 3.4

Pressure loss curves at medium viscosity of 30 cSt

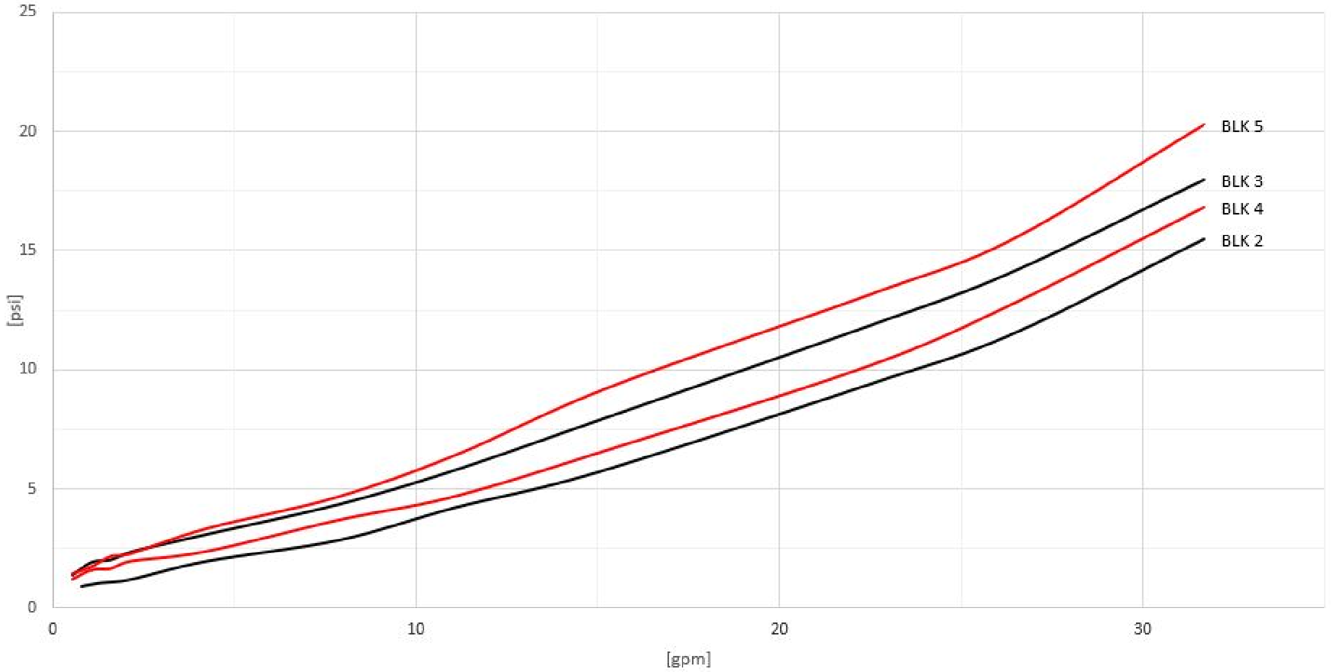


Fig. 1: Pressure loss curves BLK 2 to 5

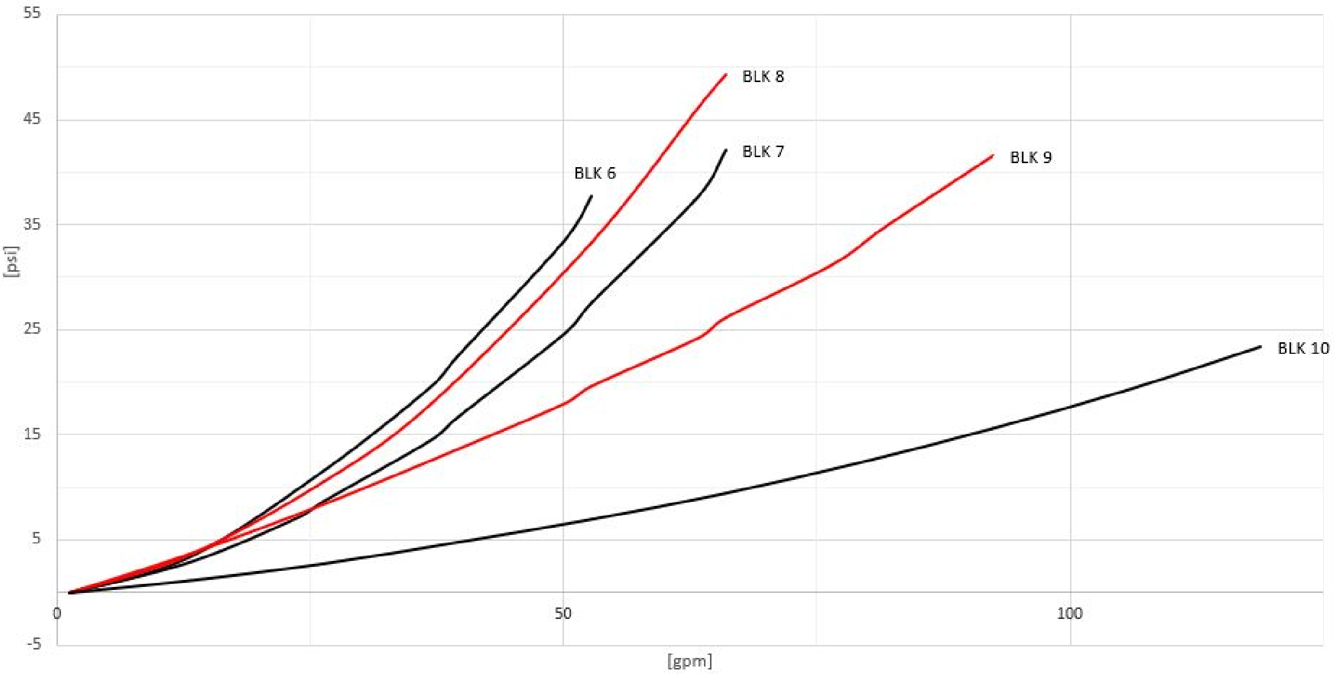


Fig. 2: Pressure loss curves BLK 6 to 10

Note: When installed outdoors or using higher viscosities, bypass valves may be required. Please note chapter Functional diagram.

Temperature/viscosity table

Type of oil	at 122 °F	at 140 °F	at 158 °F
VG 16	9.4	5.6	3.3 cSt
VG 22	15	11	8 cSt
VG 32	21	15	11 cSt
VG 46	29	20	14 cSt
VG 68	43	29	20 cSt
VG 120	68	44	31 cSt
VG 220	126	77	51 cSt
VG 320	180	108	69 cSt

