Manual

Carbon / Sulfur Analyzer CS-580A (HELIOS)

REV0004 04/19

Translation

Table of Contents

1 Contact information

Please contact your local representative in the event of problems. You can find the complete list of dealers at www.eltra.com.

Of course, you can also contact ELTRA-Germany directly:

ELTRA GmbH
Retsch Allee 1-5
42781 Haan
Germany
Web: www.eltra.com
Email: service@eltra.com

2 Notes on the Manual

This Operating Manual provides technical instructions for the safe operation of the device and contains all necessary information about the topics given in the table of contents. This technical documentation is meant to be a tutorial and a reference. The individual chapters are self-contained.
Knowledge of the relevant chapters (for the respective target groups defined according to areas) is a prerequisite for the safe and correct use of the device.
This Operating Manual contains no repair instructions. In the event of any faults or necessary repair work, please contact your supplier or Eltra GmbH directly.

Amendments

Subject to technical changes.

2.1 Explanations of the Safety Instructions

In this Operating Manual we give you the following safety warnings

Mortal injury may result from not following these safety warnings. We give you the following warnings and corresponding content.

DANGER

Type of danger / personal injury
Source of danger
– Possible consequences if the dangers are not observed.
• **Instructions on how the dangers are to be avoided.**

We also use the following signal word box in the text or in the instructions on action to be taken:
DANGER

Serious injury may result from not following these safety warnings. We give you the following warnings and corresponding content.

WARNING

Type of danger / personal injury
Source of danger
– Possible consequences if the dangers are not observed.
• **Instructions on how the dangers are to be avoided.**

We also use the following signal word box in the text or in the instructions on action to be taken:
WARNING

Moderate or mild injury may result from not following these safety warnings. We give you the following warnings and corresponding content.

CAUTION

Type of danger / personal injury
Source of danger
– Possible consequences if the dangers are not observed.
• **Instructions on how the dangers are to be avoided.**

We also use the following signal word box in the text or in the instructions on action to be taken:
CAUTION

In the event of possible **property damage** we inform you with the word “Instructions” and the corresponding content.

NOTICE

Nature of the property damage
Source of property damage
– Possible consequences if the instructions are not observed.
• **Instructions on how the dangers are to be avoided.**

We also use the following signal word in the text or in the instructions on action to be taken:
NOTICE

2.2 General Safety Instructions

C1.0002

CAUTION

Read the manual

Non-observance of the operating instructions

– The non-observance of this manual can result in personal injuries.
- **Read the manual before using the device.**
- **The adjacent symbol indicates the necessity of knowing the contents of this manual.**

Target group:

All activities required for correct use are described in this Operating Manual. Any activities that require opening of the enclosure and/or go beyond this may only be performed by authorized electricians who have received in-depth training for this analyzer.

As the operating company, you must ensure that the following applies to the persons working on the analyzer;

- Operating personnel have been made aware of and have understood all safety regulations;
- Operating personnel are familiar when starting work with all handling instructions and regulations that apply to the relevant target group for them;
- Operating personnel have access at all times to the technical documentation of this analyzer;
- New personnel are familiarized with the safe and intended use of the analyzer before starting work on it by means of a verbal introduction by a competent person and using this technical documentation.

Incorrect operation can result in serious injury and damage to property. You are responsible for your own safety and for that of your employees.

Ensure that no unauthorized persons have access to the analyzer.

C2.0089

CAUTION

Changes to the machine

– Changes to the machine may lead to personal injury.
- **Do not make any change to the analyzer.**
- **Use spare parts and accessories that have been approved by Eltra GmbH exclusively.**

2.3 Intended use

The analyzer was developed primarily for elemental analysis of organic samples (combustibles, soils). Furthermore, an analysis of ores or building materials is possible under certain conditions. Depending on the application, the sample weights, accelerator(s) and settings on the analyzer can significantly influence the accuracy and precision of the measured values.

Therefore, use is permitted only in the laboratory by appropriately trained and instructed personnel. All other applications are not permitted, especially in the private sector.

2.4 Improper use

Private use is not permitted. Repairs and modifications may only be carried out by Eltra GmbH, or an authorized representative, or by qualified service technicians.

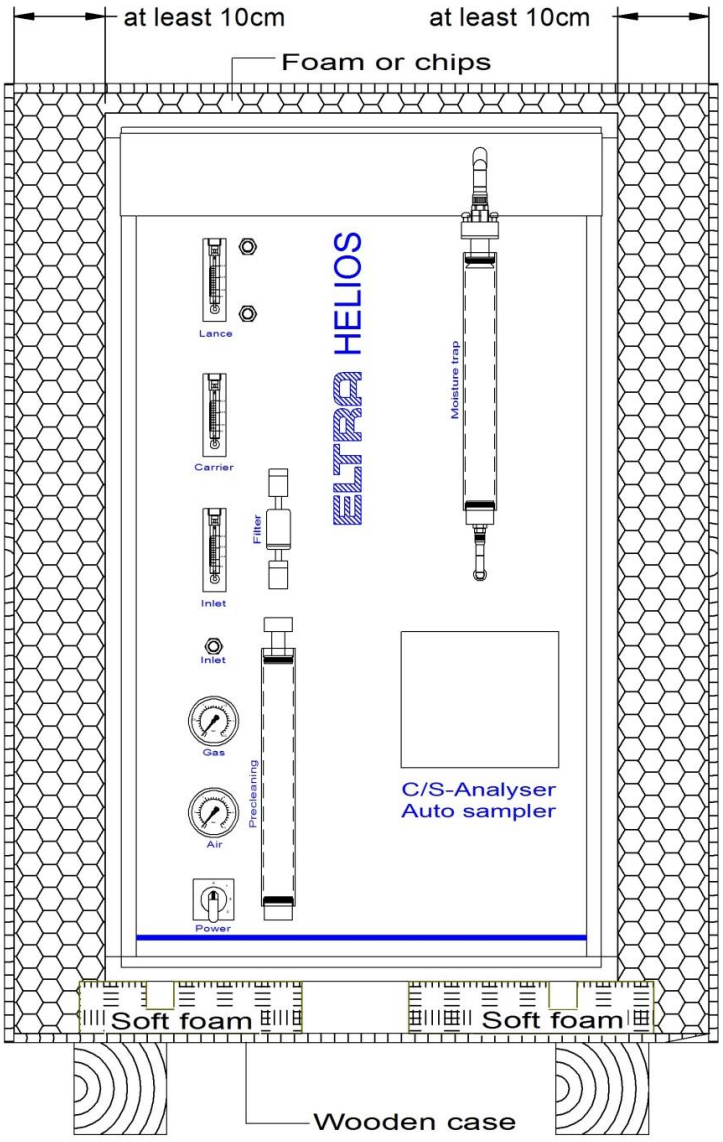
2.5 Explanation of signs and symbols

Number	Symbol	Reference	Meaning
12			Danger, high voltage, electric shock
13		IEC 60417-5041	Caution, hot surface
14		ISO 7000-0434B	General hazards – see documentation
-		BGV A8 W27	Risk of crushing

3 Packaging, Transport and Installation

3.1 Packaging

The packaging has been adapted to the mode of transport. It complies with the generally applicable packaging guidelines.



Before packing, the analyzer must be wrapped in plastic foil to protect it from moisture and dust, and then be placed in a wooden case. The wrapped analyzer should be surrounded by a layer of plastic foam (or at least chips) of at least 10cm, in order to avoid any damage during transport.
Especially the foam where the analyzer is put on is very important. It should neither be too hard nor too soft. When the foam is too soft, the analyzer will practically touch the wood. Fix the foam on the bottom of the wooden case by gluing.
The small loader (with 36 trays) can be packed in the wooden case together with the analyzer. The bigger loaders (for 104 and 130 crucibles) however, are to be packed in separate carton boxes and protected by foam or another shock absorbing material. The transportation of these carton boxes has to be made on pallet.

The glass tubes must be empty.

3.2 Transport

N1.0075

NOTICE

Transport

– Mechanical or electronic components may be damaged.
- **The device must not be bumped, shaken or thrown during transport.**
- **The device must be transported upright**

3.3 Conditions for the Installation Site

Requirements regarding the operating conditions:
– For indoor use only.
– Operation up to max. 2,000 m above sea level.
– Ambient temperature of between 5°C and 40°C.
– Maximum relative air humidity < 80 % (at ambient temperatures ≤ 31°C), with linear decrease up to 50% relative air humidity at 40˚C, non-condensing.
– A residual current operated device (RCD, 30 mA).
– An exhaust system to evacuate the combustion gases is strongly recommended.

⚠ **WARNING** Provide an external fuse (20 ampere, B-type) and a residual current device when connecting the mains lead to the mains in accordance with the regulations at the installation site.
– Information about the required voltage and frequency of the device can be found on the type plate .
– The data listed must be consistent with the existing power supply system.
– The device may only be connected to the power supply system using the connecting lead supplied.

N2.0022

NOTICE

Electrical connection
Failure to heed the data on the type plate

– Electronic and mechanical components may be damaged.
- **Only connect the device to a power supply system that is consistent with the data on the type plate.**

– Fluctuations of the mains supply voltage up to ± 10 %.
– The device must be operated in accordance with overvoltage category II and pollution category 2, DIN EN 61010-1.
– Industrial environment in accordance with DIN EN 61010-1

3.4 Type Plate Description

N3.0022

NOTICE

Electrical connection
Failure to observe the values on the type plate

- Electronic and mechanical components may be damaged.
- **Connect the device only to mains supply matching the values on the type plate.**

1	Device designation
2	Serial number
3	Year of manufacture
4	Voltage definition
5	Amps
6	Power
7	Manufacturer’s address
8	Item number
9	Mains frequency
10	Protection type
11	Disposal label
12	CE mark

Please quote the device designation (1), the serial number (2) of the device and the item number (7) if you have any queries.

