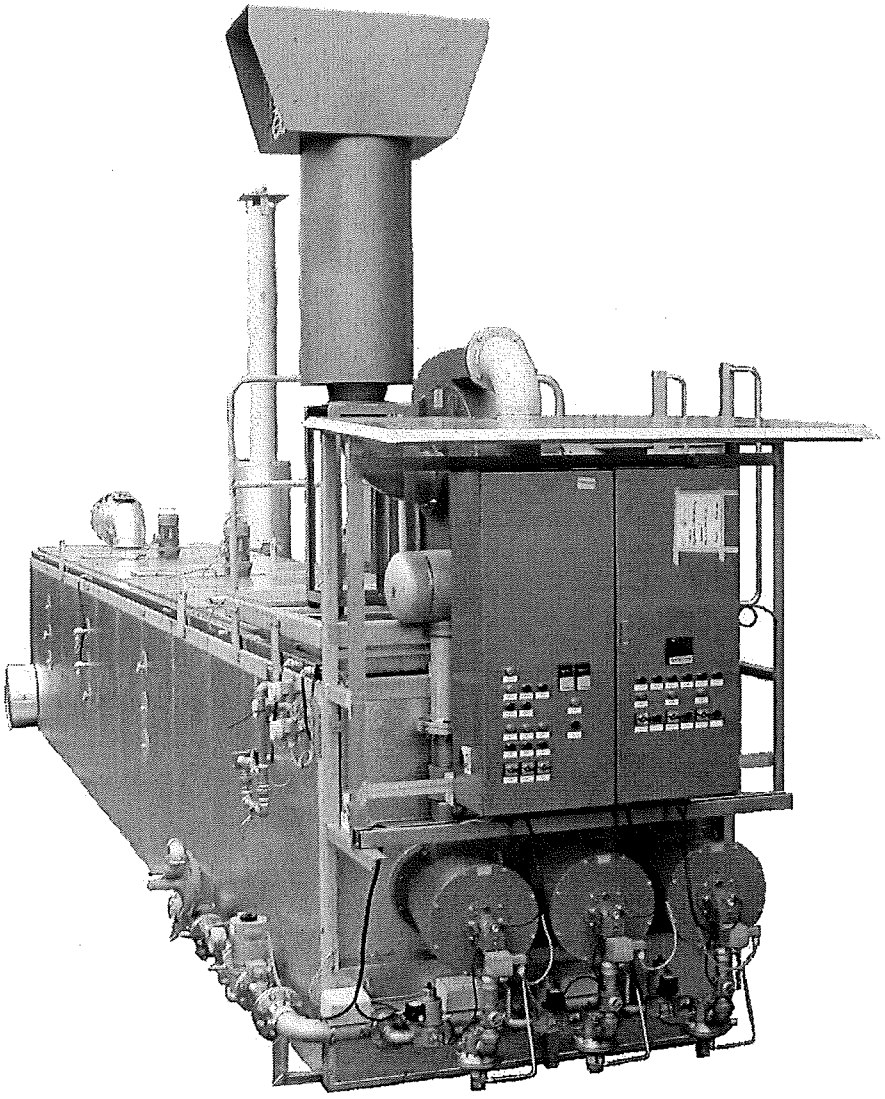
cryonorm

User Manual

Indirect Fired Waterbath Vaporiser 16000 Nm³/hr Nitrogen



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0. Contents

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1. Foreword

This Pressure Equipment has been designed and manufactured in accordance with the latest technical developments and complies with the applicable European Directive. The design has been assessed by Stoomwezen B.V. according to the Pressure Equipment Directive 97/23/EC and it has been established that the essential safety requirements, as described in annex II of the PED 97/23/EC, have been met, hence, this equipment is CE-marked.

The manufacturer shall not be held responsible for unsafe situations, accidents or damages as a result of:

- Ignoring warnings or regulations as indicated on the equipment or prescribed in this user manual.
- Insufficient maintenance.
- Use for applications other than those described in the user manual.
- Modifications to the equipment by third party and the use of other than original replacement parts, as well as modifications to the electrical system.

This user manual contains useful directions for use, maintenance and trouble shooting and must be read before operating the installation. All directions should be respected and followed up.
Keep a copy of this manual available for all operators where the unit is commissioned.

2. Introduction

The purpose of the Indirect Fired Waterbath vaporiser is to vaporise liquid nitrogen to a gaseous product of predefined temperature.