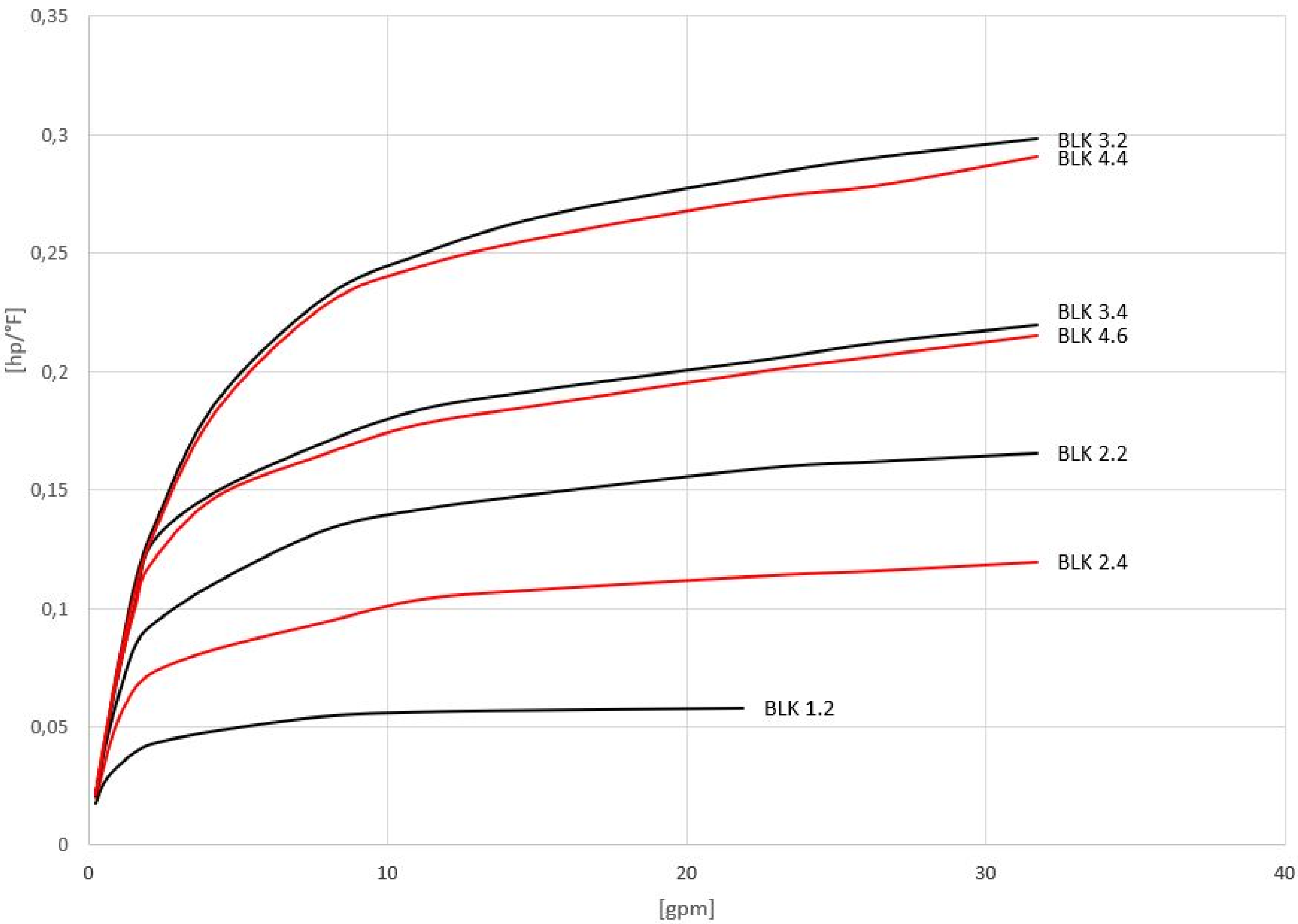
Correction k(visc)

Viscosity (cSt)	K(visc)	Viscosity (cSt)	K(visc)
10	0.6	60	1.6
20	0.8	80	2.1
30	1.0	100	2.7
40	1.2	150	4.2
50	1.4		

