Medclair

DU2010
Technical description

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Content

1. General

1.1. Scope

This document is a technical description of the central destructor DU2010.
DU2010 is a nitrous purification system that works with high gas flows supporting the use of double mask.
DU2010 is adapted to the gas flow at the customer site.

1.2. Definitions

DU Destructor Unit

2. Certification

DU2010 is CE certified and fulfils the following directives:

EU directive:

2006/42/EG	Machinery Directive
2014/108/EC	Electromagnetic compatibility, EMC
2014/35/EU	Low Voltage directive
2011/65/EU	Restriction of the use of certain hazardous substances (RoHS)

Swedish directive:

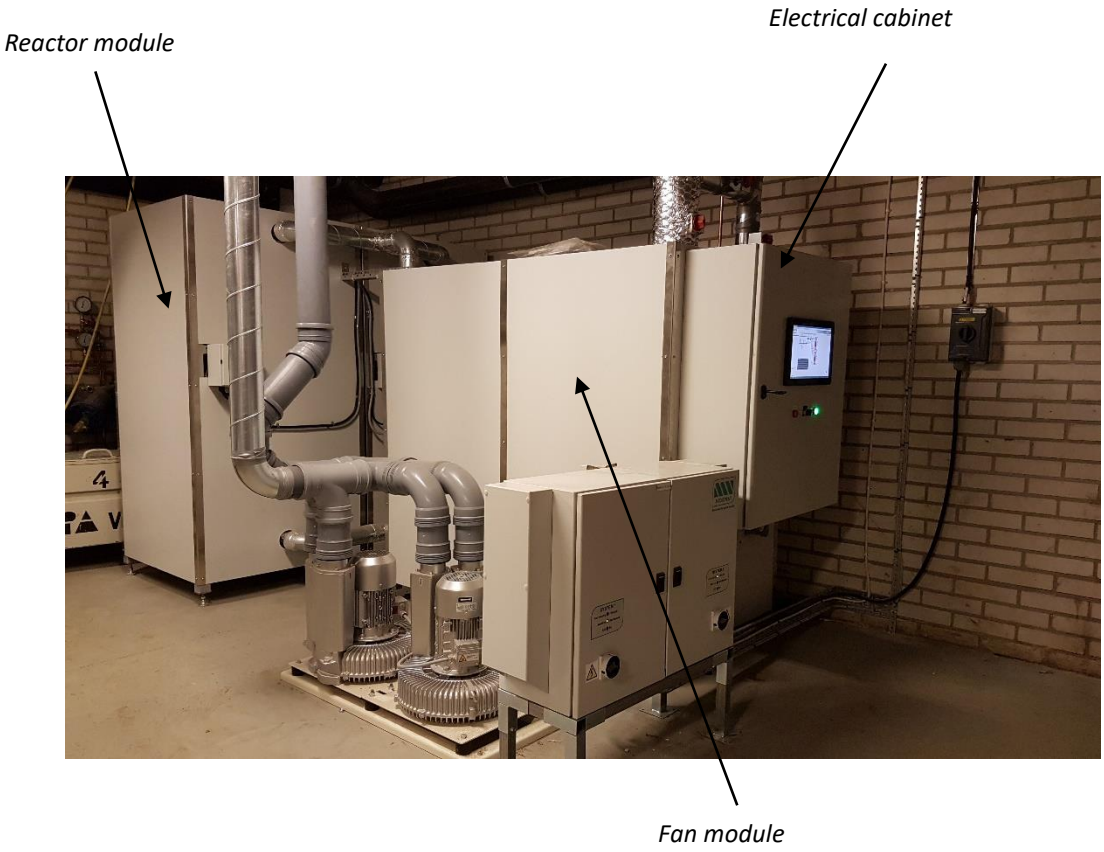
AFS 2008:3	Arbetsmiljöverkets föreskrifter om maskiner
SS EN 12100:2010	Riskbedömning och riskreducering
SS EN 60204-1	Maskinsäkerhet – Maskiners elutrustning – Del 1: Allmänna fordringar
SS EN 50581:2012	RoHS

3. Construction

DU2010 has been constructed to be robust both from a physical and technical view.
Components have been carefully chosen to achieve the requested robustness and functional stability that secure a reliable operation.

