Installation, Operation & Maintenance Guide

HYDRAULIC OIL COOLERS

BOWMAN®

100 YEARS OF HEAT TRANSFER TECHNOLOGY

Contents

Introduction

Thank you for purchasing a high quality Bowman hydraulic oil cooler.

Bowman® has been manufacturing hydraulic oil coolers for over 60 years and our products are renowned for their quality, heat transfer performance and durability.

Please read this 'Installation, Operation & Maintenance Guide' carefully before installation to ensure your hydraulic oil cooler operates efficiently and reliably.

Please keep this guide for future reference to ensure the long term performance of you Bowman hydraulic oil cooler.

Should you require advice or assistance, please contact your Bowman stockist or distributor.

Further copies of this 'Installation, Operation & Maintenance Guide' can be downloaded from our web site **www.ej-bowman.com**

1. Safety

1.1 Hazards When Handling the oil cooler

BOWMAN® Hydraulic Oil Coolers are constructed to current practice and recognised safety standards. Hazards may still arise from operation, such as:

- Injury of the operator or
- Third parties or
- Damage to the oil cooler or
- Damage to property and equipment

Any person involved with the installation, commissioning, operation, maintenance or repair of the cooler must be:

- Physically and mentally capable of performing such work
- Appropriately qualified
- Comply completely with the installation instructions

The oil cooler must only be used for its intended purpose.
In the event of breakdowns which may compromise safety, a qualified person must always be contacted.

1.2 Safety Instructions

The following symbols are used in these operating instructions:

Danger

This symbol indicates an immediate danger to health.
Failure to comply with this instruction may result in severe injury.

Caution

This symbol indicates a possible danger to health.
Failure to comply with this instruction may result in severe injury.

Take Care

This symbol indicates a possible risk to health.
Failure to comply with this instruction may result in injury or damage to property.

This symbol indicates important information about correct handling of the equipment
Failure to comply with this instruction may cause damage to the heat exchanger and/or its surroundings.

1.3 Approved use

BOWMAN® Hydraulic Oil Coolers are only approved for cooling hydraulic oil.
Any other use unless sanctioned by **BOWMAN®** is not approved.
BOWMAN® declines all liability for damage associated or arising from such use:

The maximum permissible operating pressure must not exceed:
Oil side: 20 bar max.
Water side: 16 bar max.
Applies to EC-RK three pass threaded connections only – for other versions please contact **BOWMAN®** for guidance.

The maximum permissible operating temperature must not exceed:

Oil side: 120º C
Cooling Water side: 110ºC

Variants with higher temperature and pressure ratings are available. Please contact the Sales for further details

1.4 Potential Hazards

Caution

Take Care

Ensure the maximum permissible operating pressures are not exceeded.
NB: Before the oil cooler is disconnected it must be allowed to cool and be depressurized. The supply and return from the cooler should be isolated to minimise fluid loss.

2. Installation

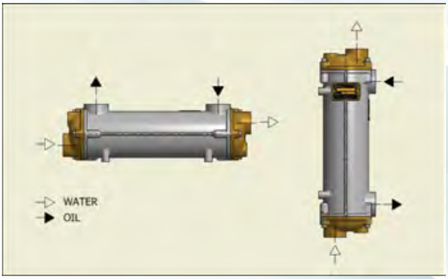
2.1 Transport / storage

The oil cooler must be drained prior to transportation. Once drained and dry, the oil cooler must only be stored indoors in a non-aggressive atmosphere. The connections should be capped to avoid ingress of dirt and contaminants.

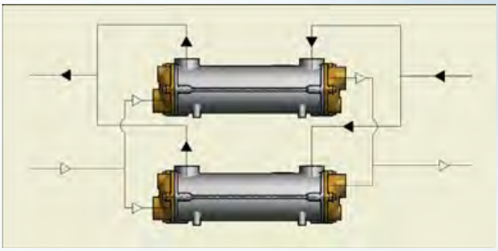
2.2 Fitting

Take Care

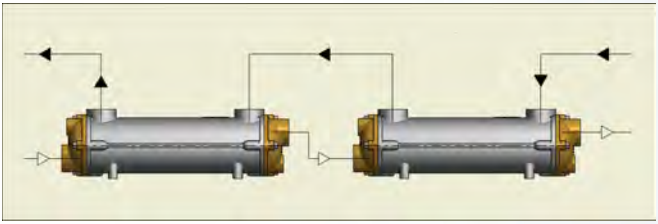
Before fitting, the cooler should be checked for visible signs of damage. The oil cooler should be connected in counterflow so that the fluids flow in opposite directions, as shown in the illustration below:



Multiple units can be connected in parallel.