Utilization of this vaporiser is mainly for use as a back up installation.
The unit will vaporise the liquid gas and bring it to it's required temperature.

Warning:

- The installation should be operated by authorized personnel only.
- **The installation is designed to vaporise liquid nitrogen to gaseous product.**

DO NOT USE THIS VAPORISER FOR GASES OTHER THAN NITROGEN!

For the design data of the installation we refer to the specifications as indicated in the table in chapter 3. Information regarding maintenance is described in chapter 8.

3. Technical Specifications

Process connections coils	
Vaporiser coil Liquid Nitrogen inlet	: N1 DN80 PN40 - flanged acc. to DIN 2635
Vaporiser coil Gas Nitrogen outlet	: N2 DN300 PN40 - flanged acc. to DIN 2635
Natural Gas Inlet	: N3 DN50
Water supply	: N4 1" BSP max. 5 bar
Water Outlet / Drain (2x)	: N5 DN50 PN 16 – DIN 2633
Tankoverflow / Vent	: N6 DN80 PN 16 – DIN 2633
Burner exhaust	: N7 DN250 PN10 – DIN 2576
Condensate drain	: N8 1" BSP
Level Switch Connection High	: N9 ¾" BSP
Level Switch Connection Low	: N9 ¾" BSP
Level Switch Connection Low, Low	: N9 ¾" BSP
Temp. Sensor PT 100 - max.	: N10 ½" BSP
Temp. Sensor PT 100 - Regulating	: N10 ½" BSP
Temperature indicator (3x)	: N10 ½" BSP
Free Connection (4x)	: N10 ½" BSP
Design Pressure	: 0 / 16 (Minimum / Maximum)
Hydrostatic test pressure coil	: 23 bar(g)
Min./max. working temperature coil	: -196°C / +80°C
Material Coil	: AISI 316L
Material Vessel	: AISI 304L
Max. working/test pressure Vessel	: Atmospheric
Capacity Coil	: 16000 Nm³/hr N2
Contents Vessel	: 17900 L
Min./max. working temp. Vessel	: 0°C / +80°C
Permitted media in Vessel	: Clean non aggressive, non corrosive water (Cl < 100 PPM) or water glycol mixture (50%)
Natural Gas Burners Eclipse Type IJ 06 (3-off)	
Max Burner output	: 3 x 950 kW (Total 2850 for 3 burners)
Net. Burner Output	: 3 x 760 kW (Total 2280 for 3 burners)
Fuel	: Natural Gas, Propane, Butane
Mixers Chemineer (3-off)	
Type	Model 30 DTD-1,5
Capacity	1,5 kW
RPM	1390
Voltage	3x 220 - 240 / 3x 380 - 415 Volt - 50 Hz
Protection Class	TEFC, IP65, isolation class F

Electric installation	
Control panel	: Stainless steel – 1200 x 1000 x 300 (hxwxd)
Isolation class	: IP65
Mains supply	: 3P 400V / 50Hz
Absorbed power (without Fan 18 kW)	: 5 kVA
Potential free contact switch rating	: 5A @ 230V max.
Water temp. Regulator *TT-013.3*	: Adjustable
Water temp. Max. TS-017.1	: Adjustable
Gas temp. Low temp. N_2 *TS-013.1/2*	: Adjustable
Water level high *LSH-016.1*	: Level switch high
Water level Low prealarm *LSL-016.2*	: Level switch mid
Water level Low alarm *LSLL-016.3*	: Level switch low

In case other than above noted set points are programmed, use the area below to register the customized set point.

Parameter	**Factory setting**	**Customer setting**	**Units**
Stand by Water temperature - on	5°C	....	°C
Stand by Water temperature - off	20°C	....	°C
Normal operation (N2 demand) - on	58°C	....	°C
Normal operation (N2 demand) - off	60°C	....	°C
N_2 Min. temp. for release	>-20°C	....	°C

More specific information regarding the used components is described in the annex concerned in chapter **Fout! Verwijzingsbron niet gevonden.**.

4. Safety

4.1 Safety valves

The water bath vaporiser has been supplied with an Air Liquide free issued safety valve. Because the required blow-off capacity of the safety relief device strongly depends on process specific properties, the customer is responsible for correct calculation, purchase and installation of the device.