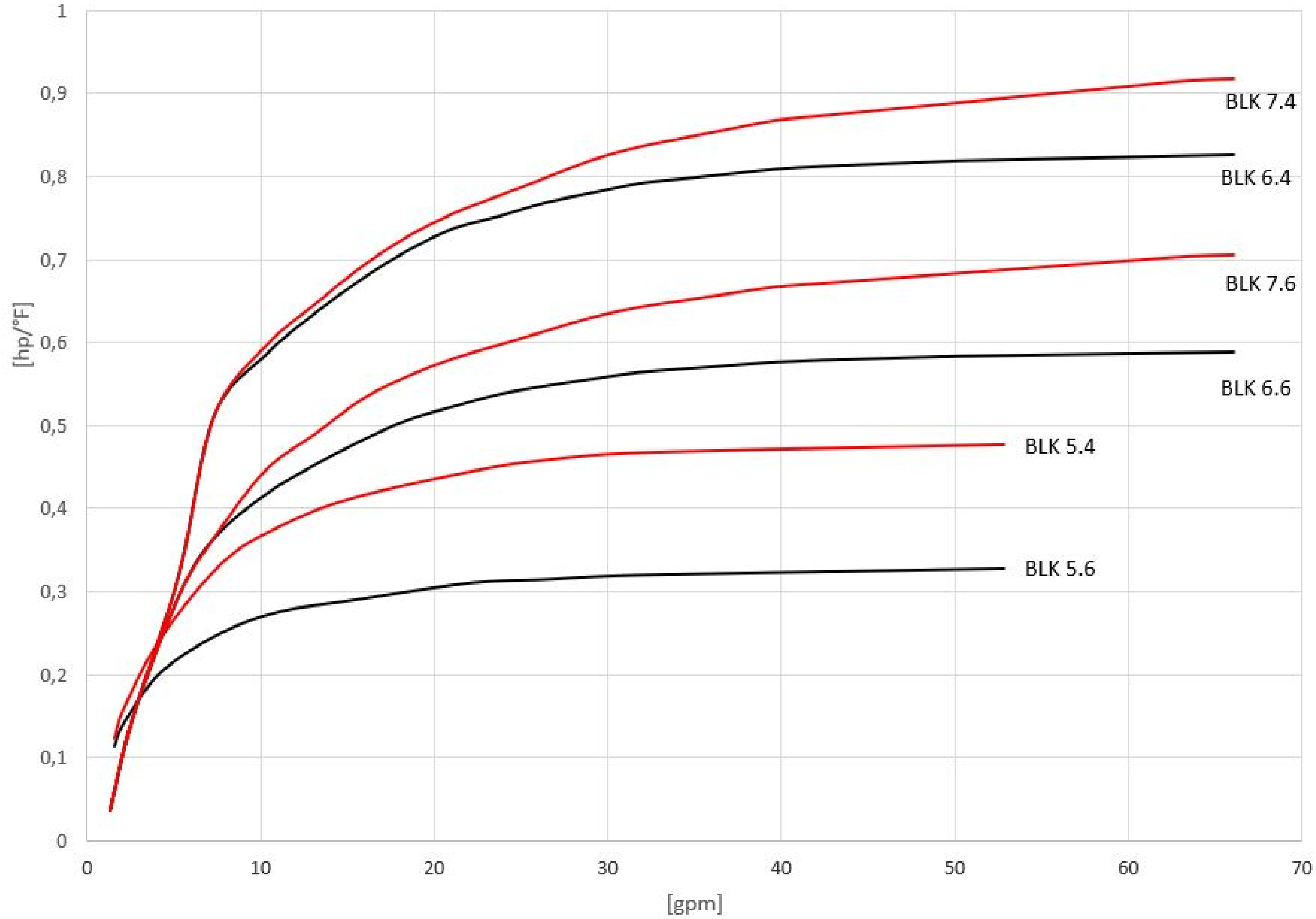
Determining the actual pressure loss

1. Determine Δp from the pressure loss graph for oil flow rate Q and the selected cooler size.
2. Determine the viscosity from the type of oil and temperature.
3. Determine the correction factor k(visc) and multiply by Δp from step 1.