Or in series:



A filter with a maximum permeability of 2.0mm should be used in the water circuit of the oil cooler.

Nothing should be welded to any part of the oil cooler.

Each unit has threaded mounting holes on its underside. Mounting brackets must be designed to protect the oil cooler from the vibration generated during engine operation. RIGID MOUNTING MUST BE AVOIDED.

The oil cooler must not be operated without adequate water flow and must be mounted so that the water outlet is uppermost.

2.3 Connecting the oil cooler

Shut off all drainage valves in the flow and return pipes in both circuits.

Take Care

When fitting the oil cooler into the pipe work care must be taken to ensure that no debris has been introduced into the oil cooler.

Unsupported lengths of pipework should be avoided so as not to subject the oil cooler to excessive loads.

Water side pipework diameter should not reduce to less than the connection size within a distance of 1m from the oil cooler.

Measures should be taken to isolate the oil cooler from excessive vibration.

Taper fittings are not recommended as these can split the shell and end cover castings if over tightened.

The correct length of fitting should be used as too long a fitting will damage the tubestack.

Pipework materials must be compatible with the oil cooler materials. Stainless steel sea water pipes and fittings should not be used adjacent to the oil cooler.

If the sea water supply is taken from a ships main, ensure that the recommended flow rate cannot be exceeded. This will normally mean that an orifice plate must be fitted in the pipe work at least 1m before the cooler with the orifice size calculated to ensure that the maximum sea water flow rate cannot be exceeded. If these precautions are not taken, it is possible that the sea water flow rate through the cooler may be several times the recommended maximum which will lead to rapid failure.

2.4 Marine installation, recommendations

No oil cooler manufacturer can guarantee that their products will have an indefinite life and for this reason, we suggest that the cooling system is designed to minimise any damage caused by a leaking oil cooler. This can be achieved as follows:

1. The oil pressure should be higher than the sea water pressure, so that in the event of a leak occurring, the oil will not be contaminated.
2. When the hydraulic system is not being used, the coolers should be isolated from sea water pressure.
3. The sea water outlet pipe from the cooler should have a free run to waste.
4. Stainless steel sea water pipes and fittings should not be used adjacent to the oil cooler.
5. Important note for marine applications: during commisioning, shutdown and standby periods, if the oil cooler has not been used over 4-6 day period, it should be drained, cleaned and kept dry. Where this procedure is not possible, drain the stagnant water and refill the oil cooler with clean sea or fresh water, which should be replaced with oxygenated sea water every 2-3 days to avoid further decomposition.

2.5 Orifice Plates

If the sea water supply is taken from a ship's main, it is important to ensure that the recommended flow cannot be exceeded.

This will normally mean that an orifice plate must be fitted in the pipework at least 1m before the oil cooler, with the orifice size calculated to ensure that the maximum sea water flow rate cannot be exceeded.

The correct orifice diameter can be determined from the table below.

Three Pass Bowman Oil Coolers		Orifice diameter in mm for max. sea water flow									
Oil Cooler Series	Max. Sea water flow l/min	1 bar	2 bar	3 bar	4 bar	5 bar	6 bar	7 bar	8 bar	9 bar	10 bar
EC	50	11	9.5	8.5	8	7.5	7.2	6.8	6.7	6.5	6.3
FC	80	14	12	11	10	9.5	9	8.7	8.4	8.2	8
FG	110	17	14	13	12	11	10	10	9.8	9.6	9.3
GL	200	23	19	17	16	15	14	14	13	13	13
GK	300	28	23	21	19	18	17	17	16	16	15
JK	400	32	27	24	22	21	20	20	19	18	18
PK	500	41	34	31	28	27	26	25	24	23	23
RK	900	48	40	36	34	32	30	29	28	27	26

2.6 Composite end cover water pipe installation

For marine versions supplied with composite end covers, it is recommended that a bonded seal is used in conjunction with the fitting and tightened to the appropriate torque figure given below to ensure sufficient sealing.