3.1. Overview

The destruction unit DU2010 is built up by modules, reactor that purifies the nitrous, fan cabinet with dampers filters and fan and an electrical cabinet (picture below shows a destructor unit with two reactor modules).



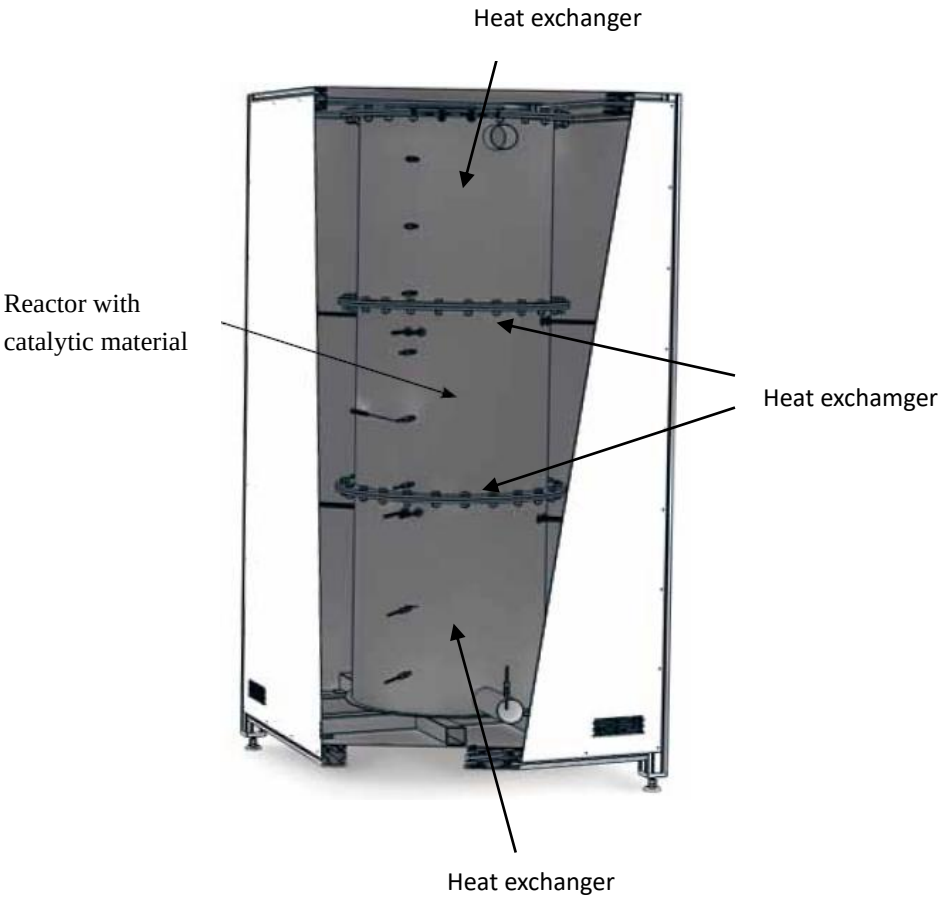
The electrical cabinet is mounted on the side of the fan module. Fan module is connected with the reactor model/modules with ventilation pipes and electrical cabling.

3.2. Reactor module

A reactor module consists of three parts, reactor, heat exchanger and electrical heater.
In the central part of the reactor module is the actual reactor where the digestion of nitrous into nitrogen and oxygen is performed. The reactor is filled with a specific reactor granules that reacts with nitrous and accomplish the digestion.

In the top and bottom of the reactor module the heat exchanger is found.

Between the reactor and the two heat exchangers there are electrical heaters used to keep the correct temperature during operation for the digestion to work.