4 Pre-installation guide

DANGER D1.0005

Mortal danger from electric shock
Exposed power contacts - High Voltage

- An electric shock can cause injuries in the form of burns and cardiac arrhythmia, respiratory arrest or cardiac arrest.
- **Set the mains switch of the analyser to position 0 and pull the mains plug of the mains socket.**

WARNING W1.0021

Fire hazard / Risk of burns
Hot parts (crucibles, reagents,..) can fall down

- Ignition of tables, floors, or any other surface the hot part falls on
- Ignition of clothes and any other material
- **Set up the analyser in a flame retardant environment. Pay special attention to the table, the floor and any other surface being in the near of the analyser**
- **Make sure that the surrounding space of the analyser stays clear of any flammable material**
- **Always wear suitable clothing**
- **Keep the work environment clear of all materials that could catch fire**

WARNING

Acceleration of fire / oxygen rich atmosphere
High purity oxygen carrier gas

- increased risk of fires
- **Since the oxygen related risks heavily depend on the installation situation in the laboratory, the user must make an own risk assessment, evaluating the necessary steps to minimize the risks introduced by handling oxygen from the source through the analyser to the exhaust system.**

Following requirements apply, when installing the analyzer:

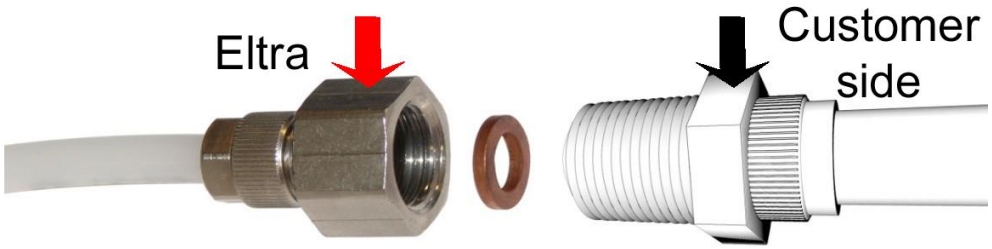
Carrier gas	Oxygen 99.95 % pure; 2 - 4bar (30 - 60psi)
Mains power supply	230VAC ±10%, 50/60Hz; 20A fuse
	CEE-Plug 230V, 32A

Analyzer dimension	550 x 1000 x 600mm
Loader dimension	850 x 350 x 450mm (depending on version)
Analyser weight	approx. 90kg
Loader weight	approx. 55kg

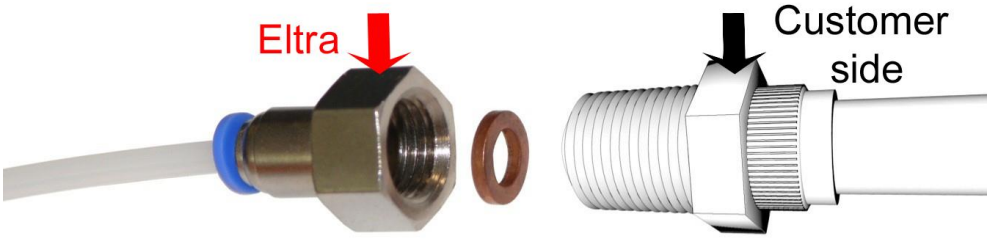
– It is important to install the instrument on a stable place.
– The balance should rest on a vibration free support.

Loader dimensions:
Version 36p: 500x250x460mm
Version 130p: 900x500x460

Gas connections:
The supplied tubes carry a connector with G¼" inner diameter ".



Connections for compressed air:
The tubes supplied together with the analyzer, carry a connector with G¼" inner diameter.



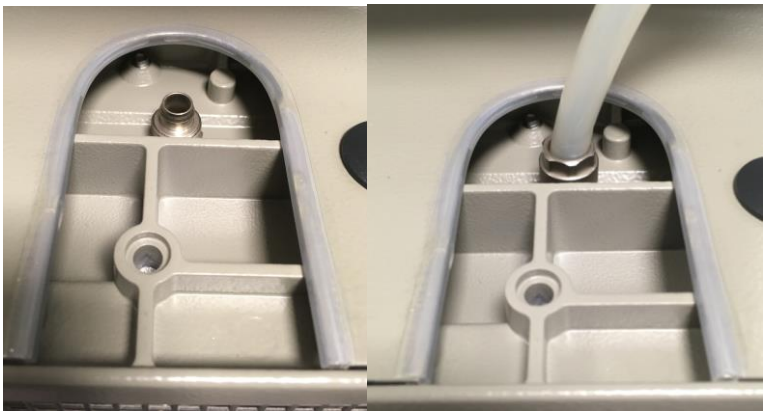
Connections for the system exhaust:

WARNING

Toxic Fumes
The analyser combusts the customer samples, this might lead to toxic fumes

- Personal health issues may arise
- **Depending on the customer samples it is highly advisable to connect the system exhaust port to a lab ventilation system**

The connection to the exhaust system (with and without connected hose) is on top of the analyzer.



5 Installation

5.1 Setting check up

CAUTION V0092

Device falling down
Incorrect erection or inadequate working space

– Due to its weight, the device can cause injuries if it falls down.
- **Only operate the device on a sufficiently large, strong, non-slip and stable working area.**
- **Ensure that all feet of the device are standing securely.**

WARNING W2.0021

Fire hazard / Risk of burns
Hot parts (crucibles, reagents,..) can fall down

- Ignition of tables, floors, or any other surface the hot part falls on
- Ignition of clothes and any other material
- **Set up the analyser in a flame-retardant environment. Pay special attention to the table, the floor and any other surface being in the near of the analyser**
- **Make sure that the surrounding space of the analyser stays clear of any flammable material**
- **Always wear suitable clothing**
- **Keep the work environment clear of all materials that could catch fire**
- **Do not store any items on top of the analyzer**

DANGER D2.0005

Mortal danger from electric shock
Exposed power contacts - High Voltage

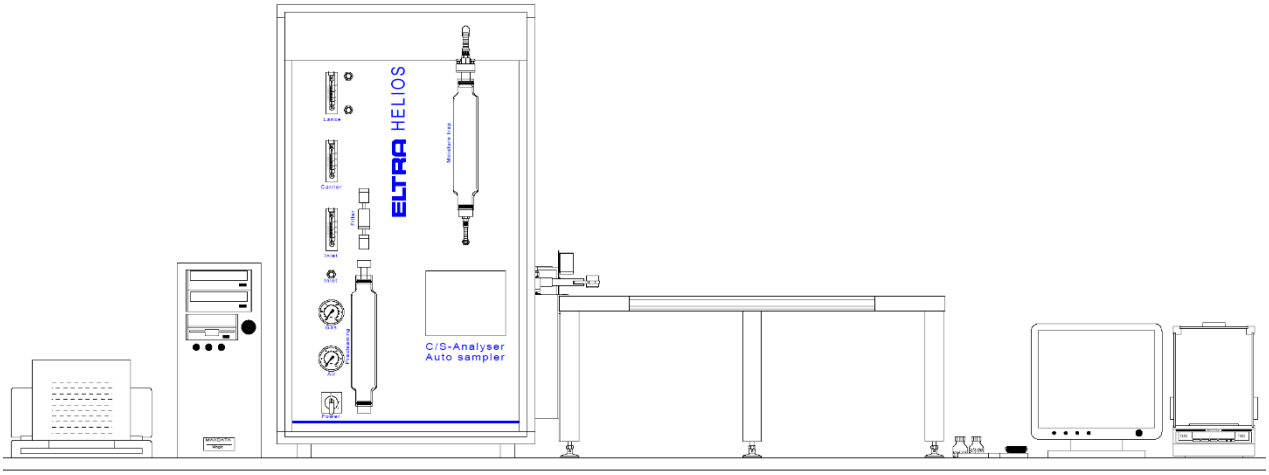
– An electric shock can cause injuries in the form of burns and cardiac arrhythmia, respiratory arrest or cardiac arrest.
- **Set the mains switch of the analyser to position 0 and pull the mains plug of the mains socket.**

NOTICE

Installation of the machine

– It must be possible to disconnet the machine from the mains at any time.
- **Install the machine such that the connection for the mains cable is easily accessible.**

Since the analyser weighs about 90 kg it should be placed on a suitably stable and flame-retardant surface. Due to the balance, the platform should be as free of vibration as possible. The loader is attached to the right side of the analyser. The size of a desktop (approx. 200 cm 80 cm for the analyzer with 130-crucibles autoloader) is sufficient for the entire set-up. Below is an example of installation:



The environment of the device does not have to necessarily be air-conditioned, although it is best if the room temperature remains between 18°C and 30°C.

NOTICE

Under no conditions the device should be placed in direct sunshine!

Avoid places exposed to the wind of air conditioners or to the wind blowing through open windows or doors.

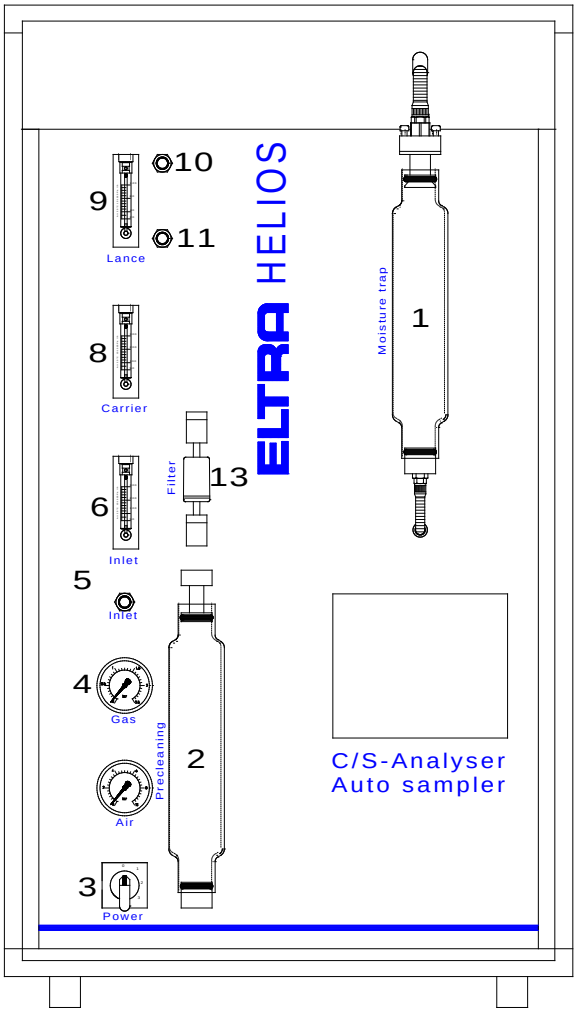
5.2 Front Panel Illustration

CAUTION

C3.0081

Danger of bursting

- Defective reagent tubes may cause injuries in the form of cuts and other personal injuries.
- **Before installing the new reagent tubes, check if they are damaged.**
- **Wear protective gloves and safety glasses when installing/removing the reagent tubes.**



1	Moisture trap
2	Carrier gas purification
3	Mains power switch
4	Compressed air gauge
5	Oxygen pressure gauge
6	Furnace inlet flow adjustment
8	Furnace inlet flow meter
9	Carrier gas flow meter
10	Lance flow meter
11	Lance flow adjustment
12	Furnace low inlet
13	Dust filter cartridge

5.3 Installation of Furnace Covers for Manual and Loader Setups

W3.0021

WARNING

Fire hazard / Risk of burns

Hot parts (crucibles, reagents,...) can fall down

- Ignition of tables, floors, or any other surface the hot part falls on
- Ignition of clothes and any other material

- **Set up the analyser in a flame retardant environment. Pay special attention to the table, the floor and any other surface being in the near of the analyzer**
- **Always wear suitable clothing**
- **Keep the work environment clear of all materials that could catch fire**
- **Install the needed covers as given in the following chapters**

5.3.1 Manual Setup

If the Helios analyser was delivered without an autoloader system, it is configured to be used in manual mode. In this case, please install the side cover plate (article number 35400-2003).

5.3.2 Autoloader Setup

If the Helios analyser was delivered out an autoloader system, it is configured to be used in automatic mode. In this case, please install the front cover plate (article number 35400-2001).