Size	Torque (Nm)
EC range (3/4" BSP)	10
FC range (1" BSP)	15
FG range (1 ¼" BSP)	20
GL range (1 ½" BSP)	25

3. Operation

Take Care

3.1 Maximum water flow rates

The following tables give maximum flow rates through the tube stack for either single, two or three pass configuration, using either sea or fresh water.

Sea Water Application (Maximum 2 m/s)

Type	3-Pass	2-Pass	1-Pass
	Max Recommended Flowrate (l/min)	Max Recommended Flowrate (l/min)	Max Recommended Flowrate (l/min)
EC range	50	80	170
FC range	80	120	230
FG range	110	170	320
GL range	200	290	560
GK range	300	450	900
JK range	400	600	1200
PK range	650	1000	2000
RK range	900	1400	2800

Fresh water Application (Maximum 3 m/s)

Type	3-Pass	2-Pass	1-Pass
	Max Recommended Flowrate (l/min)	Max Recommended Flowrate (l/min)	Max Recommended Flowrate (l/min)
EC range	75	120	255
FC range	135	200	380
FG range	180	270	530
GL range	320	470	900
GK range	460	690	1400
JK range	660	1000	2000
PK range	1000	1500	3000
RK range	1400	2150	4300

3.2 General information

The oil cooler should be pressurized on the oil (shell) side such that it is at a higher pressure than the water (tube) side. This will ensure that if a leak occurs it will be detected by a reduction in the oil level and the oil will not be contaminated. A differential pressure of 2 bar would be sufficient. It is essential that the following instructions are followed to prevent corrosion/erosion of the heat exchanger:

a) Always maintain the water pH to within correct levels. The ideal water pH should be kept within 7.4 to 7.6. On no account should it be below 7.2 or above 7.8. For fresh sea water the pH can be around 8 and this is acceptable for our oil cooler.

b) Minimum water velocity of 1m/s should be used.

c) Ensure compliance with water quality and maximum permissible pressure requirements.

d) Air must be adequately vented from both circuits.

e) Stagnant water should not be allowed to accumulate in the oil cooler. If it is not in use for any period of time the water should be drained off.

4. Commissioning

Danger

Take Care

Commissioning of the oil cooler should not be undertaken until this document has been fully read and understood. Both circuits of the oil cooler must be closed prior to commissioning.

Adequate provision should be made to ensure that correct operating/service equipment along with personal protection equipment (PPE) in accordance with current standards/legislation is used prior to the commencement of any working. Cooling water should be introduced to the oil cooler prior to the gradual introduction of hot oil. Both circuits should be vented initially and again when operating temperatures and pressures are reached. The system should be checked for leaks.

Copper-nickel alloys have a very good resistance to seawater corrosion due to the formation of a thin protective film on the surface of the metal. This film starts to develop over the first few days after the metal has been in contact with clean, oxygenated seawater, and requires a further 3 months to develop fully. This is the most important part of the process to ensure long term corrosion resistance behaviour of copper nickel. The protective surface film of cuprous oxide is indicated by either a brown, greenish brown or blackish brown thin film layer. The process of ensuring that copper alloy receives an effective oxide coating prior to service is known as "conditioning" which is a very important stage for the alloy. Ferrous sulphate can be used if commissioning in clean sea water is not possible. Schedule cleaning may help to reduce the risk possibly with non-metallic brushes. Please refer to Copper Alliance webpage for more information: www.copper.org.

5. Maintenance / Repair

5.1 Winter shutdown in areas exposed to frost

Care should be taken to prevent frost damage from a winter shutdown in conditions exposed to frost. We recommend draining down the oil cooler or removing the it completely from the installation for the duration of the shutdown period.