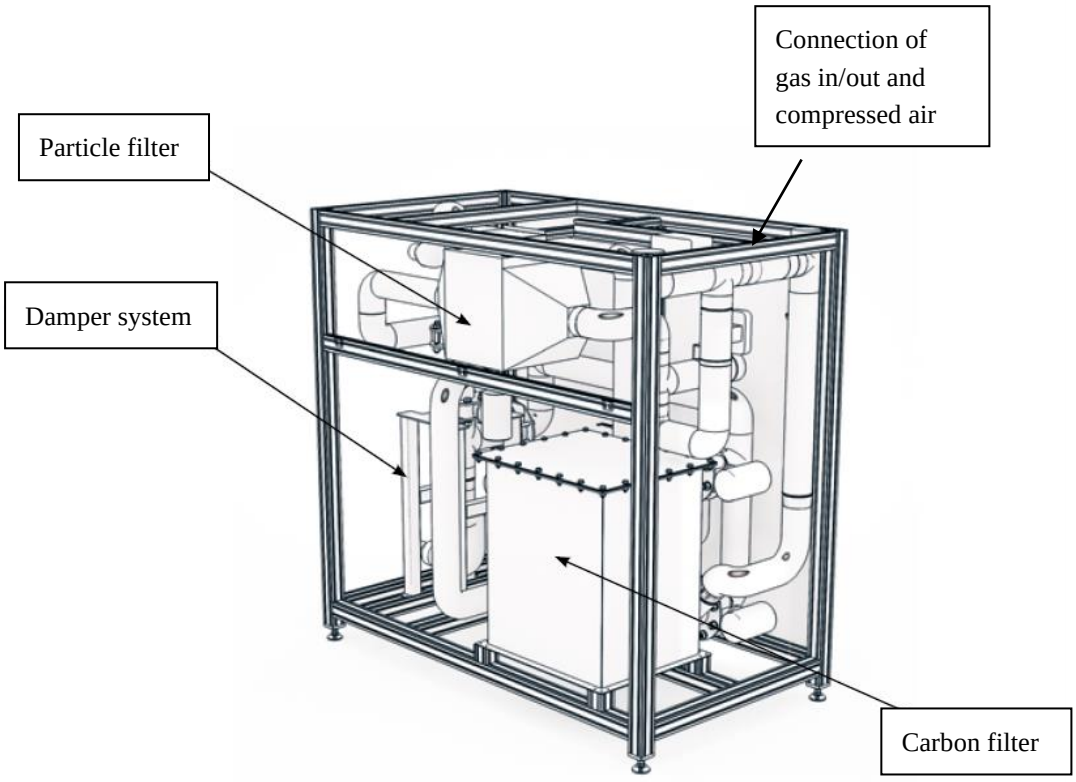


High performance isolation material is used to minimize heat loss from the reactor module.

A number of temperature sensors is mounted in the reactor module for temperature control.

3.3. Fan module

The fan module consists of fan, carbon filter, particle filter and a damper system that control the gas flow.



3.4. Electrical cabinet

The electrical cabinet contains the unit control system and electrical distribution. Most of the components needed is mounted on internal DIN rails.
There are components to handle signals from built in sensors etc. and for distribution of control signalling and current fed of the destructor (i.e., fan, heating system.

The control system for the unit is designed by Medclair AB and uses standard components to achieve a robust and flexible system. If there is a problem with a specific module it can be easily changed, and the disturbance caused thereby be minimized.

All information about the operation including measurement data can be read from the built-in LED screen placed on the front of the cabinet.
This information can also be read remote via the web or by the operation centre if there is a modbus connection available.

The cabinet also contains an UPS which provides power to the electronic components in case of a power break.

