Betriebs- und Wartungsanleitung
Operating and maintenance instructions

Hersteller / Manufacturer	OELTECHNIK® Gesellschaft für Oeltechnik m.b.H. Lessingstr. 32, D-68753 Waghäusel	CE	0036
Baujahr / Year built	2005	Typ / Type	EKE 66.230.4.1.16P
Fabrik- und Ersatzteilnummer / Serial- and Spare Part No.	*		
Höchstfüllmasse / Medium netto	798 kg	Leermasse / Vessel tara	1360 kg

		Mantelseite / Shell Side	Rohrseite / Tube Side
Medium / Fluid		N2	Water
Min./max. Betriebstemperatur / min./max. allow Temperature	TS: °C	-10/150	-10/80
max. Betriebsdruck / max. allow Pressure	PS: barg	12	8
Volumen / Volume	V: liter	720	78
Prüfdruck / Test Pressure	PT: barg	17.2	11,4
Prüfdatum / Test Date			

ZK3

* OET Nr. 106/5845/04
106/5846/04

Rev.	Datum / date / date	geändert / changed / modifie	geprüft / checked / contrôlé	Art der Änderung / kind of revision / Modification

Änderungsliste - List of Revision - Modification

zulässige Abweichung für Maße ohne Toleranzangabe / Allow. deviation for dimension without tolerance specification / Divergence admissible pour dimensions sans specification de tolerance	für Wärmeaustauscher / for heat exchanger / pour echangeurs de chaleur	für Behälter / for vessels / pour reservoirs
	DIN 28 008 *	DIN 28 005 *

* Es gilt jeweils die Norm neuesten Datums / In each case the latest edition of the standard applies / La derniere edition du standard est applicable .

	Datum / date / date	Name / name / nom	Kommissions-Nr.: / order No. / No. commande
gezeichnet / drown / dessiné	18.01.05	Fischer	106/5845-46/04 ASÜ KOSICE
geprüft / checked / contrôlé	18.01.05	Hillenbrand	

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Maßstab / scale / échelle

Benennung - Description - Désignation

Zwischenkühler / Intercooler ZK3
EKE 66.230.4.1.16P

Zeichnungs Nr. - drawing No. - plan No.

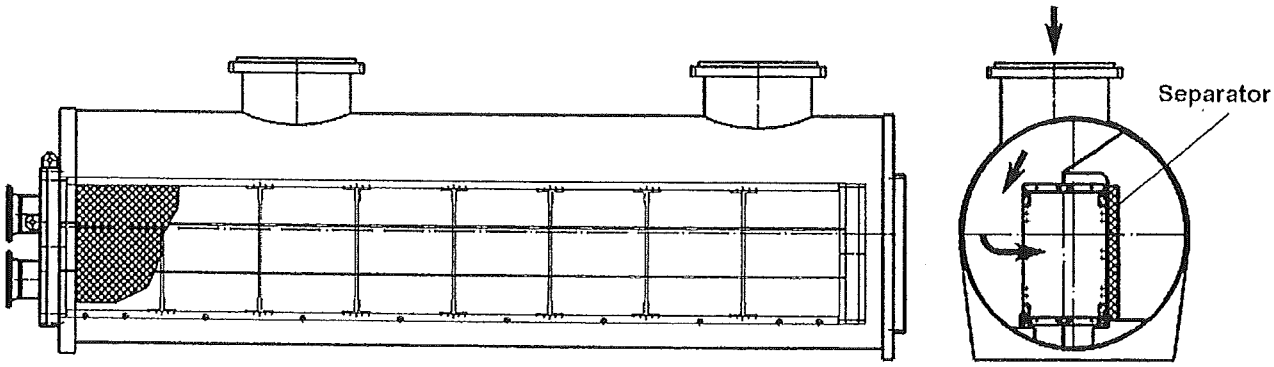
I 84 024.de/en

CAD

Operating and maintenance instructions for gas coolers

Construction

Element construction with plate-fin bundle and laterally arranged separator (E-B3)



(principle sketch)

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Apparatus description

The gas cooler is a heat exchanger which is divided into two spaces separated from one another by fixed walls in which different media flow. The criterion for the designation of the spaces is oriented to the flowing media along the actual heat transfer elements (tubes).