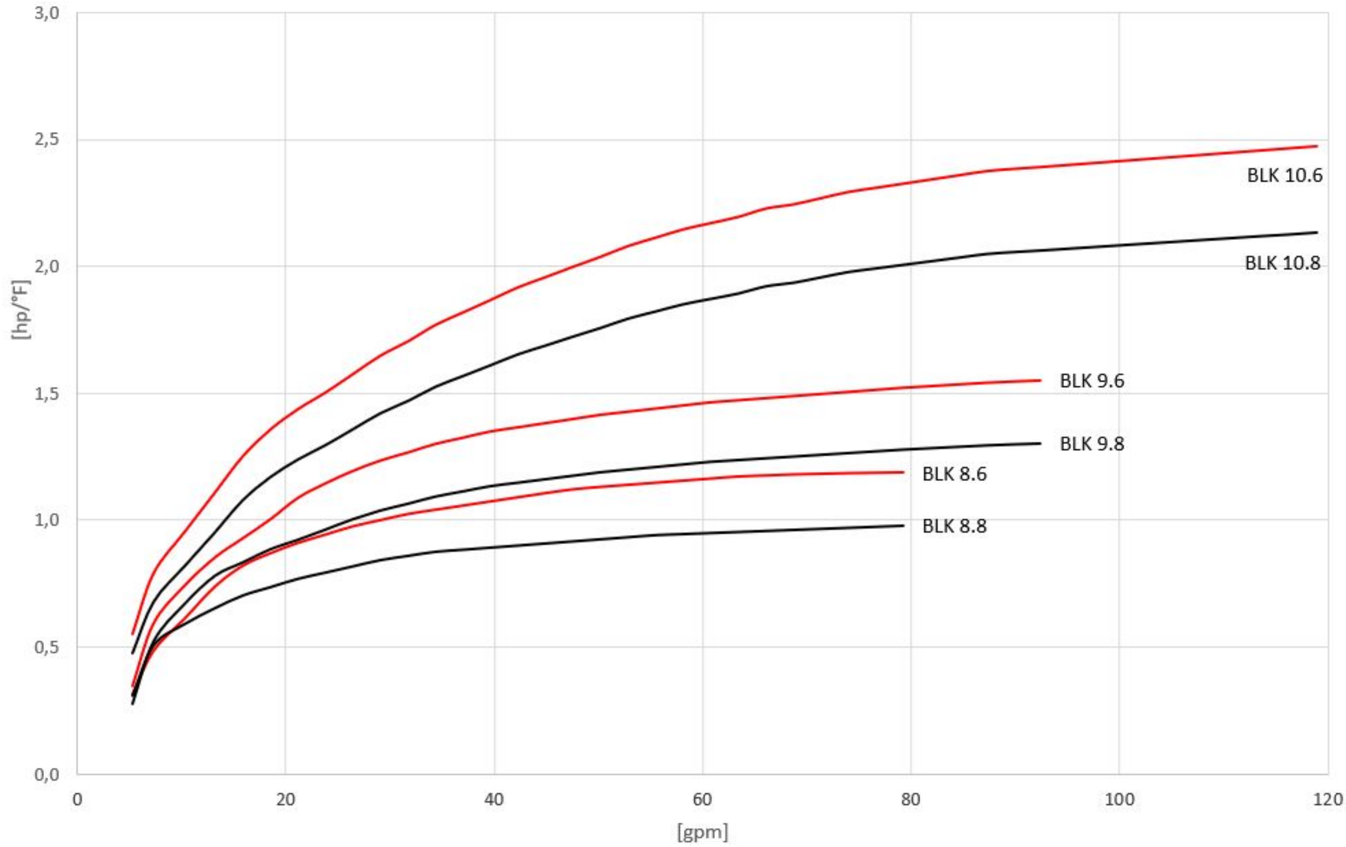
Performance curves frame size 1-4



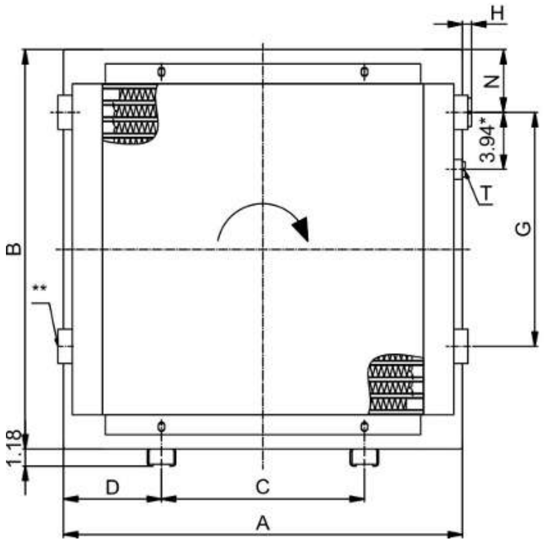
Performance curves frame size 5-7