5.4 Mains power Connections

D3.0005

DANGER

Mortal danger from electric shock
Exposed power contacts - High Voltage

- An electric shock can cause injuries in the form of burns and cardiac arrhythmia, respiratory arrest or cardiac arrest.
- **Set the mains switch of the analyzer to position 0 and pull the mains plug of the mains socket.**

D4.0005

DANGER

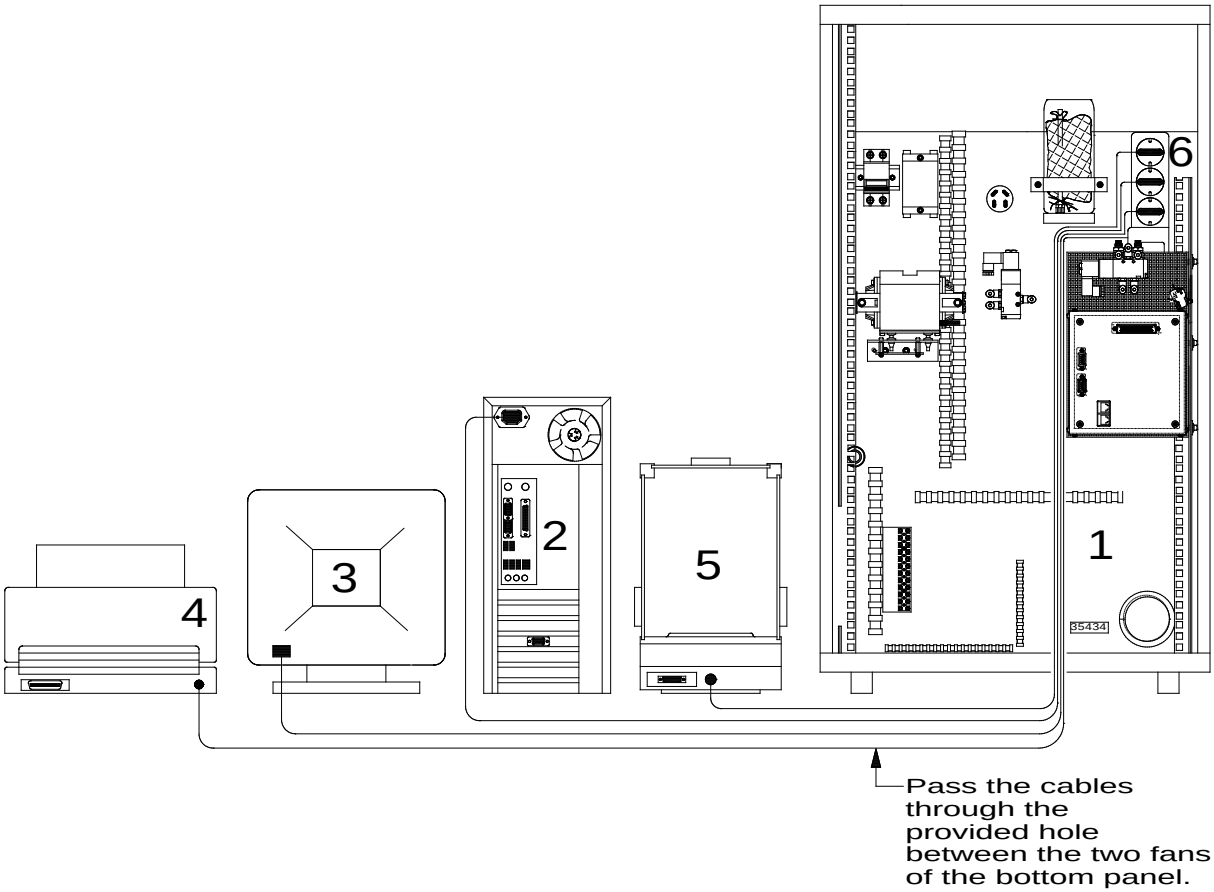
Mortal danger from electric shock
Damaged power cable

- An electric shock can cause injuries in the form of burns and cardiac arrhythmia, respiratory arrest or cardiac arrest.
- **Never use a damaged power cable to connect the device to the main.**
- **Check the power cable and the plug for any damage before use.**

NOTICE

Installation of the machine

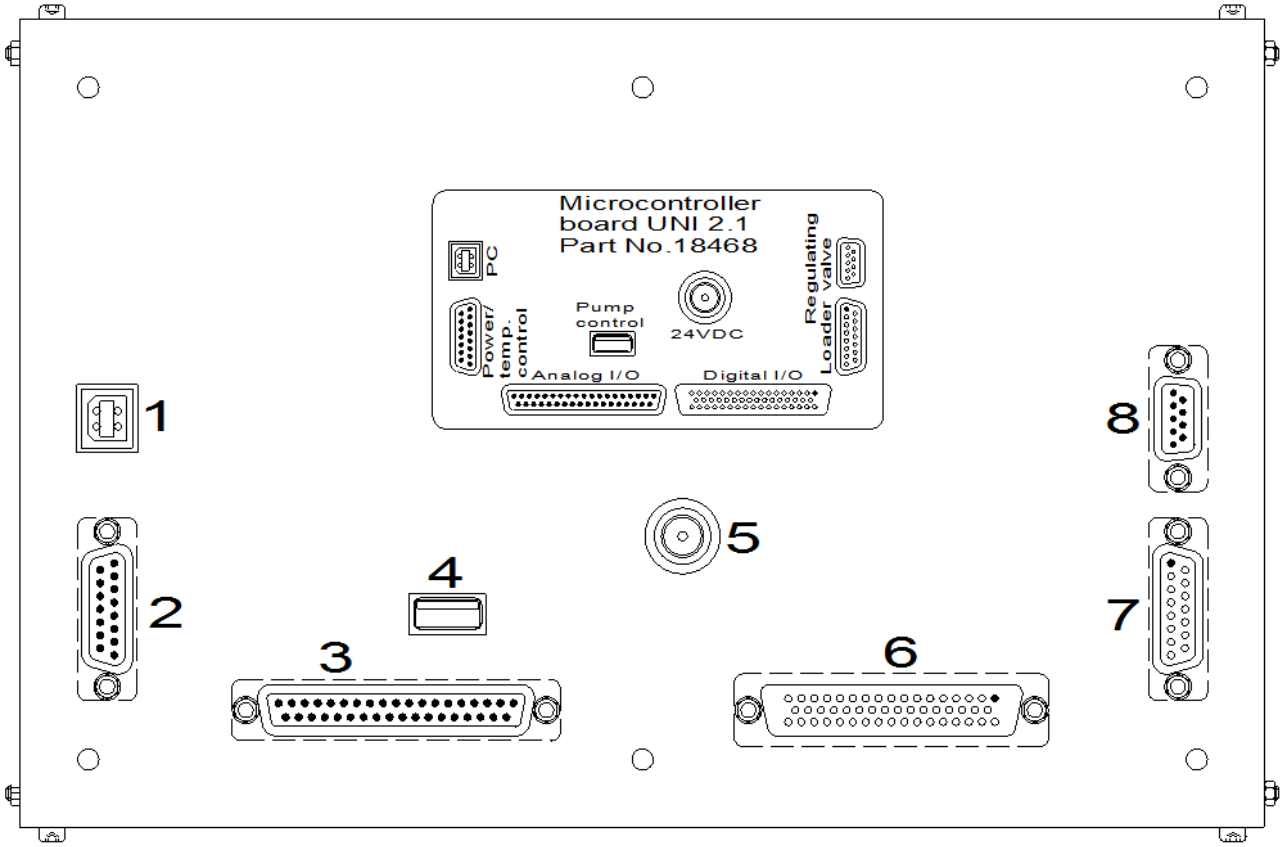
- It must be possible to disconnet the machine from the mains at any time.
- **Install the machine such that the connection for the mains cable is easily accessible.**



1	Analyzer
2	Computer
3	Monitor
4	Printer
5	Balance
6	Quad power socket

The mains power cable of the analyzer is located on the back of the analyzer. Connect the analyser to the mains power after closing the enclosure only.
All power cables of peripheral devices [computer (**2**), the printer (**4**) and the balance (**5**)] should be connected to the quad mains power socket (**6**) as shown in the figure.
Remark
Before placing balance, PC, display and printer on the desk for connecting their power cables, the loader should be attached to the analyzer and aligned. Please, refer to “LOADER installation, service and operation manual” for the instructions on installation, connection and alignment of the loader.

5.5 Data Interface



1	PC USB connector
2	Power and temperature control interface
3	Analog input/output signals
4	Pump control
5	24V connector
6	Digital input/output signals
7	Autoloader connection
8	Regulating valve (not relevant for CS-580A)

When all units are connected to the mains power, then interface connections can be made. The required interface cables are included in the scope of supply. The supplied additional devices have been already adapted to the interfaces when the analyzers are taken into operation in our company. The plugs are all different from each other, so that they cannot be interchanged. The computer is already provided with operation system and with software for controlling the analyzer.

Please note: As the balance transfers the weight to the PC, its serial interface must be programmed. This is important, if you use a balance, which was not ordered with the analyzer.

NOTICE

For all instructions for using the PC software refer to the Help-function of the software.

5.6 Oxygen Connection

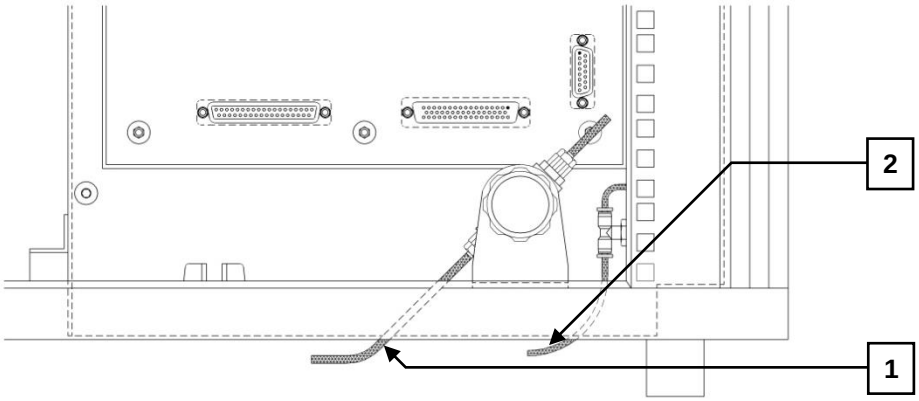
WARNING

Acceleration of fire / oxygen rich atmosphere
High purity oxygen carrier gas

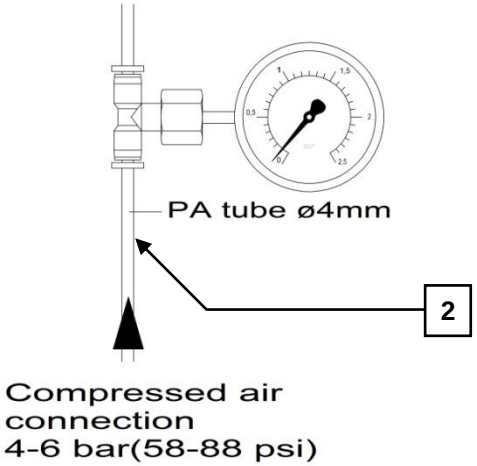
– increased risk of fires

• **Since the oxygen related risks heavily depend on the installation situation in the laboratory, the customer must make an own risk assessment, evaluating the necessary steps to minimize the risks introduced by handling oxygen from the source through the analyser to the exhaust system.**

The analyzer requires two gas connections: oxygen and compressed air. The necessary tubes for connecting the analyser to the oxygen and compressed air supplies are shipped with the analyzer. Lay these hoses at least 5cm above the table surface.



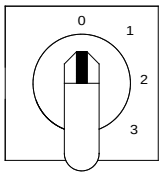
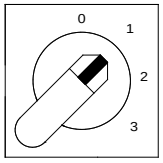
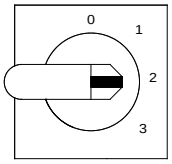
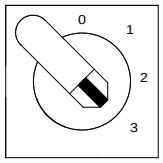
Tube (1) connects the oxygen supply to the analyzer on the fitting of a pressure regulator. This connection must be very secure, considering that the incoming oxygen pressure in the tube is 2 to 4 bar (30 to 60 psi). Do not tighten the nut too much in order to avoid damaging of the tube. Drive the cup nut manually. Don’t use any tool.