Warning:

- **This pressure equipment is delivered without safety valve. The free issued safety valve has to be of sufficient capacity in order to protect the vaporiser against overpressure. The set pressure of the safety valve shall not exceed the maximum working pressure of the vaporiser.**
- **When installing a safety relief device, always make sure that the outlet port of the valve is pointed in a safe direction, away from personnel.**
- **The set pressure of the device must never exceed the maximum working pressure of the piping and coils, as indicated in the technical data in chapter 3.**

4.2 Safety precautions

Because of the low operating temperature of the nitrogen and the high temperature of the burners, the waterbath and the exhausts, the pressure equipment has to be placed out of reach of unauthorized persons.
Emissions:

- The Waterbath vaporiser produces a noise level of 85 decibel which can damage the hearing ability.
- The burners produce waste gases.
- The water bath vents water vapor.
- The burner exhaust drain produces condensed water at start up and must be open at all time

Warning:

- Do not touch the equipment's surface because of possible high and low surface temperature
- Use protective aids such as eye, head, and hearing protection.
- Make sure to provide for adequate fire extinguishing equipment in the vicinity where the equipment is being commissioned, in accordance with local law and regulations.

4.2.1 Safety precautions for the user

Warning:

- When transporting the unit make sure that the vessel is empty!
- The unit is for outside use only!
- When the unit is switched on the mixers will start running automatically. Therefore do NOT leave the covers open while turning on the main switch. Open covers also cause a loss of heat and the chance of pollution of the waterbath.

4.2.2 Safety precautions for maintenance and repair

Warning:

- Check the presence of safety precautions and act accordingly.
- Make sure that the remote control is shut off, disabling the possibility to remote start the unit.
- Make sure that the pressure is relieved and that the mains supply is shut off.
- Use personal protective aids and make sure the surface temperature of the equipment is above 0°C !
- Use indications **"OUT OF ORDER".**

5. Description of the installation

5.1 General description

The vaporiser is based on a water filled tank in which a vaporiser coil is submerged. The water bath is heated by the exhaust gas of three natural gas burners. The exhaust gas is led through a secondary coil, positioned directly below the vaporiser coil. Because of heat transfer from the hot water to the cold liquefied Nitrogen inside the vaporiser coil, LAN will start to boil and thus evaporate.

5.2 Functional description

5.2.1 Working description control panel

The vaporiser is designed to be utilized as a back up installation and will therefore remain stand by for emergency gas supply. In stand by mode, the water bath temperature is kept at a programmable minimum value (set point 1, yet to be determined, e.g. 20°C) to protect the bath from ice formation in periods of sub zero ambient temperature. Secondary, a higher bath temperature will allow a fast start up sequence of the vaporiser.

=> In stand by mode, the vaporiser will function as follows;

Temperature controller E3 will constantly measure the water bath temperature by means of the Pt100, submerged in the bath. The controller will start the burners as soon as the measured bath temperature drops below the lower limit of the set point 1. The water bath temperature will rise, and the burners will be shut down when the upper limit of set point 1 is reached. Because of heat leak through the insulation, the bath will slowly cool off and the moment the lower limit of the set point is reached the sequence will start again.
Throughout this period, the N2 valve in the inlet line of the product coil remains closed and gas supply is not possible.

The vaporiser can only be switched to on-line mode after a specific request from the end user comes available. This request can for example be presented by a manually operated switch on a remote location, or an automatically generated signal after a system failure.

=> In on line mode, the vaporiser will follow the sequence as described below;

To bring the vaporiser on line, a contact supplied by the user (X5, ~~20,21~~ 22 23) has to be closed. Based on this action, temperature controller E3 will change over from set point 1 to set point 2. This set point allows the burners to heat up the water bath up to the required temperature of 60°C.

At this point, the water bath is warming up but gas supply is still not possible. To open the N2 valve in order to allow liquid N2 into the vaporiser coil, the user will have to provide a second confirmation. Again, this confirmation can either be generated manually by an operator or automatically by up stream equipment by means of a closing contact (X5, ~~22,23~~ 24, 25).

The moment this contact is closed, the N2 valve will open and thus gas supply is established.

5.2.2 Monitored process parameters

In order to be able to guarantee problem free service, several conditions are constantly monitored. The following list provides an overview of these conditions.

Water bath level:

In both operational modes, it is important to maintain the required water level in the tank. Low water level will cause damage to the installation and downstream equipment, high water level will result in unnecessary energy consumption.