Medium around the tubes	=	shell side
Medium through the tubes	=	tube side

The apparatus is a welded construction, consisting of a cylindrical shell with connecting nozzles for gas inlet and gas outlet, as well as emptying and venting devices. The cooling element (bundle) is transported on rails into the shell from the front and fastened to the front plate using a flange connection. The nozzle chamber with the cooling medium inlet and outlet connections, projects from the front plate. The cooling medium reversing chamber is located at the opposite end of the bundle. The bundle consists of a large number of tubes which go through the so called lamellas. The lamellas produce an enlargement of the cooling surface similar to the fins of finned-tubes. The lamellas are connected firmly with the tubes.
The gas flows through the gas inlet nozzle into the shell. The gas flow is defined by separating sheets and flow baffles. Gas flows through the heat exchanger until it finally leaves through the gas outlet nozzle.
The separator is arranged in vertical direction, directly behind the bundle. This has the task of agglomerating precipitated humidity particles into water drops, so that these precipitate allowing them to be collected.

Mode of operation

The heat exchanger (gas cooler) is used for recooling gas. Water is used as a rule as the cooling medium. The gas is guided through the shell area around the tubes of the bundle. The cooling medium flows in several paths through the tubes of the bundle. Due to the temperature gradient between gas and cooling medium, as well as the constructional measures resulting from the thermal design of the apparatus, optimum heat transfer is guaranteed taking account of maximum pressure losses that have to be complied with.

Delivery

The apparatus is delivered as a complete assembled unit.
According to the valid pressure vessel and inspection regulations, the areas subject to pressure are pressure-tested.
Before it leaves the factory, the apparatus is tested for cleanliness (purity) inside and outside. Afterwards all connections are tightly closed.

Installation

It is recommended to subject the apparatus to a visual inspection before final installation and commissioning (transport damages, impurities).
Regarding the installation of the apparatus the indications on the construction drawing have to be observed. This is especially important for apparatus of which during the operation condensate will be attracted (gradient).

Installation on spring supports (optional)

When installing the heat exchanger on spring supports the specific characteristics of this type of installation must be considered.
The heat exchanger can be installed on prestressed spring elements. By that, the apparatus is arranged immediately in the right height for assembly. However, before the springs are unstressed the operating weight of the apparatus must be provided by filling with the operating medias. This avoids that the springs push the empty apparatus against the tube connections.

Before dismantling the bundle the prestress-screws must be installed into the spring elements to prevent an upwards movement of the bundle during disassembly. For this purpose, the prestress-screws must be adjusted to the height level before the bundle disassembly. At the same time, the prestress-screws prevent a horizontal movement of the apparatus which arises from the assembly and disassembly of the bundle from the shell space.
The prestress-screws are allowed to be removed first, when the bundle is re-installed and the operating weight is provided again by filling with the operating medias.

An essential type of load is the hydraulic test of the heat exchanger. Temporarily the weight increases considerably during this test. The springs are not able to absorb these further loads. In this case, additional support elements must be temporarily located below the heat exchanger. For spring elements with integrated blocking devices, accessory direction supports are not required.

Also for this type of installation the allowable nozzle forces must not be exceeded (see point operation).
In the case of insufficient spring pre-stress there is the danger that excessive tensile tresses might appear at the connection heat exchanger / tube connection – in the reverse case: excessive pressure tensions.

The installation of a heat exchanger on spring supports is a coordinated system in connection with the compressor. In general, the machine manufacturers indicate details about how to proceed at the installation of the single components.
Regarding the characteristics of the spring supports the indications of this specialist company must be observed.

Commissioning

Before commissioning the heat exchanger, check that the cooling medium inlet and outlet supply are correctly connected. Incorrect connection can lead to reduced performance.
Open the vent valve to fill the cooling medium side.
To grant a pressure compensation in the chamber segments, the filling should take place slowly.
Filling is ended when cooling medium emerges at the vent. Only then is it guaranteed that perfect venting has been performed and the heat exchanger reaches its full capacity. After filling close the vent correctly and pressure-tight.

Set the circulation of the cooling medium into operation. You should then perform a visual inspection with regard to tightness of the cooling medium space.

Ensure in any event that the cooling medium circulation has been put into operation before gas circulation through the apparatus. The apparatus can be damaged if this sequence is not observed.

If possible, an uninterrupted operation lasting for several weeks should take place during the starting phase so that a firm adhesive protective layer (oxide film) can build up on the cooling medium side of the bundle reeding.