The tube (2) connects the device through a connector with the compressor or compressed air supply. For connecting the tube, simply push it into the connector. This connection must be also very secure, considering that the pressure in the compressed air is 4 to 6 bar (60 to 90 psi).

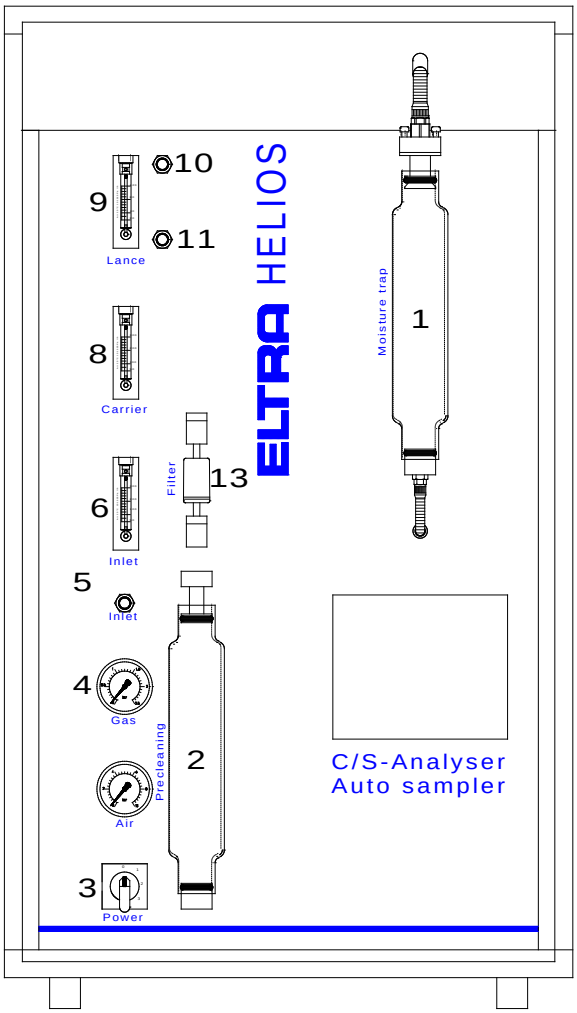
5.7 Operation Modes

There are 4 different positions of the mains power switch possible:

	0	Off.	The analyzer is completely switched off.
	1	Standby.	The thermostatic control of the IR-cell is switched on. The furnace is switched off and the gas flow is disabled. Communication with the PC is possible.
	2	Furnace on.	Furnace is switched on, but the gas flow remains disabled.
	3	Gas flow.	All functions of the analyzer are in operation mode.

In case the analyzer was switched off (pos. 0) for long, it should be set to pos. 1 for at least 1 hour, in order for the IR-cell to reach the stable operating temperature.
The furnace heating-up time depends on the set temperature. In order to power the furnace, the analyzer has to be switched to position 2. At this position the gas flow is still disabled so that there is no gas consumption.
For running analyses set the power switch to position 3. At this position, the pump is enabled so that air and any moisture which has entered the gas flow system can be purged by the oxygen flow. Keep it there for about 10-15 minutes before starting the first analysis. To save time, the purging can be started before the set temperature has been reached. The slight influence of the oxygen flow on the temperature of the infrared cell is compensated.
At short working breaks (like lunch breaks) the mains switch remains on position 2 (furnace on) to save gas and to keep the set temperature.
During longer breaks, e.g. after finishing the work for the day, the mains switch is set to position 1 (standby). The thermostatic control of the infrared cell is then working, so that no long warm-up time is needed, when re-starting the analyzer.
Energy consumption and wear are negligible on standby. The analyzer is designed for long term use, so that no damage results.
Switch off the analyzer (position 0) is only useful, when working break takes several days or weeks.

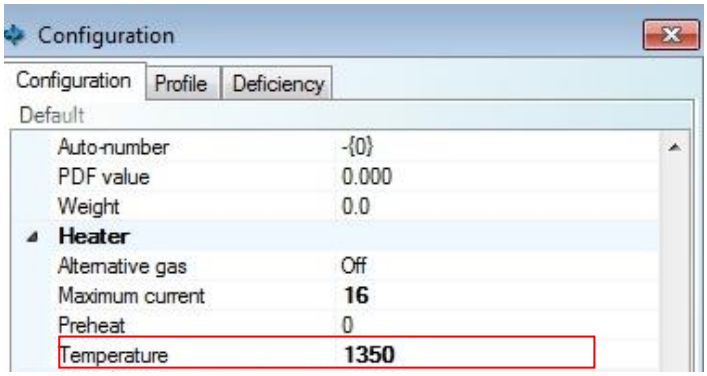
5.8 Adjusting the gas flow



1	Moisture trap
2	Carrier gas purification
3	Mains power switch
4	Compressed air gauge
5	Oxygen pressure gauge
6	Furnace inlet flow adjustment
8	Furnace inlet flow meter
9	Carrier gas flow meter
10	Lance flow meter
11	Lance flow adjustment
12	Furnace low inlet
13	Dust filter cartridge

5.9 Temperature adjustment

The furnace temperature is PC-controlled.
The CS-580A is delivered with 1350°C set temperature saved in a software profile. After switching on the instrument at position 2 and starting of the UNI-software, the heating up to the set temperature is started automatically. (The cable connection between instrument and PC is in the scope of supply).
The actual furnace temperature and the set temperature are visible in the window Heater.
You can change the set temperature in the window Configuration.



5.10 Preheating the furnace

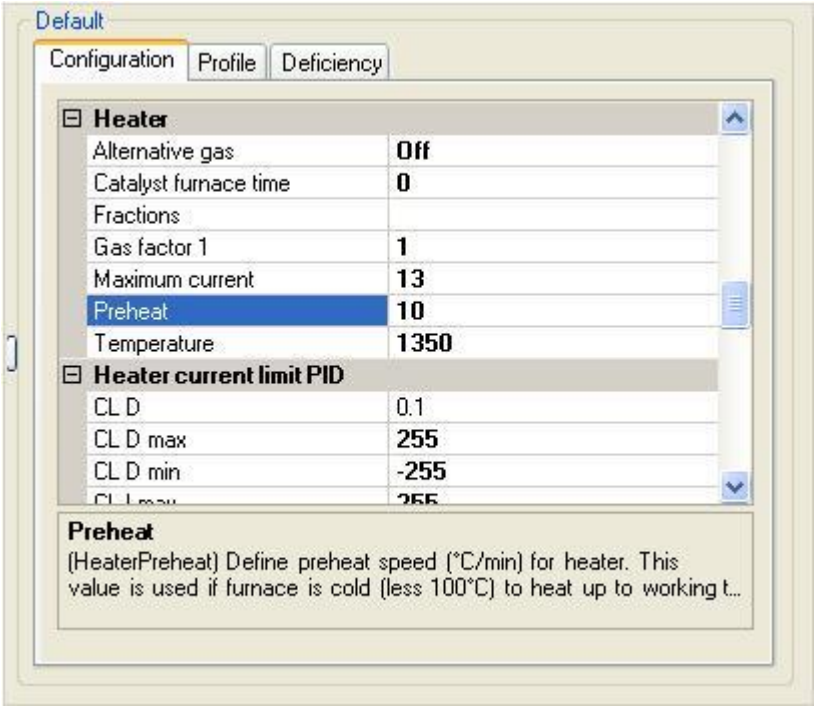
NOTICE

For heating up, the mains power switch of the analyzer has to be at position 2 and the PC has to be switched on. The configuration of the BIOS has to be done by the customer as needed.
During heating up to the set temperature, the ceramic combustion tube is under high thermic stress. This stress is increased with increasing speed of the heating up process.
For maximum service life of the combustion tube, the furnace can be heated up slowly with a heating rate of 10°C/min. In order to avoid long waiting time until the furnace heats up, the heating up of the furnace can be started automatically long before the work begins. See chapter Bios Configuration
Please note that the automatic preheating can only be started when the analyzer temperature is below 100°C.
NOTICE
The analyzer is delivered with a default heating rate of 10°C/min. Much higher heating rates are possible; however with respect to the service life of the combustion tube, higher rates should only be used when necessary.

5.10.1 Configuration of preheating

1. Open the window *Default* and choose *Configuration*.

2. In the chapter *Furnace* you find *Preheat*.



The value shows the chosen heating rate in °C/min. (The preheating function is switched off by entering 0 in this place. Then, the heating occurs with maximum speed after start of the UNI-software.)

3. Save your entry with Enter.
4. The preheating starts automatically with the next start of the software, if the furnace temperature is lower than 100°C and the analyzer switch is at position 2.

NOTICE

When the preheating function is activated (by any other value except 0) the software automatically creates a shortcut at the startup menu of Windows. This enables the start of the UNI-software with every start of the PC. The shortcut is deleted automatically when the preheating is deactivated.

5.10.2 BIOS-configuration

In order to start the preheating before the work begins, the BIOS has to be configured to start the PC automatically at the selected time. (The preheating starts automatically by starting the UNI-software.)

1. Switch on your PC and enter the BIOS by pressing the corresponding key (e.g. F2). The normal booting process is interrupted and the BIOS menu appears.
2. Choose Power Management Setup
3. Activate "Resume by Alarm" (enabled).
4. Enter the required days and times when the heating up of the analyzer should be started.
5. Save your entries at Save/Exit with Yes.
6. The booting process will be sustained.

6 Analysis

6.1 Working procedure

D5.0006

DANGER

Danger caused by scalding by samples
Sample material

- Damage to the respiratory tracts, skin and/or mucous membranes.
- Radiation damage.

- **The user must himself assess the risk emanating from a sample during the analysis.**

D6.0006

DANGER

Toxic atmosphere
Sample material

- Acute poisoning by gases from combustion.

- **The user must himself assess the risk emanating from a sample during the analysis.**
- **The analyser must be connected to an exhaust system.**
- **The exhaust system must be in operation.**

W4.0021

WARNING

Fire hazard / Risk of burns
Hot parts (crucibles, reagents,...) can fall down

- Ignition of tables, floors, or any other surface the hot part falls on
- Ignition of clothes and any other material

- **Set up the analyser in a flame retardant environment. Pay special attention to the table, the floor and any other surface being in the near of the analyzer**
- **Always wear suitable clothing**
- **Keep the work environment clear of all materials that could catch fire**

W10.0021

WARNING

Fire hazard / Risk of burns
Hot parts (crucibles, reagents,...) can fall down

- Ignition of tables, floors, or any other surface the hot part falls on
- Ignition of clothes and any other material

- **Set up the analyser in a flame retardant environment. Pay special attention to the table, the floor and any other surface being in the near of the analyzer**
- **Always wear suitable clothing**
- **Keep the work environment clear of all materials that could catch fire**

NOTICE

Never touch the crucible with your fingers. Always use clean tongs.

WARNING

Eye damage

The eye can be exposed to higher amounts of IR radiation

- Crucibles exit the furnace in a hot state, thus emiting IR radiation
- **Do not look onto the crucibles for longer periods of time**
- **If monitoring of the crucibles is necessary, wear suitable IR blocking glasses**

WARNING

W5.0019

Hand injury

Putting your hand into the closing furnace.