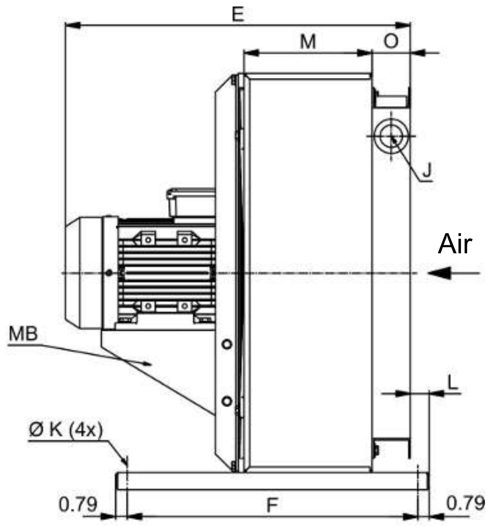


Performance curves frame size 8-10



Dimensions





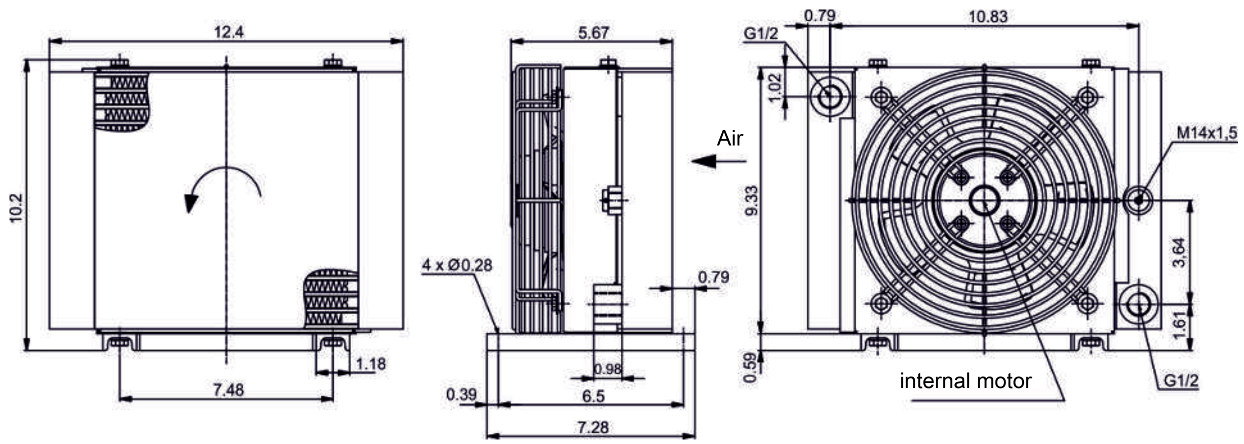
MB on some models the motors are mounted with a bracket