Operation

The operation of the apparatus must correspond to the stress levels indicated in the strength calculations.
Different loads which can appear simultaneously and special loads such as traffic, wind or earthquakes must be indicated by the customer and are also documented within the trength calculation. If there are no indications then the apparatus is not designed for these loads.
Indications regarding the allowable internal and external pressures, the ambient and working temperatures as well as regarding the statical pressure and the filling weights under working and test conditions can be taken from the construction list of the main drawing.

Allowable nozzle forces and moments are shown on the drawing and are allowed to be passed from the tube connections into the apparatus but must not be exceeded. If corresponding indications are missing the manufacturer assumes that the loads are neglectably low.

It is recommended to control the apparatus at regular intervals.
To avoid damages caused by erosion, take care that the max. flow rates recommended for the tube material used are not exceeded. If there are suspended matters within the cooling medium, their deposits on the cooling medium side should be avoided by using a minimum flow rate of ca. 1 m/s.

The life of heat exchangers depends on different influencing variables, e.g. suitable construction (manufacturing form), resistant material choice and corrosion protection.
Regarding corrosion resistance it is very important that the chemical composition of the medias flowing in the apparatus is known and considered when choosing the materials. These conditions must be guaranteed during the operation of the apparatus. If changes in the type of operation of the heat exchangers occur (e. g. temperatures, flow velocities) or medias changed (chem. behaviour) these have to be checked with regard to the construction and to the component material.

Tightness checks

Examine the gas cooler for its gasket tightness at regular intervals. Should leaks occur, then tighten the bolted connection in the region of the leak. If this should not lead to the success aimed at, replacing the gaskets is unavoidable.
Should the media become mixed, this can be due to the tube/tube sheet fastening or to a defective tube. In the case of a defect on the tube/tube sheet fastening, it is possible to re-roll or re-weld according to type of fastening. In the case of re-rolling, roll only over the tube plate thickness, less 5 mm at both ends.

A replacement is not possible in the case of leaks on cooling tubes. With a small number of leaking tubes it is possible to restore operational readiness of the heat exchanger by closing the tube ends with conical metal plugs (conicity 1:20; see spare part holding). The metal plugs will be inserted into the openings of the leaked tubes at the tube sheet. Caution: Driving in the plugs too hard must be avoided to conserve neighbouring sealing points and is also not required for tightness.

Replacement of gaskets

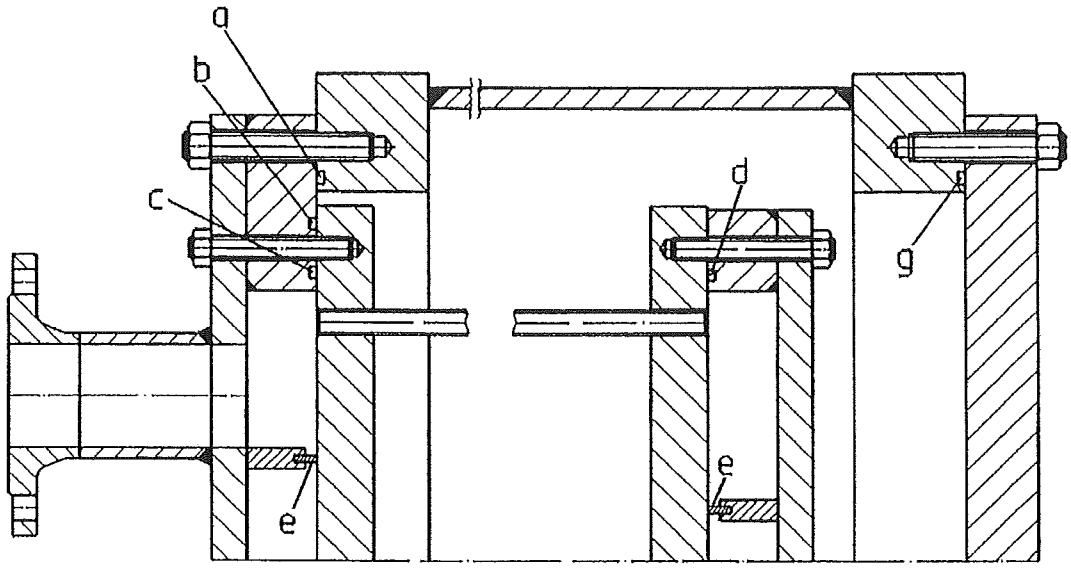
If gaskets have to be replaced, take special care that remaining parts of the old gasket are completely removed and that the sealing surfaces are not damaged.
Pay attention to perfect seating when inserting the new gasket. Perfect sealing is guaranteed only if these points are observed.
It should be a general rule, that the entire set of gaskets is replaced on occurrence of a defective gasket.