- Accidental contact with the moving furnace can lead to hand injuries, e.g. crushing of fingers.
- **Never reach into the moving furnace.**

With the CS-580A (Helios), a wide variety of materials can be analyzed. The analysis methods are therefore diverse. As different materials burn differently, the chosen sample weight, the possible accelerators and the sensitivity of the infrared cells will all be different. The user of the device can receive from us free advice regarding the different methods involved for different materials.

In the following, the procedures are described for the analysis of coal samples.

Before starting making analyses ensure the following:

- The temperature of the analyzer is stable (at least one to two hours on setting 1).
- The moisture traps are checked and, if necessary, the magnesium perchlorate is replaced. See chapter “Moisture trap replacing furnace“.
- The incoming oxygen supply has a pressure of 2-4 bar (30 to 60 psi).
- The furnace has reached its operating temperature. See chapter “Temperature adjustment“.
- The mains switch is set to position 3 for at least 10 to 15 minutes.
- The software is started on the connected PC.
- The crucible disposable bin is empty before starting the autoloader operation.

6.1.1 Procedure of carrying out analyses with autoloader, optional

WARNING

Fire hazard when disposing the crucibles/ Risk of burns while touching or moving the crucible container

Hot parts (crucibles, the container itself) can fall down

- Ignition of tables, floors, or any other surface the hot part falls on
- Ignition of clothes and any other material

- **Always wear suitable clothing and gloves when handling the container**
- **Always make sure that the disposal vessel is clear of any combustible material and that the vessel itself can withstand the temperatures introduced by the hot crucibles**
- **If possible, allow the crucible container and its contents to cool to room temperature before emptying it, or take appropriate precautions to dispose of hot crucibles properly.**

1. Place an empty crucible on the balance.
2. Tare the balance using the “Tare” button, located on the balance, or “F6-Tare” button in the “Analysis control” window of the software (F6 on the PC-keyboard).
3. Put about 250 mg coal sample into the crucible.
4. Press the “F4-Balance” button in the ”Analysis control” window of the software (or F4 on the PC-keyboard) to transfer the weight value from the balance to the PC. The transfer function is performed regardless how often the button is pressed. This enables a correction of any falsely entered weight.
5. Enter the sample ID into the corresponding input field of the “Analysis control” window of the software. This step is optional. If no sample ID is required, the entry may be omitted.
6. Press the “F7-Add” button in the “Loader” window. The sample weight and sample ID are transferred to the loader stack and memorized there.
7. Take the crucible from the balance and put it on the loader, on the first tray before the pick-up position.
8. Mark the “F8-Run/Stop” checkbox to start the analysis.

The analysis procedure begins. From now on, no operator intervention is required. The furnace is opened automatically, the crucible of the previous analysis is picked up from the pedestal and disposed, and the crucible is taken from the loader and put on the pedestal for analysis. The furnace closes. At the end of analysis, the results are displayed on the PC-screen and saved in the database of the software.
A series of analyses can be run with the CS-580A (Helios) analyzer. To do this, repeat steps 1 to 7 for every sample in the series, while each crucible is placed as next after the last one placed on the loader. This can be done at any time, with or without running analyses.
When putting the samples on the loader, the order of positioning the crucibles on the trays must be respected, i.e. the crucibles must be placed on the loader exactly in the same order in which they are weighed and memorized in the loader stack. It is allowed to leave one or more empty trays on the loader, for example in order to separate groups of crucibles carrying the same sample material or a calibration standard etc.

6.1.2 Procedure of carrying out analyses with manual loading of the sample

WARNING

Fire hazard when handling the crucibles
Hot crucibles can fall down

- Ignition of tables, floors, or any other surface the hot part falls on
- Ignition of clothes and any other material
- **Always use tongs to handle crucibles**
- **Always make sure that the disposal vessel is clear of any combustible material and that the vessel itself can withstand the temperatures introduced by the hot crucibles**
- **If possible, let the crucibles cool down to room temperature before disposing them.**

Although the CS-580A (Helios) is equipped with an autoloader and normally analyses are carried out using this autoloader, it is possible to load the sample manually for analysis.

- Place an empty crucible on the balance.
- Tare the balance using the “F6-Tare” button located on the balance, or the “Tare” button in the “Analysis control” window of the software (F6 on the PC-keyboard).
- Put around 250 mg of coal sample into the crucible.
- Press the “F4-Balance” button in the ”Analysis control” window of the software (F4 on the PC-keyboard) to transfer the weight value from the balance to the PC. The transfer function is performed regardless of how often the button is pressed. This enables a correction of any falsely entered weight.
- Enter the sample ID into the corresponding input field of the “Analysis control” window of the software. This step is optional. If no sample ID is required, the entry may be omitted.
- Press the “F2-Furnace” button to open the furnace (if it is closed).
- Take the crucible from the balance and put it on the pedestal.
- Press the “F5-Start” button to begin the analysis.

From now on, no further operator intervention is required. The furnace closes and the analysis is carried out automatically. At the end of each analysis, the results are displayed on the PC-display and saved in the database of the software.

Remarks

The sulfur range should be deactivated when only carbon is required. This avoids undue delays of the analysis caused by sulfur compounds which are difficult to burn, like it is in case of cement analysis. Accelerators are also not necessary.

6.2 TIC-determination (optional)

W6.0022

WARNING

Burning of the skin, eyes and respiratory system.

Corrosive substances:

- Corrosive substances can cause burning of the skin, eyes and respiratory system.
- **Refer to the material safety data sheet for the substance being used.**
- **Always wear suitable clothing, including protective gloves and eye protection.**

C4.0076

CAUTION

Scalding/burns
Hot furnace / combustion tube / analyzer parts

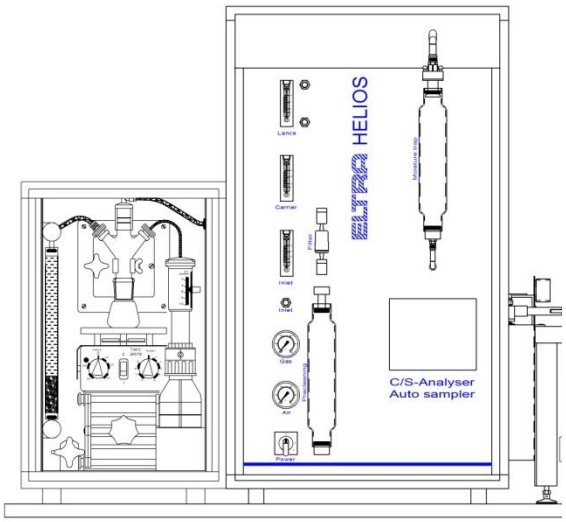
- Parts of the analyzer can be very hot.
- **Use heat protecting gloves.**

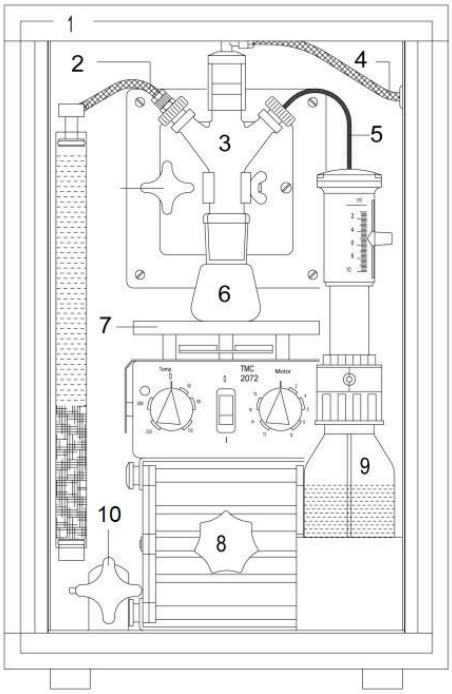
6.2.1 TIC-module

Due to the modular design of the CS-580 (Helios), the analyzer can be upgraded by a module for Total Inorganic Carbon (TIC) without further modification. For the TIC determination, the sample is treated with acid in the TIC module.

6.2.2 TIC analysis

The sample is treated with acid in an Erlenmeyer flask inside the TIC-module. The acid decomposes the carbonates in the sample, creating CO2. The oxygen flow purges the CO2 out of the flask through the gas flow system to the infrared detector.

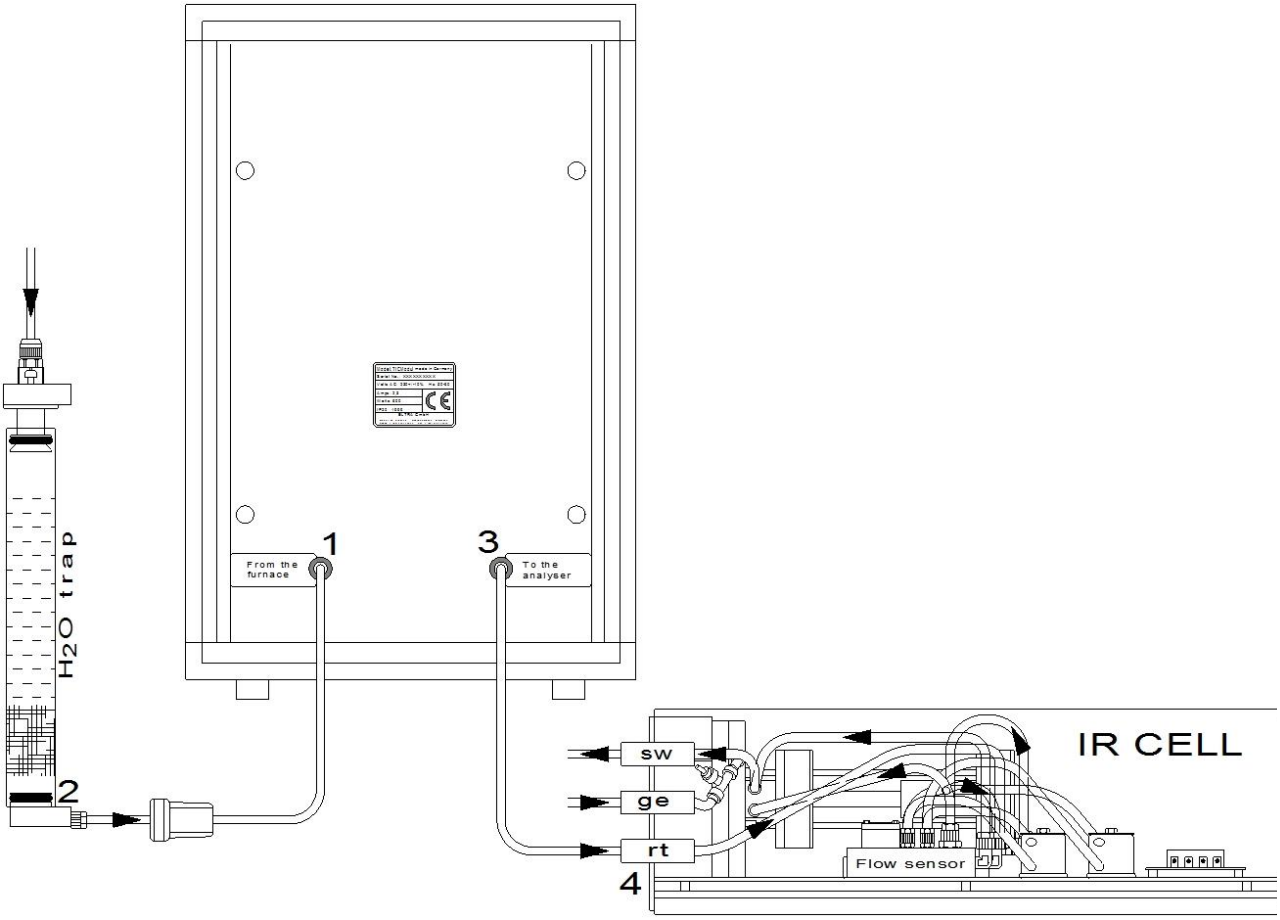




1	TIC module
2	CO2 outlet
3	Glass distributor
4	Connection to the furnace
5	Acid supply
6	50 ml glass flask
7	Heater with magnetic stirrer
8	Elevator with variable height
9	Glass flask with acid
10	TIC/TC toggle switch

6.2.3 TIC-module installation

1. The TIC module is placed next to the analyzer.
2. Connect the mains power plug to a power socket.
3. Connect the TIC module and the analyzer with the provided tubes. The connectors are located at the backside of the analyzer and of the TIC-module.
4. The outlet of the furnace is connected via the H_2O trap to the connection (**2**) and finally to the inlet (**1**) of the TIC module.
5. Inside the TIC module, this tube is connected to the input of the glass distributor (**3**) (connection on top tube 4).
6. The bottle of acid with dispenser (**9**) is placed to the right of the platform (**8**) and it is connected to the connection (**5**) of the glass distributor.
7. The glass distributor (**3**) with the glass flask (**6**) is adjusted properly when the whole surface of the bottom of the glass flask (**6**) touches the surface of the heater (**7**).
8. The heater (**7**) is switched on and the temperature is set to 75°C.
9. The stirrer is set to 400.