* on BLK 9 and 10 = 5.91 inch

** Connection fitting on BLK 9 and 10 only

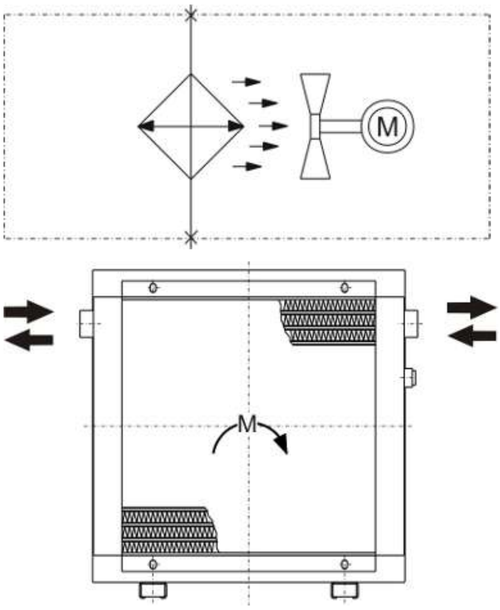
Model	A	B	C	D	E	F	G	H	J	K	L	M	N	O	MB
BLK 1.2	12.40	9.61	7.48	2.46	5.67	6.50	-	-	2x G1/2	0.28	0.79	1.97	1.30	1.77	-
BLK 2.2	14.57	14.57	7.99	3.29	16.38	20.08	-	0.98	2x G1	0.35	1.30	4.92	4.17	2.64	-
BLK 2.4	14.57	14.57	7.99	3.29	15.59	20.08	-	0.98	2x G1	0.35	1.30	4.92	4.17	2.64	-
BLK 3.2	17.32	17.32	7.99	4.67	18.27	20.08	9.06	0.98	3x G1	0.35	1.30	5.91	4.13	2.64	-
BLK 3.4	17.32	17.32	7.99	4.67	17.36	20.08	9.06	0.98	3x G1	0.35	1.30	5.91	4.13	2.64	-
BLK 4.4	19.69	19.69	7.99	5.85	18.35	20.08	9.06	0.98	3x G1	0.35	1.30	6.89	4.09	2.64	-
BLK 4.6	19.69	19.69	7.99	5.85	18.35	20.08	9.06	0.98	3x G1	0.35	1.30	6.89	4.09	2.64	-
BLK 5.4	22.83	22.83	14.02	4.41	20.24	20.08	12.01	0.93	3x G1	0.35	1.30	7.87	3.94	2.64	-
BLK 5.6	22.83	22.83	14.02	4.41	19.33	20.08	12.01	0.93	3x G1	0.35	1.30	7.87	3.94	2.64	-
BLK 6.4	27.56	27.56	14.02	6.77	24.09	20.08	16.14	0.37	3x G1 1/4	0.35	1.30	8.86	4.33	2.64	x
BLK 6.6	27.56	27.56	14.02	6.77	21.22	20.08	16.14	0.37	3x G1 1/4	0.35	1.30	8.86	4.33	2.64	x
BLK 7.4	27.56	33.07	14.02	6.77	25.08	20.08	23.23	0.37	3x G1 1/4	0.35	1.30	9.84	3.58	2.64	x
BLK 7.6	27.56	33.07	14.02	6.77	22.2	20.08	23.23	0.37	3x G1 1/4	0.35	1.30	9.84	3.58	2.64	x
BLK 8.6	34.25	34.25	20.00	7.13	25.63	20.08	23.03	0.43	3x G1 1/4	0.47	1.30	10.83	4.00	2.64	x
BLK 8.8	34.25	34.25	20.00	7.13	24.61	20.08	23.03	0.43	3x G1 1/4	0.47	1.30	10.83	4.00	2.64	x
BLK 9.6	39.76	40.16	20.39	9.69	28.11	35.04	32.36	0.12	4x G1 1/2	0.47	3.07	11.81	3.90	2.64	x
BLK 9.8	39.76	40.16	20.39	9.69	27.24	35.04	32.36	0.12	4x G1 1/2	0.47	2.87	11.81	3.90	2.64	x
BLK 10.6	46.65	46.65	23.62	11.52	33.54	35.83	37.01	0.20	4x SAE 2 1/2	0.47	2.87	12.80	5.12	3.70	x
BLK 10.8	46.65	46.65	23.62	11.52	32.09	35.83	37.01	0.20	4x SAE 2 1/2	0.47	2.87	12.80	5.12	3.70	x