4. Function

4.1. Overview

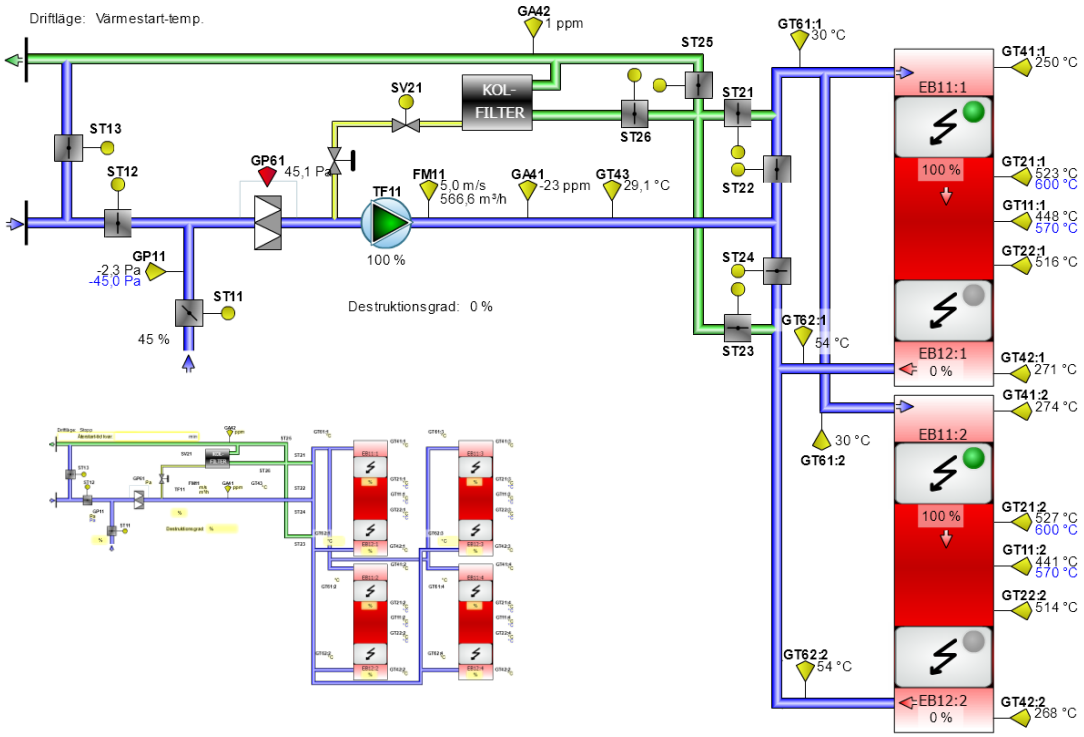
DU2010 is a unit that purifies nitrous using a catalytic process.

The heat exchanger used is a regenerative type and is integrated in the reactor module together with heaters and the catalyst. By this design the destructor becomes a compact product that has an effective heat exchange function and a process with a high purification level.

4.2. Functional principle and flow

When it is said that DU2010 uses a regenerative heat exchanger it means that the gas flow periodically switches direction through the reactor module, by this design generated heat is reused and the process becomes energy optimized.

A number of pneumatical dampers controls the gas flow and opens / closes on signals from the control system. Along the different paths of the gas flow as well as inside the reactor module there are a number of sensors measuring flow, temperature and gas concentration which can be seen in the picture below (Note: the picture shows an installation with two reactor modules with a small example of an four reactor module installation)



When the gas flow change direction there is also a switch of the active heater.
The high gas flows that this type of unit is working with gives a continues cooling contribution to the reactor and therefore it is necessary to use an effective heater of the gas to keep the correct temperature for the process to be working as expected.

For the cases when the destructor has been shut down, either manually for service or when there is a problem, the gas flow is redirected to the bypass route. At this state, the gas flow is sent directly to the outgoing ventilation without being destructed.

4.3. Reactor/Decomposition

The reactor is a catalytic system for purification of nitrous gases. The incoming gas is passing through a pre-heated bed with catalytic material and is then decomposed from N_2O (nitrous) into O_2 (oxygen) and N_2 (nitrogen).