Leaks can occur at the following places:

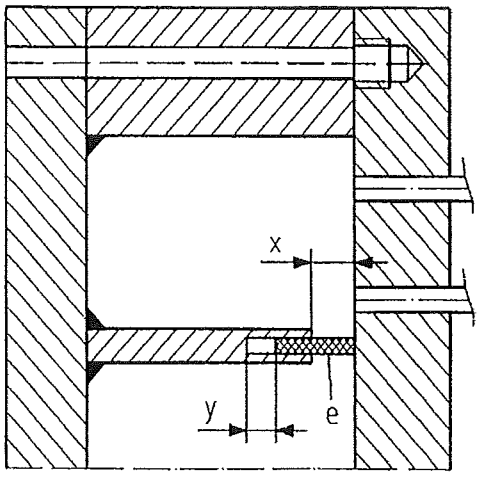
a. between nozzle chamber and shell plate
b. + c. between tube sheet and nozzle chamber
d. between movable tube sheet and reversing chamber
e. at the gaskets of the separating webs
f. at the gas-conducting gaskets

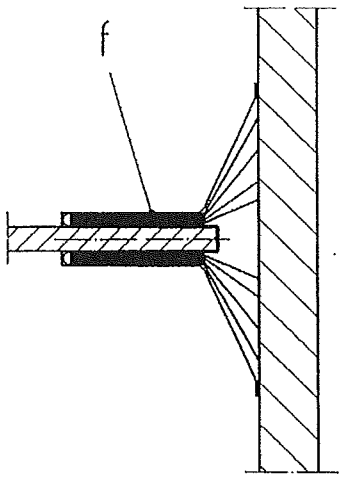
Replace the gaskets as follows:
Put the heat exchanger into a pressureless condition. Empty the apparatus on the tube side. Loosen the screw connection between nozzle chamber and front shell plate. The tube bundle can then be withdrawn from the heat exchanger together with the nozzle chamber. There is also another possiblity to remove the nozzle chamber by loosening of the second screw connection nozzle chamber/tube sheet and afterwards withdrawing the bundle including the reversing chamber from the heat exchanger. By this method the bundle rolls on rails in the shell area on brass / steel rollers.
Withdrawing the bundle can be carried out by means of a drawgear in front of the apparatus or by a bundle removal and installation device (BRID).
In the withdrawn condition the reversing chamber can be removed. All gaskets are then exposed for replacement. Check and clean the sealing surfaces for the gaskets (as described above).
Install the gaskets in the reverse order to dismantling.

Note: The gaskets listed under f. do not have to be replaced at every inspection. An appraisal should be made here by an expert. If the gaskets are still in perfect condition, these can be reused.



When installing the gasket Pos. e take care that the new gasket is not pushed in up to the end of the guidance (see principle sketch, distance Y).
It is recommended to measure the dimension X and to install the gasket with a projection of X+3 mm. During placing and fastening of the chamber the gasket is then compressed to the exact dimension in the guide. The seat of the gasket at the nozzle chamber can be checked by a look into the nozzle opening.





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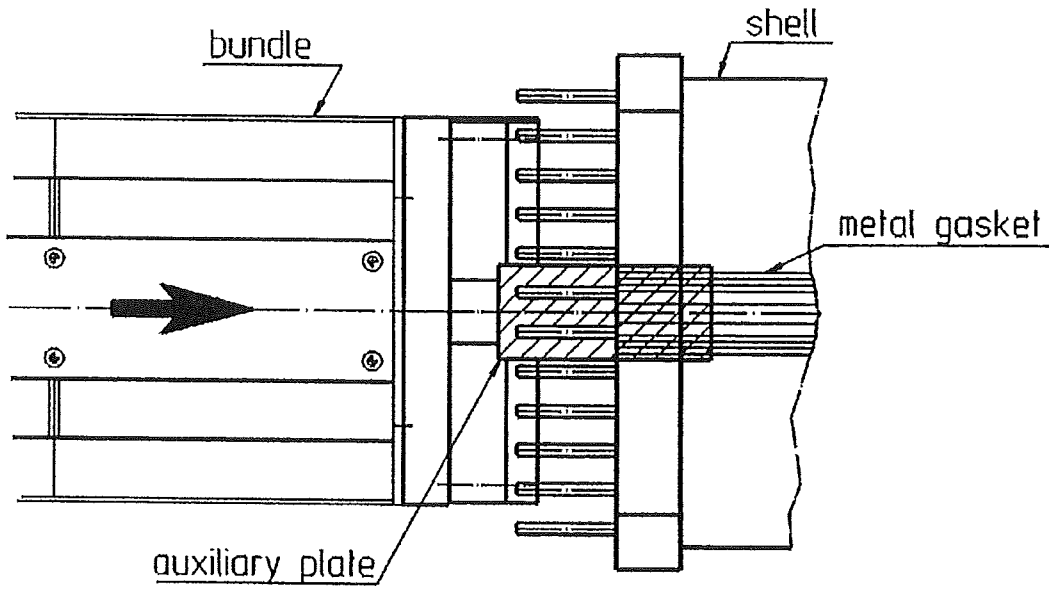
Date 04.07.02	Date 04.07.02	Date						