BLK 1



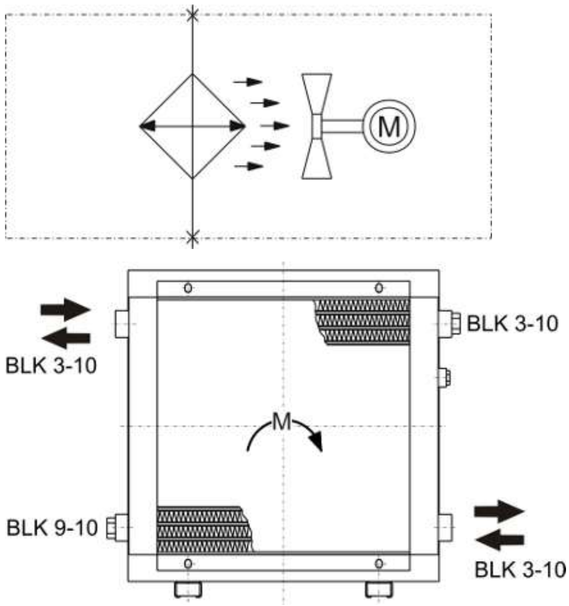
Functional diagram

Standard version BLK 2



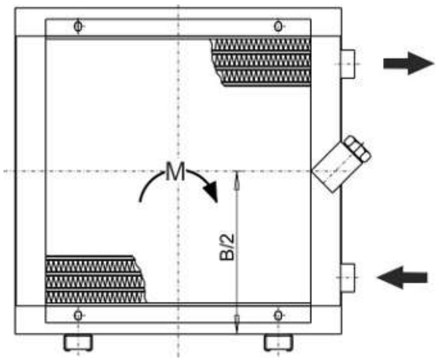
Direction of flow left to right or vice versa.

Standard version BLK 1, 3 to BLK 10



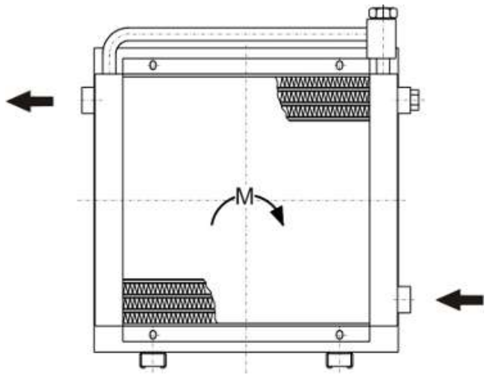
Direction of flow BLK 3-10 top left to bottom right or the exact opposite. The oil outlet is always on the opposite side. The second connection must be closed.

Internal bypass IB/ ITB (BLK 3-9)



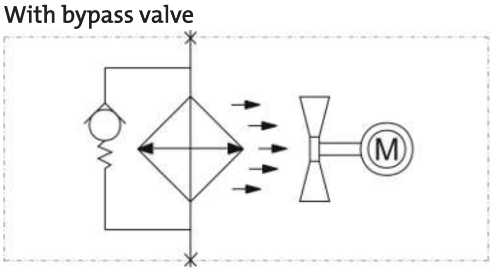
The oil inlet and outlet are always on the same side. Connections on the opposite side must be closed.

External bypass AB (BLK 2-10) / ATB (BLK 2-9)

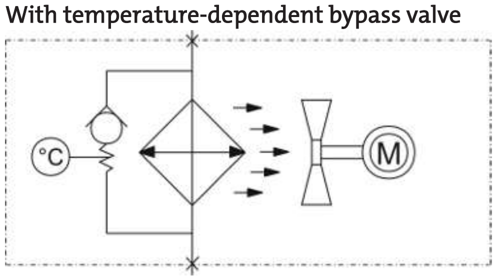


Oil inlet always at the bottom. Other connections must be closed. Oil outlet always on the opposite side.

With bypass valve



With temperature-dependent bypass valve



With temperature switch attached