Installation, Operation & Maintenance Guide

CHARGE AIR COOLERS

BOWMAN®

100 YEARS OF HEAT TRANSFER TECHNOLOGY

Introduction

Thank you, for purchasing a high quality Bowman charge air cooler.

Bowman has been manufacturing charge air coolers for over 50 years and our products are renowned for their quality, heat transfer performance and durability
Please read this 'Installation, Operation & Maintenance guide' fully and carefully before installation to ensure your charge air cooler operates efficiently and reliably.
Please keep this guide for future reference to ensure the long term performance of you Bowman charge air cooler.
Should you require additional advice or assistance, please contact your Bowman stockist or distributor.
Installation, Operation & Maintenance guides are also available in:


French


German


Italian


Spanish


Polish


Russian


Chinese

If you require a copy of this guide in one of these languages, visit **https://www.ej-bowman.com/downloads/** where copies are available to freely download.

Contents

1. Safety

1.1 Hazards When Handling the Cooler

BOWMAN® Charge air 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 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 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® charge air coolers are only approved for cooling charge air.
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:

Charge Air:	5.5 bar g (EC120 - GK190)
	4.0 bar g (JK190 - RK250)
Water:	16.0 bar g

The maximum permissible operating temperatures must not exceed:

Charge Air (primary side): 250° C

Cooling Water (secondary side): 110° C

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

1.4 Potential Hazards

Caution

Ensure the maximum permissible operating pressure on the primary or secondary side of the cooler is not exceeded.

Take Care

NB: Before the Charge Air Cooler is disconnected it must be allowed to cool and be depressurized. The supply and returns from the cooler should be isolated to minimise fluid loss.

2. Installation

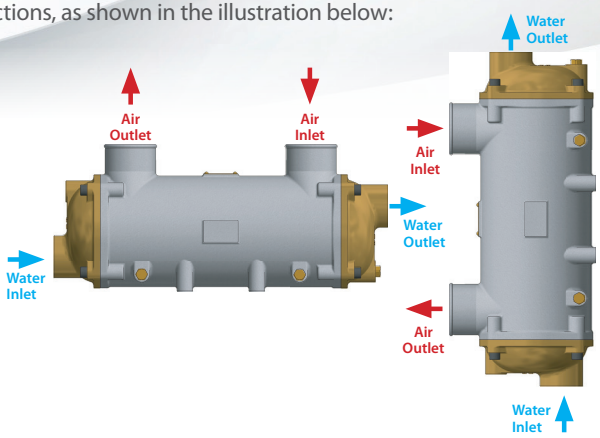
2.1 Transport / storage

The cooler must be drained prior to transportation. Once drained and dry, the 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 cooler should be connected in counterflow so that the fluids flow in opposite directions, as shown in the illustration below:



A filter with a maximum permeability of 2.0mm should be used in the water circuit of the cooler. Nothing should be welded to any part of the cooler. Each unit has threaded mounting holes on its underside. Mounting brackets must be designed to protect the cooler from the vibration generated during engine operation. RIGID MOUNTING SHOULD BE AVOIDED. The cooler must not be operated without adequate water flow and must be mounted so that the water outlet is uppermost.

2.3 Connecting the cooler

Take Care

When fitting the cooler into the pipe work, care must be taken to ensure that no debris has been introduced into the primary or secondary circuits.

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

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

Measures should be taken to isolate the cooler from excessive vibration. Water pipe connections are parallel thread. Taper pipe fittings are not recommended as they can split the end cover if over tightened.

The charge air inlet and outlet are designed to have hose connections using hose clamps apart from the PK and RK cooler sizes which have flange connection faces.

Please ensure that the connection flow area is maintained into the cooler and avoid tight bends to prevent excessive pressure loss.

Type	Connection Type	Size	Water Connections
EC120	Hose	52 mm	¾" BSP
FC100	Hose	52 mm	1" BSP
FG100	Hose	76 mm	1¼" BSP
GL140	Hose	76 mm	1½" BSP
GK190	Hose	89 mm	2" BSP
JK190	Hose	102 mm	2½" BSP
PK250	PN6 Flange	4 x M16 x 32mm on a 170mm PCD	3" BSP
RK250	Flange	4 x M16 x 32mm on a 212mm PCD	8 x 18mm on a 180mm PCD (PN6-DN100)

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

3. Operation

3.1 Maximum flow rates

The table below gives maximum flow rates for Charge Air Coolers in either single two or three pass configuration, using either sea water or fresh water cooling.

Sea Water Application (Maximum 2 m/s)

Cooler	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)

Cooler	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

Take Care

It is essential that the following instructions are followed to prevent premature failure of the Charge Air Cooler due to erosion or corrosion.

a) Always maintain the water pH to correct levels. The ideal water pH should be kept within 7.4 to 7.6. On no account should it fall below 7.2 or rise above 7.8.

b) The table above gives the maximum fluid velocities through the cooler and must not be exceeded. If in doubt contact our technical sales team for guidance.

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

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

e) Air must be adequately vented from the water circuit.

f) Stagnant water should not be allowed to accumulate in the cooler. If it is not in use for any period of time the water should be drained. During commissioning, shutdown and standby periods, if the cooler has not been used over a 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 cooler with clean sea or fresh water, which should be replaced with oxygenated sea water every 2-3 days to avoid further decomposition.

4. Commissioning

Commissioning should not be undertaken until this document has been fully read and understood.