6.2.4 TIC-module Operation procedure

1. Place the empty glass flask (**6**) on the balance.
2. Press tare.
3. Put the sample into the flask and enter the weight into the analyzer (F4- button).
4. Place a magnetic stirrer into the flask and attach the flask to the distributor (**3**).
5. Raise the adjustable platform to support the flask. Check, and if necessary, readjust the flask so that its bottom lies flat on the heated platform.
6. Switch to TIC-mode with the TIC/TC toggle (13).
7. Start analysis (F5 or click START).
8. Inject acid in two or three doses, when the word “Analyzing” appears.
9. When all the CO2 has been released from the sample, the analyzer's signal will return to the baseline level and the analysis will be terminated.
10. switch to TC-mode with the TIC/TC toggle (13).

NOTICE

The rotary speed of the stirrer should be kept low. The rotary speed and the acid dosing should be done in a way to avoid sample particles being pushed up and stick on the inner glass surface.

The heater must be switched on. Do not allow boiling or evaporation of the solution in the flask!

The table below shows approximate sample weight and acid volume depending on the expected TIC content in the sample.

TIC-content	**Sample weight**	**Acid**
>5 %	100 - 200 mg	2×2 ml
1-5 %	200 - 500 mg	3×2 ml
<1 %	1000 - 2000 mg	3×3 ml

Used Acids:

Acetic acid 25% concentration or Phosphoric acid 50% concentration.

NOTICE

Only the carbon of easily decomposable carbonates can be determined. Carbonates which are difficult to decompose cannot be measured. For example, elementary carbon (graphite, soot) and cyanides cannot be analyzed.

6.3 Applications

D7.0006

DANGER

Danger caused by scalding by samples
Sample material
- – Damage to the respiratory tracts, skin and/or mucous membranes.
- – Radiation damage.
- **The user must himself assess the risk emanating from a sample during the analysis.**

D8.0006

DANGER

Toxic atmosphere
Sample material
- – Acute poisoning by gases from combustion.
- **The user must himself assess the risk emanating from a sample during the analysis.**
- **The analyser must be connected to a exhaust system.**
- **The exhaust system must be in operation.**

This chapter describes the operation modes for analysis of different sample materials. For further materials contact the manufacturer.
NOTICE
The maximum weights of the samples should not be exceeded!

6.3.1 Coal

Temperature	1350°C
Weight	300mg-500mg (Depending on the sensitivity of the IR cell and on the C- and S-content of the sample.)

6.3.2 Calcium Carbonate

NOTICE
Calcium carbonate can be used for calibration in the range of 12% C.

Temperature	higher than 1000 °C
Weight	100mg-500mg (Depending on the sensitivity of the IR-cell.)

6.3.3 Graphite

NOTICE
Analysers with a range of 100% C can be calibrated with graphite.

Temperature	higher than 1000 °C
Weight:	250mg

6.3.4 Limestone

NOTICE
Calibrate analyser with calcium carbonate of 12% C.

Temperature	1250 °C or higher.
Weight	300mg

6.3.5 Oil, Asphalt and Rubber

Temperature	1450 °C
Weight	80mg-100mg (fuel oil and other thick oils). Up to 50mg (thin oil analysis)

6.3.6 Wood

Temperature	1300 °C
Weight:	350mg

Set the minimum analysis time to 50s. Set the comparator level to 20mV.

7 Maintenance

WARNING

V0074

Scalding/burns
Hot furnace / combustion tube / analyzer parts

– Parts of the analyzer can be very hot.

- **Check the furnace temperature in the software.**
- **For maintenance the furnace temperature has to be less than 40°C.**

7.1 General information

– Replace the magnesium perchlorate of the moisture trap of the furnace after 150 analyses. See chapter “Front panel illustration” and “Filling the reagent tubes”.

– The content of the oxygen pre-cleaning glass tube on the analyzer’s front panel, see chapter ”Front panel illustration” , should be replaced every 300 analyses. The depleting of these chemicals depends on the purity of the carrier gas used.

NOTICE
Pay attention to the condition of the chemicals used and the cleanliness of the analyzer. Inadequately maintained chemicals and e.g. Dirty ceramic tubes can make a significant contribution to variations in C / S determination.

The following chemicals are used:

– Magnesium perchlorate (anhydrone) as moisture absorber

– Sodium hydroxide (ascarite) as CO2 absorber

The chemicals are replaced when they are saturated.
Please refer to the following schematics to identify the glass tubes on the analyzer. In addition to the reagents in the glass tube, fill the bottom end of the tube with glass wool. One should pay attention that the glass wool should be only as thick as necessary, otherwise the gas flow can be choked. Under no conditions should the amount of glass wool be less than that shown in the following schematics, otherwise fine particles of magnesium perchlorate can pass through the glass wool layer blocking the hole of the fitting underneath.
It should be pointed out that magnesium perchlorate is a very strong oxidizing material.
At both ends of the glass tube, you should leave sufficient space for the gas connections to be fitted. The free space at the tube ends serve as sealing space. They must be cleaned after filling. The O-rings must be cleaned. Both the O-rings as well as the sealing areas of the tube must be greased with high vacuum silicon grease. This will be easier to assemble or disassemble and further it improves the sealing of the glass tubes.
Make sure that the O-rings are completely sealed around the glass tubes, by looking at the imprint of the O-ring on the inner surface of the glass tube. Check whether there are fibers of glass wool trapped between O-ring and glass tube. This causes leakages.
The O-rings are only replaced when they can no longer adequately seal, due to a damage or age. When removing the old O-rings, be ensure that the sealing areas of the fittings are not damaged.

NOTICE
When replacing O-rings, never grease the new O-rings before installation. Otherwise, the O-rings will turn with the glass tube when trying to remove it.

7.2 Cleaning

WARNING W13.0029

Danger to life through electric shock
Cleaning with water

- An electric shock can cause burns, cardiac arrhythmia, respiratory arrest, as well as cardiac arrest.
- **The power cable must be unplugged before cleaning the device.**
- **Use a cloth dampened with water for cleaning.**

NOTICE N8.0077

Damage to the housing
Use of organic solvents

- Organic solvents may damage the coating.
- **The use of organic solvents for cleaning the housing is permitted.**

7.3 Reagent tubes filling

7.3.1 Reagent tube replacing

C5.0076

CAUTION

Scalding/burns
Hot furnace / combustion tube / analyzer parts

– Parts of the analyzer can be very hot.
- **Use heat protecting gloves.**

CAUTION

V0062

Injuries in the form of cuts and other personal injuries
Danger from glass splitters

– Injuries in the form of cuts can be caused by damaged sample flasks and glass splitters.
- **Replace damaged sample flasks**
- **Do not touch glass splitters with your hands**.

C6.0081

CAUTION

Danger of bursting

– Defective reagent tubes may cause injuries in the form of cuts and other personal injuries.
- **Before installing the new reagent tubes, check if they are damaged.**
- **Wear protective gloves and safety glasses when installing/removing the reagent tubes.**

W7.0017

DANGER

Danger of toxication and personal injuries

– Some chemicals may cause a fatal toxication or dangerous skin corrosion.
- **Refer to the material safety data sheet of the used substances.**
- **Always wear the necessary personal protection equipment**
- **Never eat or drink close to the chemical substances.**

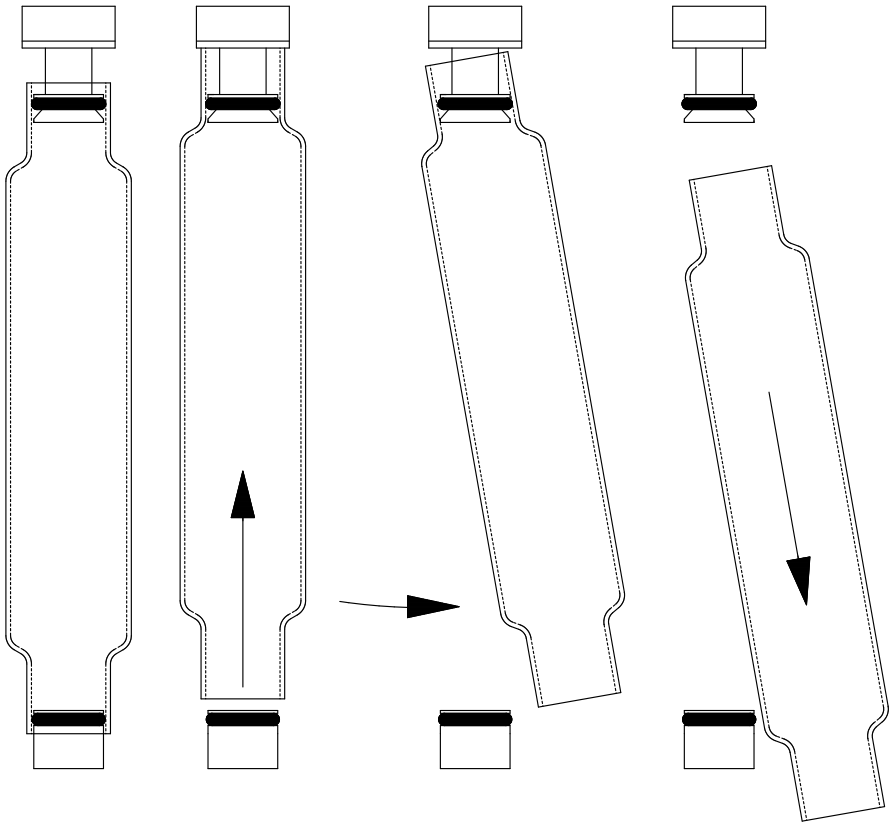


Fig. 1: Installing the reagent tubes

The reagent tubes are first lifted and then swung to one side, detached diagonally downwards and emptied.

Remark

The dimensions for filling the glass tubes given in the schematics of chapter ”Reagent tubes filling” should be respected in all cases.

When, for example, there is a rest of quartz wool in the bottom of the glass tube, it is possible that dust, forming magnesium perchlorate can fall through and block the fitting below or this can damage the analyser and the infrared cell.