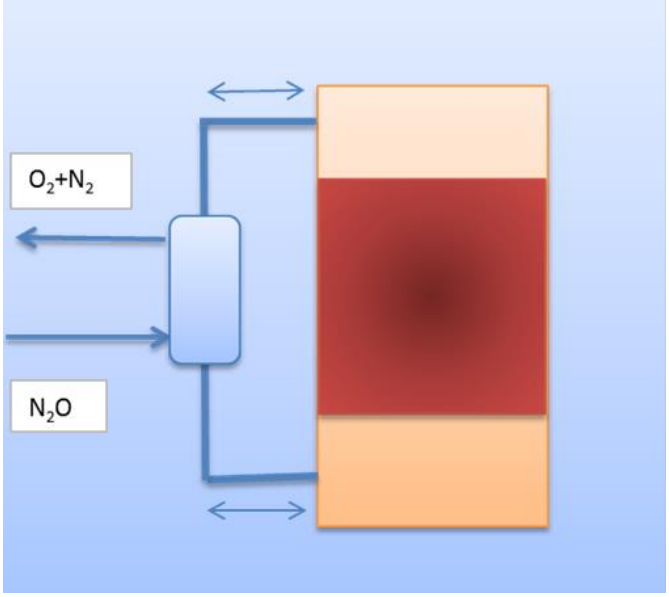
This process reaches a purification level of incoming nitrous above 95%.

Decomposition of nitrous is being performed in the process as long as the temperature is contained which is being handled by the control system together with the heating system.

The catalyst material is inert which means that it will not be consumed by the process and thereby have a long lifetime.

4.4. Heat recovery

The regenerative heat exchanger is based upon the principle that the heated gas emits its energy to an inert material with high heat capacity (and heat resistance) and by switching the gas flow via the dampers an effective energy recovering process is achieved. See figure below.



The gas flow is periodically being switched using pneumatical dampers.

4.5. Control system

The process is controlled and supervised by a built-in control system. Informationen is gathered from a number of measuring sensors (temperature, gas flow, pressure and gas concentration).
Analysis of gathered information is used for control of dampers, valves and heater.

The system controls the process, saves measurement values and calculates average values e.g. nitrous purification, nitrous in and out and energy consumption.

Measurement values for nitrous in/out and energy consumption is presented by hour, day and month via the interface shown on the web page and Led screen.

Statistics can be accessed for all measured parameters and be presented in diagram or exported in Excel format

4.6. Alarm handling

Several parameters is supervised during operation and when their value isn't within specified intervals an alarm is generated.

All generated alarms are logged to facilitate backtracking of the processing history.

Generated alarms are divided into three groups: A-alarm, B-alarm and C-alarm.

A-alarm	A serious problem has occurred, the destruction unit will be halted and the by- pass valve will be opened. Inform Medclair as soon as possible for initial troubleshooting. The problem will either be corrected remotely or by a visit at the site and the problem has to be acknowledged in order to cancel the alarm and enable the unit to start up again.
B-alarm	Less serious problem that doesn't affect the operation and its safety i.e. communication error. This is not an acute problem but Medclair must be informed to monitor the unit. The alarm doesn't need any intervention and will be cancelled automatically when restored to normal operation.
C-alarm	Alarms in this group do not affect the unit operation or its safety and may be considered as user information. These alarms do not need to be acknowledged.

5. Daily use

5.1. Daily operation

Medclair AB will train the customer staff in operating the CDU and take care of its daily use and alarm handling.

All setpoints such as temperature, flow and pressure as well as alarm handling (acknowledgement, levels, priorities) can be performed from the Medclair service centre.

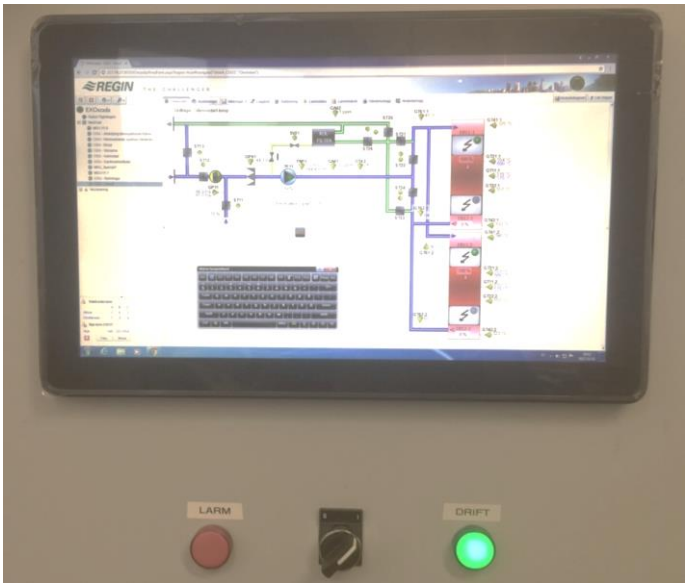
Operation information can be read by the customer via the built-in LED screen or via a modbus connection to an operation centre.
Questions and error reporting is done to the Medclair technical support: support@medclair.se.

