VDL Delmas GmbH
Heat Exchangers + Cooling Plants

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General Maintenance and Operating Instructions for Heat Exchangers

Preamble

Due to the diversity of operating conditions and the necessity for transparency and clarity of presentation, the maintenance and operating instructions can only be taken into consideration for general operations only.

For special cases, e.g. unusual environmental or operating conditions and special safety regulations, it is necessary to check and coordinate with the VDL Delmas GmbH.

Heat exchangers are designed for continual operation at the technical values indicated in the order confirmation. Operating values which deviate from these must be checked and approved by the VDL Delmas GmbH.

Start-up and shut down procedures and load alternation must take place properly (allowable temperature gradient).

When the heat exchanger is integrated as part of an entire cooling plant, specific features and possible effects on the heat exchanger shall be taken into account.

The pressure containing components of heat exchanger must not exposed to danger due to an unforeseen rise of internal pressure, acting of external forces and moments, loads caused from shock or thermal expansion, et cetera.

The heat exchanger shall not be operated out of the limits given with the technical documentation.

The heat exchanger is designed for the intended application only; special loads resulting from other operating conditions will be considered in design according reasonable points of view and on demand.

Especially following possible threat and endangering circumstances shall be considered by the owner and/or operator in order close out inadmissible loads by suitable measures:

- crossing the max. allowable inside and outside working pressure,
- loads from extreme ambient or operating temperatures,
- loads from traffic, wind and earthquake,
- response to external forces and moments caused from supports, fix-points, piping, etc.
- reduction of loading capacity by corrosion, erosion, material fatigue, etc.
- effects to material by decomposition of instable fluids

Simultaneous acting of different loads shall be considered with attention to the probability of their occurrence at the same time.

In order to prevent that persons are endangered by possible high-temperature leakages sufficient safety measures shall be applied. Especially the faces of heat exchanger and piping must be secured with a sufficient protection against accidental contact.

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Pay attention to all safety advises mentioned in this operation and maintenance instruction and also to the applicable national rules and regulations for accident prevention as well as possible internal rules of the owner for a safe work and safe operation.

All necessary work during mounting, commissioning, operation, inspection and maintenance shall be done by personnel who have been sufficiently qualified for the respective scope of work.

Receipt / Storage / Transport

The construction of the heat exchanger as well as the description of the individual assembly groups and parts is shown in corresponding drawings (if necessary with sectional view and list of items).

Quality control and pressure test of each heat exchanger are performed by the manufacturer. Nevertheless we recommend undertaking a leakage test with the corresponding test pressure before installing the heat exchanger.

At receipt of the unit, the customer should look whether there were any damages; especially damages which could cause corrosion have to be repaired at once. If the unit is equipped with eye-bolts or butt straps for the lifting, the lifting gear has to be fastened on to them. Please keep in mind that the eye-bolts and butt straps have only been constructed in accordance with the weight of the heat exchanger.

If a longer intermediate storage is necessary please note the following instructions:

- Storage up to 18 months:

Heat exchanger has to be sealed hermetically in polythene foil (PE), adding drying agent and moisture indicators.

- Storage up to 3 years:

As above, but use a plasticized aluminium foil.

- Storage over 3 years:

After three-years'-storage the package of the modules needs to be renewed.

As a rule the storage of the heat exchangers shall be carried out in dry, frost-free rooms.

The heat exchangers have to be packaged and stored in a way which protects they against mechanical damages.

After long periods of storage, chamber and flange joint sealing screws should be tightened. Soft material seals (e.g. NBR or EPDM) can become deformed if stored for long periods of time. If the necessary tightness cannot be achieved by tightening the screws, all old seals are to be replaced with new ones. Afterwards, a tightness check must again be carried out.

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Connection and Commissioning of the Heat Exchanger

When installing the heat exchanger sufficient venting and total draining must be guaranteed. Connected piping for media supply or similar pipe-work must be supported so that no additional load will be con-ducted to the nozzles and flanges of the heat exchanger.

It is recommended that an elastic connecting piece (compensator) be provided for this connec-tion. In order to avoid tension, the flanges facings must be parallel to each other. After the seals have been installed, the screws are to be tightened alternately and cross-wise in order to ensure a uniform setting of seals.

If forces and moments for screwed joints have been specified, the given values for oiled (greased) screws, nuts and plates apply.

Make sure that the provided filters are ready for service. Supporting aggregates (blowers, pumps, monitoring devices) and valves must be tested for correct function. Limit points which must not be exceeded have to be tested.

All the systems of the construction - inclusive the heat exchanger - need to be filled. Please note the corresponding supplier's instructions for the media. Do not use anticorrosive sub-stances in connection with anti-freeze agents.

After filling, the systems have to be ventilated at the ventilation points so that no air stays in the system. Please make sure that there is no remaining air in the heat exchanger as well as the whole system.

After venting, a leakage test of the whole system must be carried out, then a short run of the circuits must be made; afterwards, another venting is necessary. Before starting-up, the circuits must probably be refilled with the media.