5.2 General maintenance

While the unit is in operation, weekly inspection of the heat exchanger and its connections should be made for leaks and externally visible damage. **BOWMAN®** recommend that the tubestack should be cleaned and inspected annually and the o rings should be renewed at this time. Removal of the screws around the periphery of each end cover will allow the end covers and seals to be removed. The tubestack can then be withdrawn from either end of the body.

5.3 Cleaning

Whilst we strongly recommend that mechanical and chemical cleaning of the heat exchanger is carried out only by specialised companies, below are some general guidelines that may be useful;

a) Removing the end covers allows access to the tube stack, which can be removed from the body.

b) Wash the tube plates and tubes using a hand held hose or lance. An industrial steam cleaner can also be used if available.

c) Tube brushes can be used to clean through each tube to aid removing stubborn deposits. Small diameter rods and brushes for tube cleaning are available from companies such as Rico Industrial Services www.ricoservices.co.uk

d) Detergents or chemicals suitable for use with the tube material* can be used if fouling is severe. Allow time for the detergent or chemical cleaner to work, before hosing down with plenty of water. **Please refer to the spare parts list for details of the tube materials.*

e) The tube stack should be flushed through with clean water to remove all traces of cleaning chemicals/detergents. If necessary, the cleaning fluid should be neutralised.

f) **When refitting the end covers after cleaning, new 'O' seals must be used**

5.4 End cover screw tightening sequence


Take Care

End covers must be refitted in their original orientation and tightened to the torque figures below.

Cooler Series	Screw Size	Torque (Nm)	Cooler Series	Screw Size	Torque (Nm)
EC	M6	8	GK	M12	54
FC	M8	22	JK	M16	95
FG	M8	22	PK	M16	130
GL	M10	37	RK	M16	130

6. Potential Service Issues

6.1 Tube failures

The majority of problems facing an oil cooler are those of corrosion or erosion on the water side. Three common types of failure are:

a) Impingement attack (or erosion corrosion)

This is caused by water containing air bubbles flowing at high speed through the tubes. The impingement of rapidly moving water may lead to a breakdown of the protective copper oxide film on the tubes thus allowing corrosion/erosion. This is worse with water containing sand or grit. The effect of these conditions would be pockmarking and pinholing of the tubes.

b) Oxide corrosion

This is caused by water containing organic matter such as that found in polluted estuaries. Usually this water produces hydrogen sulphide, which is very corrosive and can cause failure of the tubes, particularly if excessive water flows are used.

c) Pitting

This problem is caused by very aggressive sea water in the tubes, especially in partially filled coolers where the sea water is stagnant. Low sea water flow rates can create a high temperature rise on the sea water side. Under these conditions deposits may build or settle in the tube, allowing pitting corrosion to take place under the deposits.

This is only a brief introduction to corrosion problems. The subject is complex and the purpose of these notes is to outline in very general terms what may occur under extreme conditions.

6.2 Fault finding

Symptoms	Possible Causes	Remedy
Increase in temperature on shell side or excessive pressure loss	Oil sludging, tube scaling or build up of both resulting in an insulating film covering the tubes	The complete oil cooler should be thoroughly cleaned
Pressure loss is as expected, but the temperature of the oil rises	Film, scale or restrictions on the inside of the tubes	The complete oil cooler should be thoroughly cleaned
Oil leaking into the cooling water circuit or vice versa	Split or perforated tubes	Tubes should be blocked with hard wooden plugs as a temporary measure & the tubestack replaced asap
Inadequate performance	Flow rates too low Unit connected in parallel flow	Check flow rates & increase if necessary Reconnect in counterflow as per section 2.2

7. Warranty

All **BOWMAN®** Hydraulic Oil Coolers are guaranteed against manufacturing and material defects for a period of twelve months from the date of delivery.

BOWMAN® should be contacted immediately if a unit is received damaged. No attempt should be made to repair a faulty unit as this will invalidate the warranty.
For full warranty terms, please see the **BOWMAN®** Conditions of Sale. A copy of which is available on request or via download from the website: **www.ej-bowman.com**

8. Spare Parts List

A comprehensive stock of spare parts is always available. Details are given in the Hydraulic Oil Coolers brochure which can be downloaded from: **www.ej-bowman.com/downloads**
Please contact our sales department for price and availability or nearest stockist.