No special tools, test equipment or simulators are needed for daily operation and are therefore not included in the delivery.

5.2. User interface

The internal process of the CDU can be supervised via the buit-in LED screen where the process data is displayed in real time. The data is also distributed to an external server where both the customer and Medclair can log in via the internet to read data. Medclair support can also adjust parameters and handle alarms via the internet connection.

The same data as can be obtained from the server can also be made available to an operation centre via the modbus interface.



6. Delivery, installation, and commissioning

DU2010 is delivered to site as separate pretested modules. At site they will be put into correct positions and joined together to form a complete destruction unit. After this the unit is connected to power, extraction and ventilation system, compressed air, alarm or operation centre and internet. Finally, a functionality check is performed before the unit is ready for final inspection and operation.

Below is the main required actions and responsible party (Medclair/customer) listed:

6.1. Preparations

Before delivery to the installation site, the following must be performed:

Step/Activity	**Medclair**	**Customer**
Functional and performance testing of the unit	X	
Delivery to site	X	
Installation of safety switch with the specified rated power is installed close to the installation place (max 5m away).		X
Provide possibility for connection of compressed air nerby its installtion (ca: 5m) from the unit. **Note:** If compressed air isn't available at site a compressor has to be ordered and included in the delivery from Medclair.		X
Inform Medclair if there are specific requirements regarding the connection of gas in/out		X
Inform Medclair about the placement of the destructor		X
If connection to operation or alarm centre is required, make sure that cables are available at the destructor. Possible connections to the destructor is a discrete alarm connection and modbus. As an option the modbus connection via TCP/IP can be provided (if TCP/IP interface is desired, contact Medclair prior to installation).		X
Enable mobile connection (3G/4G) at the site for connection to external server		X

6.2. Installation

Following is to be performed during installation:

Step/Activity	Medclair	Customer
Mounting of delivered modules to a complete destruction unit	X	
Make sure that there is an electrician available for connection between destructor and security switch.		X
Connection of compressed air towards the unit	X	
Provide connection points towards extraction system and outgoing ventilation for specified pipe dimensions		X
Connection to operation or alarm centre.		X
Connection of destruction unit to extraction system and ventilation according to customer instructions	X	

6.3. Commissioning

Step/Activity	Medclair	Customer
Verify that all connections are made correctly	X	
Perform functional check.	X	
Verify that connection to external server works as expected	X	
Verify that the unit heats up and operating temperatures is reached within intended time frame	X	
Perform a final check of the destructor including: ▪ Performance control using calibrated N_2O ▪ Verification of by-pass function ▪ Verification of UPS function by simulating a short power failure ▪ Verification of the alarm function by simulation of fault situations (if connected to an alarm centre verify that correct information is transferred)	X	
Final inspection	X	X

7. Maintenance (service & repair)

Service and support is only to be performed by Medclair AB:s personnel, or by personnel educated by Medclair AB.

7.1. Preventive maintenance (service)

The preventive maintenance consists of regular check of operation parameters, perform calibration and change of filter when needed. All to ensure a stabile operation over time.

Service is normally performed once a year at site and time for service is planned together with the customer.

The service is performed without disturbing daily activities at the customer since the destructor does not need to be shut down during the visit.

The service will be performed according to actual check list containing the main action points listed below:

- Print out of operational data from last service
- Visual inspection of the equipment
- If needed upgrade of the software
- Control of particle filter (change of filter if needed)
- Control of zero-point calibration
- Control of damper/valves
- Calibration of N_2O measurement sensors using calibrated gas
- Performance measurement using calibrated gas
- Control of efficiency
- Solve customer reported problems
- Writing of service report with measurement data and delivering it to customer

7.2. Remedial maintenance (repair)

If the destruction unit for whatever reason stops functioning, contact Medclair as soon as possible. Medclair will then check the unit to see if the problem can be sorted out remote or if a repair is needed.