The water level is self regulating through the use of a mechanic float valve. The valve will open due to a decrease of water volume, thus allowing fresh water into the tank. The moment the upper level is reached, the valve will close and water supply is shut off.

Secondary, three level switches are mounted in de tank to be able to monitor the water level. Two of the switches are applied to monitor low level, the third is used for high water level detection.

The first low level switch will only generate a pre alarm on the control panel. On low-low level detection on the second switch, the burners will shut down and an alarm is generated on the control panel.

The high water switch will close the solenoid valve mounted upstream of the float valve, in order to force shut down of the fresh water supply and will generate an alarm on the control panel.

Mixer status:

In both operational modes, the water bath is kept turbulent to establish more efficient heat transfer throughout the volume of water. To be able to start the burners, at least one out of three mixers must be switched on.

The status of the mixers is displayed on the control panel. In case of thermal failure, an alarm is generated for each separate mixer. Only when all three mixers fail simultaneously, the burners will shut down.

Gaseous N2 temperature:

Low temperatures will cause damage to downstream equipment. In on line mode, the outlet temperature of the gaseous N2 is therefore constantly monitored and displayed by two temperature controllers.

one of the
As soon as both controllers detect a gas temperature lower than the programmed set point, the N2 valve will close. The status of the valve will be displayed on the control panel by means of a red pilot lamp. The heating process will not be interrupted, and the valve will automatically open when the temperature has reached acceptable level again. and the
yellow trip has been reseted in the DCS

Burner status:

On each burner start up, parameters such as combustion air pressure, gas pressure, possible gas leakage and burner ignition are automatically checked by the burner installation. Because of the obvious importance of correct burner performance, the vaporiser will not start up in case any of these parameters fail.

Again, an alarm is generated on the control panel.

5.2.3 General burner start up

In order to ignite, the burners have to be provided with combustion air. To obtain sufficient flow and pressure, a fan is mounted on the installation. The equipment to start the combustion air fan is not integrated in the local control panel and has to be provided in the MCC.

During start up – triggered by controller E3 due to low bath temperature – a potential free contact is closed on the control panel. Based on this contact (X5, ~~16,17~~ 26,27), the fan must automatically be started from the MCC.

From the thermal relay, a confirmation has to be sent back to the control panel by means of a closing contact (X5, 3,4).

5.2.4 General notes

- All three burners must be switched on (S1) in both stand by and on line mode. The individual burners should only be switched off for service purposes.

- All three mixers must be switched on (S10, S11, S12) in both stand by and on line mode. The individual mixers should only be switched off for service purposes.

Warning:

- Ignoring the alarms described in above stated paragraphs can have fatal consequences for the installation, processes and operating personnel!

6. Installation

6.1 General safety precautions

Installation should only be carried out by skilled and authorized personnel. Take notice of the information given in this manual and on the applicable drawings. Respect the local labour requirements and regulations concerning the installation of this type of equipment.

Warning:

- **This pressure equipment is delivered without safety valve. The free issued safety valve has to be of sufficient capacity in order to protect the vaporiser against overpressure. The set pressure of the safety valve shall not exceed the maximum working pressure of the vaporiser.**
- **When installing a safety relief device, always make sure that the outlet port of the valve is pointed in a safe direction, away from personnel.**
- **The set pressure of the device must never exceed the maximum working pressure of the piping and coils, as indicated in the technical data in chapter 3.**

6.2 Installation manual

6.2.1 Placing the unit

The unit has to be handled in conformance with the lifting instructions drawing CN 4333-3, however one must take care in order to prevent any damage to the components.
The unit can be positioned to the desired location on a concrete foundation. The foundation must have provisions for water drainage and must be level in order to avoid problem with the water level control and alarms.

Warning:

- When transporting the unit make sure that the tanks are empty and the chimney and silencer are dismounted.

6.2.2 Interconnecting Process piping

Once the unit is placed, the interconnecting piping between the N2 tank, the unit and the plant process piping can be constructed. See P&ID CN4518-2
To ensure correct function of the automatic water filling, constant water pressure must be applied on the solenoid valve 011 mounted on connection N4. For easy filling without the power on there is a by-pass valve 012 by-passing the solenoid valve.
Make sure to close this valve again before starting up as in case off mobrey failure 010 , the high level action; closing the solenoid, will have no effect and the tank will overflow.
Mount the Herose pneumatic operated valve 006, N1.
Connect the pressure control valve 020, Pressure indicator 019.1 and solenoid valve 018 to the pneumatic actuator of valve 006. Connect an air supply to the pressure control valve.
Connect the gas supply to N3.