Danger

Adequate provision should be made to ensure that correct operating/service equipment along with personal protection (PPE) in accordance with current standards/legislation is used prior to the commencement of any work.


Take Care

Cooling water should be introduced to the cooler prior to the introduction of hot charge air.

The water circuit 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 fully draining the cooler on the water side or removing the cooler completely from the installation throughout the duration of the shutdown period.
There is a drain plug on one of the end covers for this purpose.

5.2 General maintenance

While the unit is in operation, weekly inspection of the cooler 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 seals 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 heat exchanger 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 ; Easy Products www.easyproducts.com or 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.*

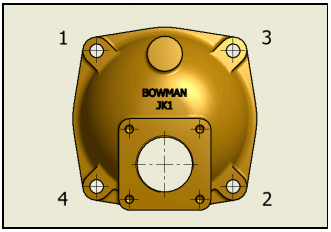
e) The tube stack should be flushed through with clean water to remove all traces of cleaning chemicals/detergents. If necessary, the cleaning fluid should be neutralised.

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

5.4 End cover screw tightening sequence

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

Take Care



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

5.5 Draining any condensate in the body of the cooler

Moisture can condense from the air and collect in the charge air cooler. There are drain plugs which can be removed to allow condensate in the body of the cooler to drain. If mounting the cooler vertically, always ensure there is a means of draining any condensate from the unit.

6. Potential Service Issues

6.1 Tube failures

The majority of problems facing a cooler are those of corrosion or erosion on the water side. 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 built up by the tube thus allowing corrosion/erosion. This is worse with water containing sand or grit. The effect of these conditions would be pockmarking and pin holing of the tubes. In Charge Air Cooler applications, erosion problems could occur on the outer surface of the tubes due to localised high velocity "wet" gas impingement attack, therefore it is important that the risk of overcooling is minimised.

b) Microbial corrosion and pitting corrosion

This is caused by water containing organic matter, such as that found in polluted estuaries, which cause the surface films to be predominantly sulphide and less protective. Please avoid extended exposure to stagnant water which can encourage sulphate reducing bacteria and in the presence of deposits, pitting corrosion will take place under the deposits.

Titanium tube stacks

Titanium tube stacks are available as a replacement for standard cupro-nickel tube stacks, for applications where corrosion issues are being experienced. Titanium provides a highly durable, long life solution for the most demanding applications and comes with a full 10 year guarantee on all titanium in contact with cooling water.

6.2 End covers

a) Galvanic corrosion

Avoid mixed metal connections where the end covers are more anodic, especially if it has a relatively small surface area. Alternatively, insulate the connection or coat either the anode or cathode to prevent electrical connections.

b) Localised corrosion

The end covers can also suffer erosion corrosion and therefore flow and velocity guidelines must be adhered to. Avoid installation with tight angle bends or obstructions which can cause local areas of turbulence.

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.

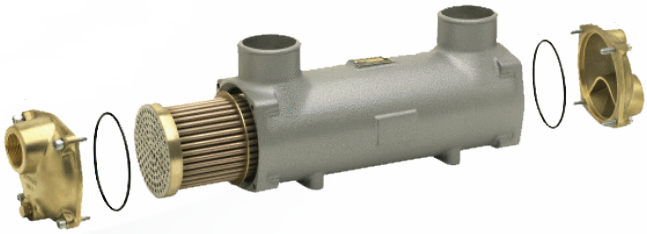
7. Warranty

All **BOWMAN®** Charge Air 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. Please contact either your nearest stockist, or our sales office for price and availability.



9. CE Marking Documentation

Charge Air Coolers are covered by the Pressure Equipment Directive 2014/68/EU 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 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

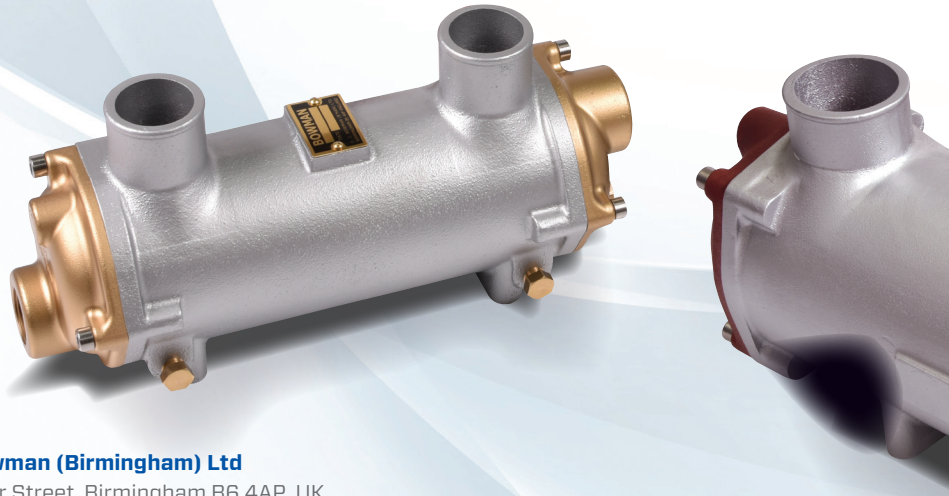

Stainless Steel Heat Exchangers


Header Tank Heat Exchangers


Plate Heat Exchangers


Transmission Coolers


Engine Oil Coolers



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