Remark

Before the reagent tubes are fitted, both, the O-rings and the inner ends of the tubes are lubricated with high vacuum silicon grease.

The components are refitted in reverse order.

NOTICE

The dimensions for filling the glass tubes should be respected in all cases to secure proper analyzing and to avoid any damages of the device (see chapter filling quantities). When there is not enough glass wool in the lower end of the glass tube, it is possible that dust of magnesium perchlorate can fall through and block the fitting below. This can damage the analyzer and the infrared cell.

Also with the right hand glass tube (moisture trap after the furnace outlet), one must pay special attention that enough magnesium perchlorate is available. Otherwise, water vapor can condense on the inside free glass wall before it reaches the magnesium perchlorate.

NOTICE

Before the reagent tubes are fitted, the O-rings and the inner ends of the tubes should be lubricated with high vacuum silicon grease.

7.3.2 Filling quantities

CAUTION

C7.0076

Scalding/burns
Hot furnace / combustion tube / analyzer parts

- Parts of the analyzer can be very hot.
- **Use heat protecting gloves.**

CAUTION

C8.0090

Risk of injury to eyes
Chemicals

- When changing the chemicals, the smallest particles of chemicals may be suspended in the air and cause damage to eyes.
- **Always wear protective goggles when working with chemicals.**
- **Please heed the safety data sheets for the chemicals used.**

DANGER

W8.0017

Danger of toxication and personal injuries

- Some chemicals may cause a fatal toxication or dangerous skin corrosion.
- **Refer to the material safety data sheet of the used substances.**
- **Always wear the necessary personal protection equipment**
- **Never eat or drink close to the chemical substances.**

NOTICE

Please comply with the safety data sheets and local regulations when handling the chemicals

NOTICE

Only use the chemicals sold by ELTRA. Other qualities may, despite the same brand name, lead to fluctuating measurement readings and damage to the analyzer.

CAUTION

C19.0091

Chemicals / sample material spurting out
Excess pressure in the system

- **No change of reagents may take place during the leak test or analysis.**

As different samples can contain different amounts of moisture, it is hard to give a precise number of analyses that can be made before the content of the reagent tubes should be replaced.
A regular check of the reagents is essential to secure a failure free operation of the analyzer.
The moisture stems from the combustion and has two sources. One source is the water content of the sample. By drying the sample in a furnace at about 80 °C, the moisture content can be reduced. The sample is laid in a fairly flat bowl and should be spread as thin as possible. The drying process takes some hours.
The second source is the hydrogen content of the sample itself, available in various hydrogen compounds.

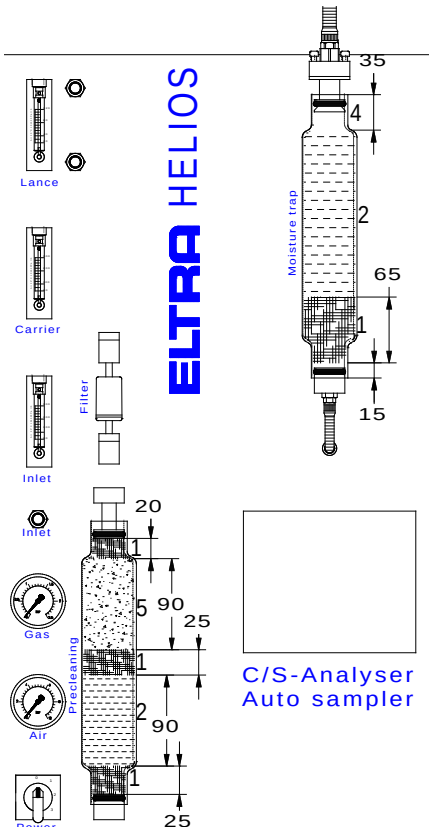
The following chemicals are used

Magnesium perchlorate (Anhydrone)	as moisture absorber
Sodium hydroxide	as CO2 absorber

The reagent tubes have to be replaced when they are saturated. If the absorber particles do not move when tapping on the glass, it is a sign that the magnesium perchlorate is saturated. It is essential to change the absorber before it is completely solid. The sodium hydroxide changes its color after being saturated (it turns to light grey).

Please refer to chapter front panel illustration to identify the glass tubes on the analyzer.
Before filling the reagents into the glass tubes, their lower end has to be stuffed using glass wool. One should pay attention that the layer of glass wool should be pressed only as strongly as necessary, otherwise the flow of gas could be choked. Under no conditions the amount of glass wool should be less than that given in the following schematics, as fine particles of magnesium perchlorate could penetrate the glass wool and accumulate at the bottom of the tube blocking the fitting and building deposits in tubes and in the Infrared cell paths.
At both ends of the glass tube, you should leave sufficient space for the gas connections to be fitted. The free spaces at the tube ends serve as sealing areas. They must be cleaned and greased after filling.

Both, the O-rings as well as the sealing areas of the tube are to be greased with high vacuum silicon grease. This enables easy reassembling as well as later removing. In addition, greasing improves the sealing of the tubes to the O-rings. Only the upper end of the right hand glass tube (moisture trap) and the corresponding O-ring should not be greased.
Make sure that the O-rings are completely sealed around the glass tubes!



Filling quantities allow tolerances of about ± 20 %.

	Filling	Ordering number
1	Glass wool	90331
2	Magnesiumperchlorat (Anhydrone)	90200
4	Empty	
5	Sodium hydroxide	90210

7.4 Moisture trap replacing (furnace)

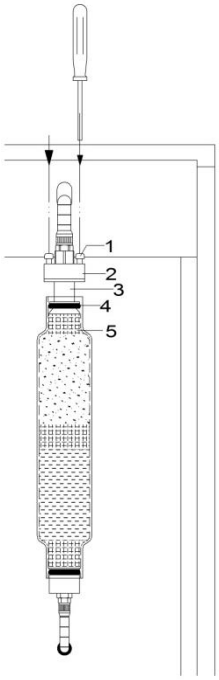
CAUTION

C9.0076

Scalding/burns

Hot furnace / combustion tube / analyzer parts

- Parts of the analyzer can be very hot.
- **Use heat protecting gloves.**



1. Turn both screws (**1**) counter clockwise, until the ring (**3**) touches the part (**2**).
2. Lift the glass tube (**5**) upwards, tilt it to the side and pull downwards.
3. Replace the magnesium perchlorate (Anhydrone). See chapter reagent tube replacing
4. Install the glass tube (**5**) in reverse order after greasing the lower O-ring.
5. Turn both screws (**1**) clockwise until the O-ring (**4**) is properly pressed on the inner surface of the glass tube (**5**).

Remark

The O-ring imprint on the whole circle length of the glass tube should be of about 2 mm width.

7.5 O-rings replacement

CAUTION

C10.0076

Scalding/burns
Hot furnace / combustion tube / analyzer parts

– Parts of the analyzer can be very hot.
- **Use heat protecting gloves.**

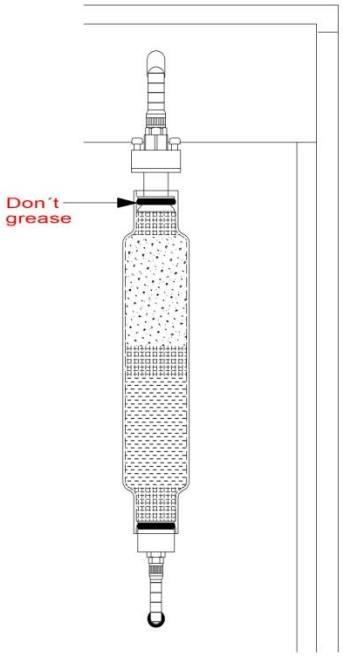
CAUTION

V0062

Injuries in the form of cuts and other personal injuries
Danger from glass splitters

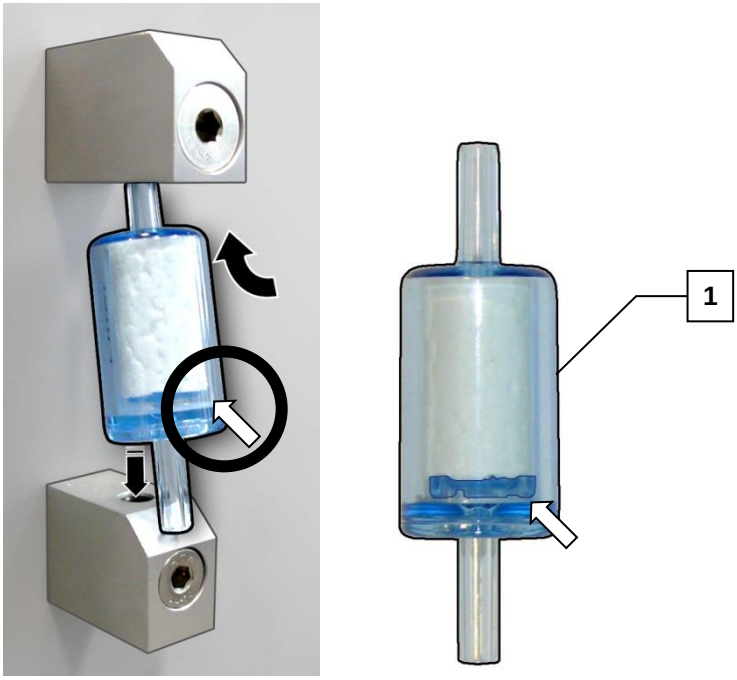
– Injuries in the form of cuts can be caused by damaged sample flasks and glass splitters.
- **Replace damaged sample flasks**
- **Do not touch glass splitters with your hands**.

The O-rings are only replaced when they no longer adequately seal, due to severe damage or aging. When removing the old O-rings, be sure that the sealing area of the fittings is not damaged. Grooves where the old O-rings are installed must be cleaned to be completely free of grease.
New O-rings should under no circumstances be greased before installing but only after installation. Otherwise, the O-rings would turn with the glass tubes when trying to remove them at a later stage.
It is recommended not to grease the upper O-ring of the moisture trap.



7.6 Dust filter cartridge replacing

The dust filter cartridge filters smallest dust particles from the combustion gases. Its saturation depends on the sample material and its combustion characteristics. The filtering material of a new cartridge is white. Replace the dust filter cartridge when the filtering material shows coloration, or at least every 500 analysis.



1. Lift the dust filter cartridge (**1**) upwards.
2. Tilt its low end to the front and pull downwards.
3. Install a new cartridge by acting in reverse order.

Take care for the cartridge body to have the smaller diameter up and the bigger down.