Connect the the overflow N6 and the tank drain N5 to the plant's drainage.
Mount the air silencer to the air fan.
Mount the burners exhausts / chimneys N7. Use the gasket supplied the vaporiser.
Connect the chimney drain N8. Assemble the insulation on the flangeconnection to the tank.
During each start up of the burners water will condensate and must be drained.
Keep in mind that in every cubic meter of natural gas there is approximately 1 liter of water which will condensate when the exhaust is still cold. The condense must be drained.
Check all flanges and fitted connections on leakage

Warning:

- Make sure the chimney drainvalve 021 is open at all times.
- Ensure strain free assembly of the flanges.
- Make sure the ventilation grids, burner exhausts and generator exhaust are not obstructed in any way.
- Careful, the exhausts and drains can be hot. Make sure the exhausts and drains do not create a hazard to personnel or the environment!
- Make sure the water used has no aggressive or corrosive effect on the Stainless Steel (304L) Vessel, the coils, nor the internals. (Cl content < 100 PPM)

6.2.3 Electrical connections

Connect the Control panel to the main supply.
Connect the remote signal terminals and fan motor to the starter panel the of the local MCC in accordance with the Electric wiring diagram (Eclipse document 605356)
Cables are to comply to local requirements and regulations.

7. Operation, use

7.1 Adjustment

The burners have been adjusted at sea level at Cryonorm.
When the vaporiser is to be commissioned it is strongly recommended that on start up the burners are to be readjusted by the burner supplier, eclipse to ensure optimal burner performance by setting the right balance of air – natural gas mixture.
The difference in caloric value and altitude will necessitate to adjust the settings.

7.2 First use and start up

Once the installation is carried out according to the procedure described in chapter 6, and all safety requirements have been met, the system is ready for use. Follow the next steps to complete the initial start up procedure. Use the P&ID CN4518-2 and make the settings for each temperature controller. See Chapter 5 for functional descriptions of components.

Warning:

- When the unit is switched on the mixers will start running automatically. Therefore do NOT leave the covers open while turning on the main switch.

1. Open the door to the control panel and check if the circuit breakers are switched on. Close the door and lock it with the supplied key.
2. Fill the the waterbath either by using the manual by-pass valve 012 or let it fill automatic when the main power switch is on.
3. Check that the solenoid by-pass valve 012 is closed.
4. Check that the chimney drainvalve 021 is open at all times.
5. Switch on the system by turning main switch.
6. Switch on the mixers. (S10, S11 and S12)
7. Switch on the burners (3 times S1 on right panel door)
8. Check the direction of rotation of the mixers and the burner's fan motor.
9. Check that the mixers and fan (only when burners are starting) are running.
10. Once the vessel is filled and the unit is switched on as described above the water will be heated to the set values of the temperature controller.

7.3 Running conditions and trouble shooting

7.3.1 Burner start op sequence

Two ways of operation modes are possible
-Standby = Modulating on a low temperature setpoint
-Normal operation = Modulating on a high temperature setpoint.

Switch at least 1 of the 3 mixers on by manual switches on the panel.
Switch the burners on.

Automatic burner start follows:
Mixers will start.
No pressure check combustion air pressure switch.
Start combustion air fan in MCC.
Combustion air pressure check.
Max temperature check
Level switch Low/Low check
Leak test of gas safety valves (LDU unit in panel)
Release burner conditions
Actual burner start by burner control unit (LGK unit in burner panel)
Low fire check
Ignition spark
Opening gas safety valve
Ignition spark off
Flame check by flame rod
Burner is in operation.
Time delay to heat-up the firing tube in low fire
Release temperature control.

7.3.2 Running conditions

All burner stops:
Not 1 of 3 mixers on
Combustion air pressure failure
Temperature too high
Level Low/Low

Stops only related burner:
Manual switch, burner off.
Fuel gas pressure too high.
Flame safeguarding (flame rod in burner)

Pre alarm:
Level switch low

7.3.3 Change over from stand by to normal operation

In stand by the setpoint on the temperature controller is ab. 20 °C.
The burner and mixers are switched on/off by a limit contact in the temperature controller.
Adjusted on 5 °C , off 20 °C , but free adjustable.
To change from stand by to normal operation a change over signal must be given on
X5-22/23
(sheet 12)
A digital input to the temperature controller changes the setpoint from 20 to 60 °'C
The burner on/off function is changed over to another limit contact in the controller
Adjusted: on 58 °C , off 60 °C , but free adjustable.