9. CE Marking Documentation

Heat exchangers are covered by the Pressure Equipment Directive 97/23/EC which is mandatory for all EU member states.. This manual is part of the compliance and points out all essential safety requirements to be observed.
BOWMAN® Hydraulic Oil Coolers fall within the Sound Engineering Practice category of the Pressure Equipment Directive 2014/68/EU and as such cannot be CE marked.

10. Notes on Zinc Anodes

The use of zinc anodes in heat exchangers has been employed for some years, generally by manufacturers using admiralty brass tube or its variants. The purpose of the zinc anode, or zinc pencil as it is sometimes called, is to prevent dezincification of the brass alloy tubes. As such zinc anode acts sacrificially in favour of the tube. There are a number of American and European manufacturers that use these anodes in their products.

BOWMAN®, do not fit zinc anodes as the tubes used in the construction of our coolers are of copper nickel alloy and as such do not require a zinc anode. It is possible that if this anode is fitted it can actually destroy the copper oxide film built up by the tube as a natural defence which can allow the tube material to be attacked. It is usual with the copper nickel alloys to use an iron anode which allows an iron oxide film to build up inside the tube which breaks down as a sacrificial element reducing the possibility of corrosion to the heat exchanger. In **BOWMAN®** designs it is not practical to fit iron anodes as their size has to be very generous.

Therefore as an alternative a piece of black iron pipework can be placed before the heat exchanger which in itself acts as sacrificial element protecting the cooler. The Royal Navy has often used this technique and when the black iron pipework corrodes, it is simply replace with a fresh piece.

We do know that some manufacturers of oil coolers, mostly those that are copies of better known products, often fit zinc anodes with copper nickel alloys in error.

Bowman heat transfer solutions

Bowman heat exchangers and oil coolers can be found in Active Fire Protection Systems, Automotive Testing, Combined Heat & Power, Hydraulic Systems, Marine Engineering, plus Mining Equipment and Machinery, in a range that includes:


Exhaust Gas
Heat Exchangers


Hydraulic Oil Coolers


Swimming Pool
Heat Exchangers

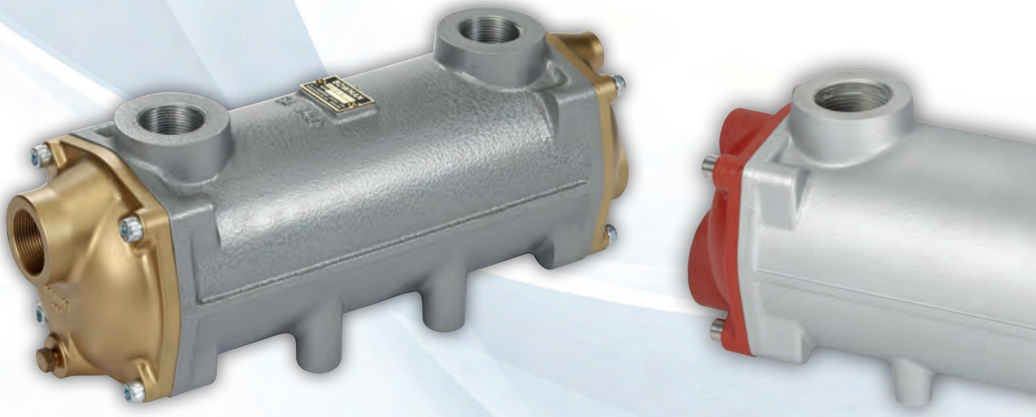

Stainless Steel
Heat Exchangers


Header Tank
Heat Exchangers


Plate Heat
Exchangers


Engine Oil Coolers


Transmission Oil Coolers



EJ Bowman (Birmingham) Ltd
Chester Street, Birmingham B6 4AP, UK
Tel: +44 (0) 121 359 5401
Fax: +44 (0) 121 359 7495
Email: sales@ej-bowman.com
www.ej-bowman.com

BOWMAN®
100 YEARS OF HEAT TRANSFER TECHNOLOGY

bsi. ISO 9001 Quality Management
FM38224

E