Using *air coolers* one has to take care that the condensation (condensed water) can be drained off. Used air-flues must be so constructed that the cold air speed is less than 4 m/s in order to prevent falling out water drops from being carried away.

Measures to develop a protective Layer

If corrosion-producing liquids such as water are involved the heat exchanger should continuous-ly work for at least 2 months in order to get a passivated film on the metal surface.

Please pay attention to the prescribed capacities and to a constant speed in the corresponding circuits. The adjustments of the prescribed capacities must be done by the destined control valves.

The agreed qualities of media must be inspected by analysis.

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When the protective layer is being developed, running with contaminated, poor in oxygen water should be avoided; otherwise the development of the protective layer would be disturbed by the deposit of grime.

To support the development of the protective layer a dosage of the water with small quantities (5 g/m³) of easily soluble iron sulphate (inhibitor) is recommended. This treatment should be carried out for one hour a day when the system is being put into operation.

Maintenance

Inspection of Media and Test of guaranteed Quality

In adequate intervals the ingredients of the media must be tested (i. e. cooling water analysis). In case of differences please test danger of corrosion.

In case of deviation from prescribed operating temperatures make sure that the media do not change their prescribed aggregate state. E.g. in case of danger of frost the media must be prevented from freezing by using a standstill heating or by adding anti-freezing agent.

Inspection of Capacities and Speed

The permissible speed within the system must be secured. The correct velocity is obtained at the calculated flow rate. The corresponding values are specified in the *technical part of our order confirmation* or on our *type plate*.

- *Higher speed* than allowed may cause abrasion which may destroy the passivated film and cause corrosion.

- *Lower speed* may cause deposits of solid matter, so that under unfavourable conditions corrosion damages may follow (development of "ventilating cells"/pitting corrosion).

Check of Filters and Strainers

If filters and strainers are badly contaminated the loss of pressure in the system is higher and consequently the capacity and flow rate become lower, so that the cooling capacity may be reduced. Filters and strainers must be tested and cleaned in sufficient intervals according to instructions of filter manufacturers.

Check of Cooling Capacity

The cooling capacity results from the circulating quantity and the achieved difference in the temperature of a media. Usually the check of the cold temperature of the two heat exchanging media is sufficient. If the required quantity cannot be achieved any more, a check of the circulating quantity and the correspond-ding temperature of the media are necessary.

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Furthermore, a check of the cooling surface of the heat exchanger because of contamination has to be carried out.

Inspection of Contamination of the Heat Exchanger

The heat exchanger system has to be cleaned in regular intervals but at least once per annum. The required cleaning intervals result from the kind and the contamination of the media of the heat exchanger and the type of the heat exchanger.

At the latest in case of reduced transmission capacity or increased pressure drop the surfaces of the heat exchanger have to be cleaned and checked to prevent corrosion.

Side by side water cleaning does not only maintain the cooling capacity but also reduces the risk of corrosion of the surfaces of the heat exchanger. Deposits and contamination lead to corrosion by the development of "ventilating cells", the so-called pitting corrosion.

Cleaning of the Heat Exchanger

The cleaning may be done mechanically, hydraulically or chemically.

The permanent cleaning of the inside of the tubes can be carried out by brush and ball systems (BALL-TECHNIK or TAPROGGE). One must follow the maker’s instructions.

Before the cleaning the heat exchanger is emptied, the media is totally removed. As a rule the passivated layers of the surfaces of the heat exchanger must neither be damaged nor removed in the cleaning process.

There is a difference between cleaning of tube-bundles when installed and tube-bundles when dismounted from the shell.

In case of cleaning when the *tube-bundle is installed,* it must be ensured that no inadmissible media, splash water or foreign substances get into the heat exchanger or into the attached machine. Make sure that the circuit which is normally not disconnected is correctly sealed (i.e. oil/ water heat exchanger with transformer oil).

At least one chamber or one chamber lid which is attached by screws have to be dismantled when cleaning the *inner side of the tubes*. To do so, loose the connecting flanges and unscrew the screws which bolt the chamber. There are threaded holes in the chamber flange for the corresponding screws. After the cleaning it may be necessary to use new joints. The screws need alternate and crosswise tightening up to guarantee an even settling of the joints.

Damaged materials, especially coated parts, must be repaired.

When assembling the heat exchanger, it should be ensured that the seals used are fully functional and that the tube bundle is reinstalled in the original position (e.g. nozzle orientation,

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position of baffles and pass partitioning plates). After assembly, a tightness test should be carried out with the intended testing pressure.

After cleaning and mounting the heat exchanger shall be started up according to the above mentioned instructions. If the heat exchanger is not put into operation immediately after the cleaning, all moisture must be removed from the heat exchanger by a drying process.

Mechanical Cleaning

Loose contamination can be removed by oil-free compressed air. Strong firm contamination can be removed by water and with the help of special brushes with synthetic bristles. Afterwards rinse well until no more contamination is coming off or visible.