In the worst case, when the water bath temperature is 5 °C, it will take approximately ½ an hour to before the Nitrogen valve can open with the current factory settings. If this is unacceptable the settings will have to be adjusted.

7.3.4 Condition for N2 release

See
wiring diagram sheet 13.
Limit contact in temperature controller must be closed (on 58 off 40 °C)
Level alarm Low/Low must be OK
2 Temperature limit switches must be > minus 20 °C
Signal from user must be given.

7.3.5 High level alarm

If a high level alarm occurs the water supply valve Y11 (sheet 7) will close.
The burner installation is kept in operation at a high level alarm.

7.4 Shut down and system restart

To shut down, simply turn off the burner switches and the mixer switches.
To switch on again, turn the burner and mixer switches on again. Reset alarms if necessary.
Turn off the main switch as well if the system will not be restarted again.

7.5 Operations by user

During normal service, the presence of an operator is not required. However, after first start up or after adjustments in process specifications, for safe use, the correct set point for the water temperature and alarm temperature have to be determined and monitored.

Because the output of the vaporiser depends on a number of different variables such as amount of liquid flow, required gas temperature and tank pressure, the correct values cannot be calculated and have to be determined by trial and error method.

Raising the water bath temperature will result in higher gas temperature at equal flow rate, or will allow larger capacity at equal gas temperature.
Opposite to this, lowering the water bath temperature will result in lower gas temperature at equal flow rate, or will allow smaller capacity at equal gas temperature.

Follow the procedure described in the Jumo manual in the annex concerned, to alter the set points programmed in the temperature controller. When doing so always bear in mind the set points of the other instruments.

Warning:

- Ignoring the described adjustment procedures will lead to system failure and possible damage!
- Ignoring the alarms described in above stated paragraphs can have fatal consequences for the installation, processes and operating personnel!

8. Maintenance

The design of the system is such that little maintenance is required. However, in order to ensure correct functioning of the system, the following points of interest should be observed:

Warning:

- Follow all the "Safety precautions" as described in chapter 4 before any maintenance is carried out and act accordingly.

- Check all flanges and fitted connections periodically (each three months) on leakage and if necessary replace damaged seals or gaskets.
- Check for the presence of moisture inside the control panel each three months.
- Check the safety valves at regular intervals or at least once a year. Replace immediately if correct function cannot be ensured.
- Check the electric agitator mixer both visual and on correct function each three months.
- Check the function of the temperature controllers, level switches, the N2 ball valve with it's actuator and pressure regulator valve on correct function each three.
- Check the overall condition of the vessel and the coils yearly. To do so, the vaporiser must be shut down completely and the cover must be lifted. Inspect the coils and interconnecting piping on corrosion and leakage. Make sure there is no pollution in the vessel.
- Have the burners checked by an Eclipse dealer or representative for correct function at regular intervals in accordance with the manual from the burner's manufacturer.
- Check the burner exhaust for excessive soot at least once a year or in case of substantial loss of vaporizing capacity. Clean the exhaust channel if necessary.
- In case the coil is removed from the vessel for maintenance or repair, make sure that after reassembly all the supports and brackets are placed back in the vessel. These are necessary for the strength of the vessel wall and proper support of the coils.
- Make sure that the mixers can rotate freely.

It is recommended to integrate the system into the local maintenance schedule and to keep a log file of carried out inspections, repairs or replacements.

9. Malfunction, repair

Warning:

- In case of failure, only qualified and skilled personnel should carry out trouble shooting.

In case the system malfunctions, always observe paragraph 7.3 Running conditions and trouble shooting and the following points first;

- Power supply and state of the circuit breakers.
- Programmed settings on the temperature controller.
- Function of level switches.
- Function of the automatic fill solenoid valve and presence of water.
- Gas supply for the burners.

Always report corrections and repairs in the recommended log file.

10. Dismantling, removal

Carry out the dismantling in reverse order as described in chapter 6 Installation.

Remark:

- The locally applicable environmental regulations should be respected, e.g. laws on separate removal of materials.