Flexible metal gaskets f

Pay special attention when installing the bundle that the flexible metal gaskets fitted in the shell for gas conduction are pushed carefully on the sealing surfaces on the bundle. This can be done by auxiliary sheets (dimensions approx. 10 * 40 cm).
For this purpose, these plates are pushed forwards at the level of the sealing surface between the reversing chamber and gasket in the position – *the bundle projects slightly into the shell front plate, but is still in front of the metal gasket.* I.e. on further inwards movement this auxiliary plate is located between the actual sealing surface on the bundle and the gasket. It acts like a wedge and gently pushes the metal gasket back when moving in. Once this process is performed successfully on all sealing surfaces, the bundle should now be moved in carefully a small amount. Then check the position of the gaskets by visual inspection. The auxiliary plates can then be withdrawn. The metal gasket now lies up against the sealing surface. The bundle can now be moved completely into the shell.



Oxygen operation (optional)

In the case of repairs to components which come into contact with oxygen, the corresponding oxygen regulations must be complied with. Parts and assemblies must be free of substances such as oil, grease, rust, scale, swarf, grinding dust, pickling residues and blasting sand. When gaskets are renewed, only use gasket materials suitable for oxygen operation which is confirmed by an official certificate.

Surface protection

For protection against corrosion the endangered components receive a corrosion protection. This can be a multi-layer coat, a thermally applied plastic coat or rubberization. The type of the coating is according to the requirements of the cooling medium and according to the attacks / reactions on the contacted components which are to be expected, respectively according to the customer's requirements.

Basically, care must be taken with coatings that they are not damaged in repair or cleaning work. Regular inspection of the coating is recommended.
In case of damaged coatings improvement is possible as a rule (repair set). Reference must be made in this case to the instructions of the manufacturers of the coating material.

Separator (optional)

Demister - Separator

Due to their high porosity of approx. 89 to 99 % wire mesh droplet separators are relatively insensitive to soiling.
Under normal operating conditions with sufficiently high liquid flow the droplet separator cleans itself automatically, as solids are washed out by the liquid flow.

However, in the event of deposits or caking in the knitted wire mesh package, it can be cleaned by jets of water, steam, or diluted bases or acids, whereby the chemical resistance of each material involved has to be taken into account.
If cleaning is carried out by help of cleaning equipment, the kind and quantity of the pollution has to be taken into account.
The demister manufacturer suggests the following standard values:

Quantity of water:	20 - 80 l/m² min
Jetting time:	5 - 10 min
Distance of the jets:	300 - 500 mm
Distance jets - wire mesh:	300 - 500 mm
Jetting admission pressure:	approx. 3 bar

During service works at the heat exchanger the demister separators must be checked with regard to soiling and mechanical damages.
In the case of damage the demister separator must be changed.

Waveband separator

Under normal operating conditions with sufficiently high liquid flow the droplet separator cleans itself automatically, as solids are washed out by the liquid flow.
However, in the event of deposits or caking in the knitted wire mesh package, it can be cleaned by jets of water, steam, or diluted bases or acids, whereby the chemical resistance of each material involved has to be taken into account.

During service works at the heat exchanger the separators must be checked with regard to soiling and mechanical damages.
In the case of damage the waveband separator must be changed.

Lamellar Separator

The lamellar separator is a rebounding surface separator which has been developed for horizontal flow to separate liquid drops from flowing gases. The separator consists of a frame in which profile baffles are arranged vertically and parallel at the same distance to each other. The design of these profile baffles produces a reversing of the gas flow.
By that, liquid drops are conducted towards the surface of the baffles and guided in the direction of the gas flow into so-called collecting channels (vertical draining channels).