Hydraulic Cleaning

Strong firm contamination can be removed by water (strong pressure cleaning), if requested weak cleaning agents can be added. This process can only take place when the tube-bundles are withdrawn.

High pressure cleaners with specific nozzles are used for the cleaning of the inner sides of the tubes.

Chemical Cleaning

If the mechanical or hydraulic cleaning does not succeed, a chemical cleaning must be carried out. Do not use aggressive chemicals.

The complete heat exchanger is either attached to an external cleaning circuit or filled with cleaning agent while sealed with blind flanges. The duration of the cleaning process depends on the dissolving capacity and the degree of contamination.

Rinse well with clean water between two chemical cleanings.

We can recommend the following commercial cleaning agents, please follow the instructions of the makers.

PRODUCER	CLEANING AGENT
HENKEL, Düsseldorf	PORODOX
DREW AMEROID GmbH, Hamburg	Drewclean 20
VECOM GmbH, Hamburg	DESCALANT NF

To remove stone crusts in tubes you can use a 10% HCl-acid.

Immediately after the cleaning, the heat exchanger has to be rinsed well with clean water. Residues of the cleaning agent shall not remain in the heat exchanger.

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Standstill of the Water Supply

The standstill of the water supply (cooling water or process water) is harmful to all parts of the heat exchanger in contact with water. Such standstills are especially dangerous for copper tubes and copper alloys when the passivated protective layer is not yet developed or when there is corrosion due to deposits.

In case of danger of frost the water must be prevented from freezing by appropriate measures (e.g. standstill-heating or addition of anti-freezing agent)

Standstill during the Commissioning

The running should not be interrupted by standstills during the first two months. If the cooling water-supply breaks down and the operation will be resumed within three days, the coolers can remain filled with cooling water if the tubes are free of deposits.

If the tubes are not free of deposits the heat exchanger shall be drained, the tubes should be cleaned, rinsed well with clean water and dried. It has proved very useful to blow warm or pre-dried air through the tubes.

In case of standstills of more than three days the coolers showing deposits should be treated as above mentioned.

In short-term standstills the operation can take place with a low velocity of flow of the cooling water, if deposits in the tubes are avoided. This measure is preferable to a complete standstill of the cooling water in the tubes because products of decay
(NH_3, H_2S) are removed from the place of their origin.

Standstill after the Commissioning

Standstills after commissioning should be handled in the above mentioned way. After long periods of downtime, the chamber and flange joint sealing screws should be tightened. Long periods of standstill can lead to deformation of seals in soft materials (e.g. NBR or EPDM).
If the necessary tightness cannot be achieved by tightening the screws, the old seals must be replaced with new ones. Afterwards, a tightness check must again be carried out.

Warranty

If the contractual warranty period exceeds our normal warranty period (24 months after delivery) a major maintenance has to be carried out latest 24 months after delievery. This maintenance has to be done by Delmas or by Delmas authorised staff at owner’s expense.
In case no maintenance has been carried out and proper documented, the contractual warranty expires!

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Leakages / Leakage Tests

In case of leakages the course of action should be decided in co-operation with us or another specialized maker of the system.

Leakages within the chamber, joint or cover part are localizable from the outside. Leakages must be removed by specialized staff. It may be necessary to consult us in this connection.

If a leakage is not localizable from the outside a leakage test must be carried out.

According to the type of construction and the assumed place of defect the leakage test is carried out either from the outer side (shell or housing) or inner side (chamber or header side). In this way the leakage or defect tube is localized.

The leakage test takes place when the system is withdrawn and with a media corresponding with the working material. If individual tubes need squeezing off, the chambers have to be dismantled at first. Rubber plugs can be used to seal the tube examined. A tube to which an air or water tube is attached goes through one of the plugs. Use low pressure for the squeezing off.

Several Possibilities to repair a leaking Tube

- Putting out of Operation of a defect Tube by sealing it up

Place slightly taper-turned plugs into both sides of the tube. As a material for the plugs we recommend hardwood, rubber or plastic.

Metal plugs should not be used as they might deform the drill holes of the tube. This can cause difficulties in the future use of new tubes. If several tubes need sealing up it must be tested if the so-caused reduction of the transmission power is still acceptable.

- Using an inner Tube with a smaller Diameter

Place a snug fit tube made of a suitable material into the defect tube. The inner tube is connected with the bottom of the defect tube by rolling or welding. If possible the inner tube should be widened to keep the thermal loss low. If several inner tubes have to be installed it must be tested if the reduction of the transmission power is still acceptable.

- Replacement of the defective tube

For this, a new tube made of suitable material and size is put into the tube bundle. The connection with the tube plate is made either by rolling or welding, depending on the type of construction. These repairs shall only be made by professional staff of an approved manufacturer.

After the repairing and connection of the heat exchanger a pressure test with the prescribed test pressure has to be carried out. Furthermore please note instructions for putting into operation.

Putting out of Operation

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In case of a putting out of operation: drain off corrosive working media and clean, dry and preserve the corresponding parts of the heat exchanger. Afterwards note the above described measures for an intermediate storage.