If, at a preventive service, a potential problem is discovered which most likely will need a repair this will be forwarded to the customer for discussion/decision.

7.3. Software update

Software update is performed by Medclair or appointed partner and is normally made remotely via the internet connection.

After a software upgrade following shall be checked.

- No changes of the unit configuration have been made
- All measurement equipment operates correct and shows values as expected
- Transfer of data to external server can be carried out
- Alarm function has not been affected (performed by simulations)
- Inform operating staff about the software upgrade

7.4. Commissioning

If the unit has been shut down after a repair situation, the following shall be checked before the unit is put back into operation:

- Repaired or changed module/part is functioning correctly
- The unit starts up and reaches the processing temperature correctly.
- Operation information displayed by the unit is correct

Note: Time for start-up and reaching the correct processing temperature depends on the initial temperature (i.e. how much it has cooled down since last shutdown)

8. Interrupt management

The destruction unit has six external connections/interfaces.

- Power
- Internet (for connection to server)
- Compressed air
- Incoming gas
- Outgoing gas
- Modbus connection

Below it is described how the destructor handles interruptions for these connections/interfaces and if there is a need for manual intervention.

8.1. Power

Short power cut (max 10 min)

- An alarm will be generated
- The unit will stop
- The control system will be powered by the built in UPS
- The unit starts up automatically when power comes back
- Generated alarm will be restored automatically

Longer power cut

- An alarm will be generated
- The unit will stop
- The built in UPS will not be able to supply the control system with power
- The unit must be started manually when power is back
- Generated alarm will be restored automatically

8.2. Internet

The destructor has an 3G/4G modem inside the electrical cabinet for mobile internet connection towards a server.

- At a power cut or problem with the mobile connection the modem will automatically restore the connection.

8.3. Compressed air

Interruption in the compressed air:

- An A-alarm will be generated
- By-pass will be opened and the unit will stop.

After restoring of the compressed air:

- The unit must be started manually
- Generated alarm will be restored automatically after damper functionality is checked

8.4. Incoming gas

If the gas flow becomes zera the unit will be standing by and secure the correct temperature in order to be prepared to start destruction as soon as the gas flow starts up.

8.5. Outgoing gas

The Destruction unit do not have any information of if the outgoing ventilation works or not and will terefore cpontinue sending uot the purified gas inte the ventilation system.

8.6. Connection towards operation centre

The destruction unit can be connected to an operation centre either via a discrete alarm connection or the modbus. These interfaces will go stop to work at a longer power cut but willl come back automatically will power becomes available (if there isn't something in the operation centre that prevents this).

9. Technical data

Power supply:	230/400 VAC, 50Hz
Power consumption (2 reactor modules):	25 A max
Power consumption (4 reactor modules):	60 A max
Rated power (2 reactor modules):	15 kW
Rated power (4 reactor modules):	30 kW
Energy consumption, warming up:	12 kW
Energy consumption, operation:	Ca: 2 500 – 3 000 W (depending of load)
Compressed air:	Min 5 bar
Normal system pressure:	Ca: 2500 Pa

Operational conditions:

Temperature, storage:	-25°C till 50°C
Temperature, operation:	10°C till 30°C
Relative humidity:	10 – 80 %
Above sea level:	< 2000 meter
Surrounding environment:	No flammable environment, no combustion gases or presence of halogenated anaesthetic gases
Purification degree (nitrous):	> 95 %
Normal outlet temperature:	Ca: 50°C
Weight:	Reactor module: Ca: 820 kg (piece)
	Fan module with electrical cabinet: Ca: 600 kg
Size (WxDxH):	Reactor module: 950 x 950 x 1960 mm
	Fan module with electrical cabinet: 950 x 2020 x 1660 mm
Pipe connection gas in/out:	100 alt. 125 mm Spiro
Compressed air connection:	Standard connector

Medclair, founded in 2013, is a Swedish research and development company with leading-edge expertise in process gas purification, gas measurement, ventilation and control. We solve healthcare and environmental challanges through innovation.