Within the single draining channels the condensate flows down where it is collected and removed by draining channels.
Under normal operating conditions with sufficiently high liquid flow the droplet separator cleans itself automatically, as solids are washed out by the liquid flow.
However, in the event of deposits or caking in the knitted wire mesh package, the separators can be cleaned by jets of water, steam, or diluted bases or acids, whereby the chemical resistance of each material involved has to be taken into account.

During service works at the heat exchanger the separators must be checked with regard to soiling and mechanical damages.
In the case of damage the lamellar separator must be changed.

Cleaning
It is necessary to clean the apparatus at certain time intervals depending on the contamination level of the media used.
Cleaning on the tube side is limited to the nozzle chamber, reversing chamber and the inside of the tubes. The tubes can be cleaned (mechanically) using a nylon brush (OET spare part). This is a brush with a long handle which is guided into the tubes of the bundle. After brushing the inner wall of the tube, the tube must be blown out. Cleaning on a chemical basis is possible in the case of impurities which cannot be removed with the brush method. In this case the tubes are cleaned chemically in a flushing process with corresponding chemicals. This method is problematic since on the one hand the contamination should be dissolved but on the other hand the tube material must not be attacked. If this cleaning method should be used, we recommend calling in a specialist company.
Blow out the tube bundle on the gas side by means of compressed air.
When cleaning the shell space take care that the gaskets for the gas circuit (f.) are not damaged.
After cleaning new gaskets must be used for re-assembly. Installing old gaskets leads to leaks in most cases.

Automatic cleaning systems (optional)
In case of using tube cleaning systems for regular cleaning of the inside tubes the operation instructions of the manufacturers must be observed.

Taprogge method
The Taprogge method works according to the principle of "circulating sponge rubber ball". These balls are slightly oversized in comparison to the inside diameter of the cooling tubes and are moved with the cooling water through the tubes of the heat exchanger. The balls are available with different surfaces and must be selected for the level of cleaning required. The sponge balls are fed to the cooling medium flow before the apparatus and taken out again by a sieve device in the outlet line. These are supplied to the cooling medium supply line again by means of a return unit.

Brush method
This system consists of two collecting sleeves and a special brush which is installed in each tube of the heat exchanger bundle. The collecting sleeves are connected permanently with the tube and serve for holding the brushes.

The brushes are moved through the tubes by changing the flow direction with normal pump pressure to remove the existing deposits.
It is necessary to reverse the direction of the cooling medium flow by means of reversing valves for the cleaning process.

Still-standing / Intermissions
By resting cooling medium (water) which stands for a longer period – more than 8 days – within the tubes or the shell space of the cooler attacks of corrosion are stronger. Depending on the composition of the cooling medium this can leed to destruction of the tubes and other parts within a disproportionately short period of time. Therefore, it is absolutely necessary to empty the apparatus during still-standing times extending over a lengthy period.
Intermissions must not last longer than 8 days for apparatus filled with cooling medium. Normally, no damages can be expected during this time if afterwards operation is started again.
If emptying the apparatus is not possible due to operative reasons then a circulation of the cooling medium on the cooling medium side has to be guaranteed. This flowing-through avoids attacks of corrosion which would arise by resting cooling medium.
In case of cold weather the apparatus also has to be emptied (risk of freezing).

Spare part holding
It is recommended that at least one complete set of gaskets is held per heat exchanger (OET spare part).
In the case of leaks on cooling tubes conical metal plugs should be provided for closing the tube ends in order to restore operational readiness (see tightness checks).
Should a tube defect occur, then inspecting the entire tubing is recommended. Use a new tube bundle in the case of larger tube defects.

Safety advice
It has to be guaranteed by suitable steps that the allowed limits of the operating conditions are complied with during operation.
The operator has to pay attention to the possibility of solution of instable fluids within the apparatus during the process.
It is expressively pointed out that welding work at pressurized parts of the vessel are forbidden.
It must be guaranteed during service work for which opening and walking through the shell space is necessary that there is no dangerous (poisonous or burning-expediting) gas within the shell space. When using dangerous gas a sufficient flushing by air as well in the shell space as in its surroundings is necessary.
Personnel experienced in dealing with heavy loads are needed for maintenance and repair work. The accident prevention regulations have to be observed.