7.7 Combustion tube replacement

D9.0005

DANGER

Mortal danger from electric shock

Exposed power contacts - High Voltage

- An electric shock can cause injuries in the form of burns and cardiac arrhythmia, respiratory arrest or cardiac arrest.
- **Set the mains switch of the analyzer to position 0 and pull the mains plug of the mains socket.**

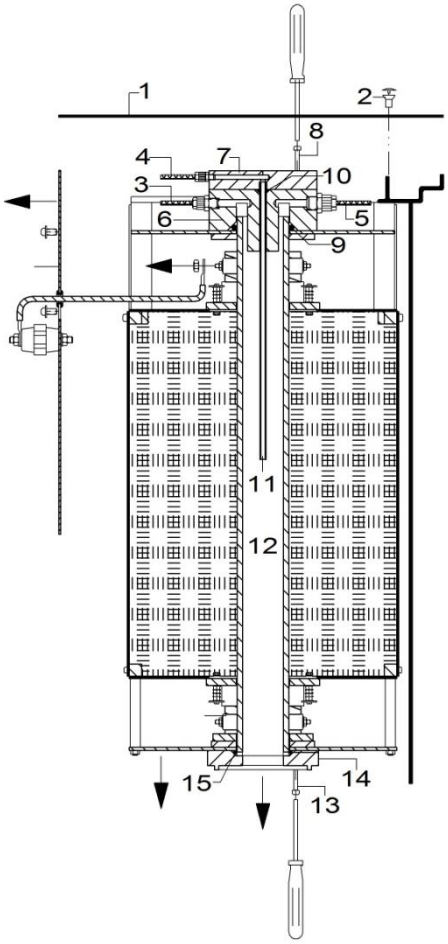
C11.0076

CAUTION

Scalding/burns

Hot furnace / combustion tube / analyzer parts

- Parts of the analyzer can be very hot.
- **Wait before start working until the analyzer is cooled down.**



- Switch off the analyzer and disconnect the power plug.
- Remove the cover panel (1) of the cabinet. Unscrew 4 screws (2) on top.
- Remove the tubes (3), (4) and (5) from the upper furnace closure assembly (6/7).
- Remove the 4 screws (8) which hold the assembly (6/7) on the furnace. The 4 screws and nuts holding the disk (7) on the part (6) should remain in place.
- Lift the upper furnace closure. The assembly consisting of the parts (6), (7), (9), (10) and (11) is then taken out of the furnace. Take care to lift it in straight vertical direction to avoid collision of the lance (11) with the combustion tube (12). If the assembly is not free to be easily lifted, slightly tilt it carefully in different directions until it becomes free.
- Unscrew the 4 screws (13) by holding the ring (14) to prevent the combustion tube (12) from falling down.
- Remove the ring (14).
- Remove the O-ring (15). If this O-ring and the combustion tube remained in the furnace after lifting the assembly (6/7), take care to prevent the combustion tube from falling down out of the furnace. This can be done by keeping one hand underneath the furnace or by supporting the ring (14) with two manually driven screws (13).
- Lift the combustion tube (12) out of the furnace top. Lift it in straight vertical direction to avoid collision with the heating elements.
- Place a new O-ring (9) on a new combustion tube (12).
- Reinstall in reverse order.

NOTICE

Enter the new combustion tube very carefully in straight vertical direction to avoid collision with the heating elements.

7.8 Lance replacing

DANGER D10.0005

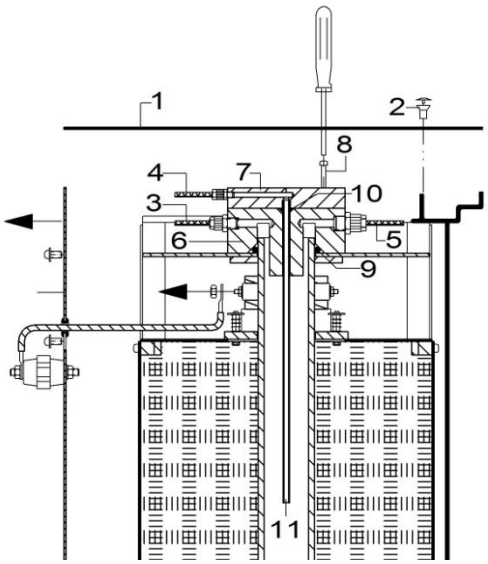
Mortal danger from electric shock
Exposed power contacts - High Voltage

- An electric shock can cause injuries in the form of burns and cardiac arrhythmia, respiratory arrest or cardiac arrest.
- **Set the mains switch of the analyzer to position 0 and pull the mains plug of the mains socket.**

CAUTION C12.0076

Scalding/burns
Hot furnace / combustion tube / analyzer parts

- Parts of the analyzer can be very hot.
- **Wait before start working until the analyzer is cooled down.**



- Switch off the analyzer and disconnect the power plug.
- Remove the cover panel (1) of the cabinet. Unscrew 4 screws (2) on top.
- Remove the tubes (3), (4) and (5) from the upper furnace closure assembly (6/7).
- Remove the 4 screws (8) which hold the assembly (6/7) on the furnace.
- Lift the assembly (6/7) in straight vertical direction.
- Unscrew the four screws and nuts which hold the parts (6) and (7) together.
- Replace the lance (11)
- Replace the O-ring (10)
- Replace the O-ring (9)
- Do reassembling in reverse order

7.9 Heating elements replacing

D11.0005

DANGER

Mortal danger from electric shock while replacing/installing the heating elements

Exposed power contacts - High Voltage

- An electric shock can cause injuries in the form of burns and cardiac arrhythmia, respiratory arrest or cardiac arrest.
- **Set the mains switch of the analyzer to position 0 and pull the mains plug of the mains socket.**
- **The task of inserting/replacing the heating elements may only be performed by a trained electrician or Eltra service personnel**

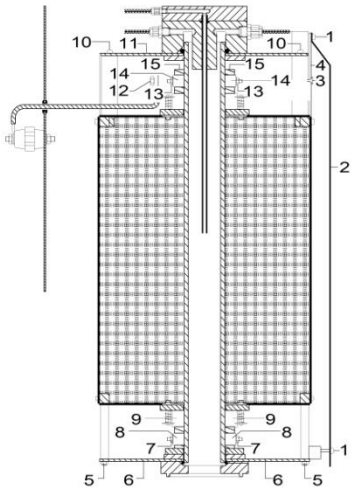
C13.0076

CAUTION

Scalding/burns

Hot furnace / combustion tube / analyzer parts

- Parts of the analyzer can be very hot.
- **Wait before start working until the analyzer is cooled down.**



- Switch off the analyzer and disconnect the power plug.
- Remove the combustion tube. See chapter “Combustion tube replacing”
- Remove the two screws (1) fixing the right hand side panel (2) of the analyzer’s cabinet.
- Slightly tilt the panel to the right and carefully lift it. The loader should not be shifted otherwise it will lose its mechanical adjustment.
- Unscrew the two screws (3) and remove the heat shield (4).
- Unscrew the four nuts (5) and remove the panel (6).
- Loose the four nuts (7) and remove the two double clamps (8).
- Remove the four ceramic spacers (9).
- Apply the panel (6) in its original place and manually fix it with two nuts (5) diagonally to prevent it from falling down.
- Unscrew the four screws (10) and remove the panel (11).
- Remove the two nuts (12)
- Loose the four nuts (13) and remove the two double clamps (14).
- Pull up the four heating elements (15)
- Reinstall in reverse order using new heating elements.

Remark

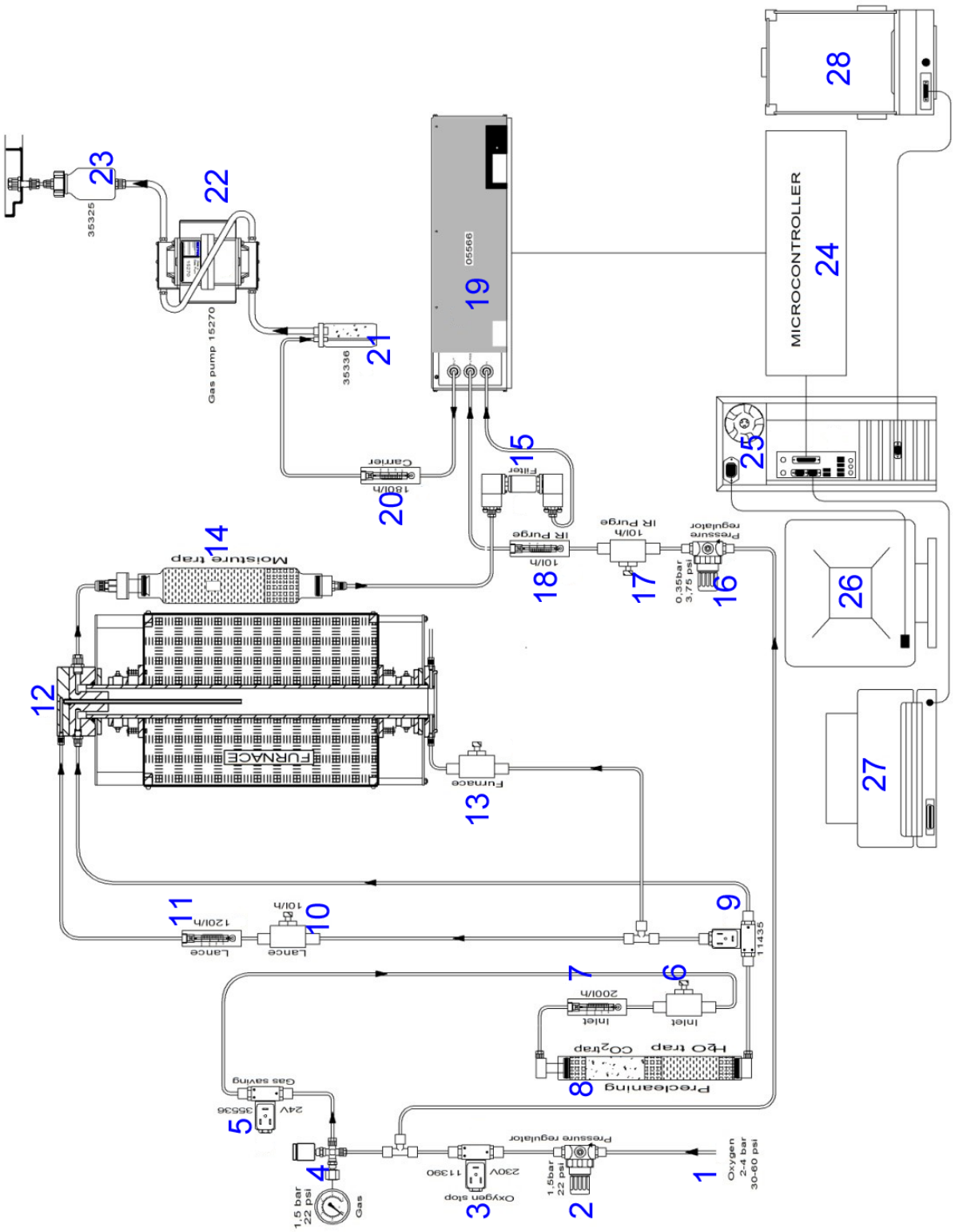
Install the clamps (14) in a position which allows the heating elements to move at least 5 mm in vertical (axial) direction. Insert the thermocouple deep enough, to touch the combustion tube and fix it with the spring.

8 Function description

8.1 Measuring principle

The measuring method is based on the principle of sample combustion and the analysis of the combustion gases, using infrared absorption.
A wide variety of sample materials in various forms is possible, like powders, grains, chips, solid pieces and also some materials in liquid form. Typical materials are coal, ashes, steel, cement, soil samples, rubber, oil etc.
During combustion, the sulphur and carbon components present in the sample are oxidized to form SO_2 and CO_2. Typical combustion temperature is 1350°C.
Combustion is obtained by supplying oxygen which at the same time acts as carrier gas. An electronic flow controller keeps the flow quantity at a constant level of 180 l/h.
Dust traps and a moisture absorber ensure that a dry, dust free gas mixture is supplied to the infrared cells.
The graphical representation of the detectors' signals (peaks) is shown on the PC's screen during and after analysis. At the end of analysis the results are displayed as well. All analyses data for every finished analysis are saved in the PC and remain available for review, results recalculation, calibration, etc. and they can be printed out on a printer or exported to another software, if necessary.

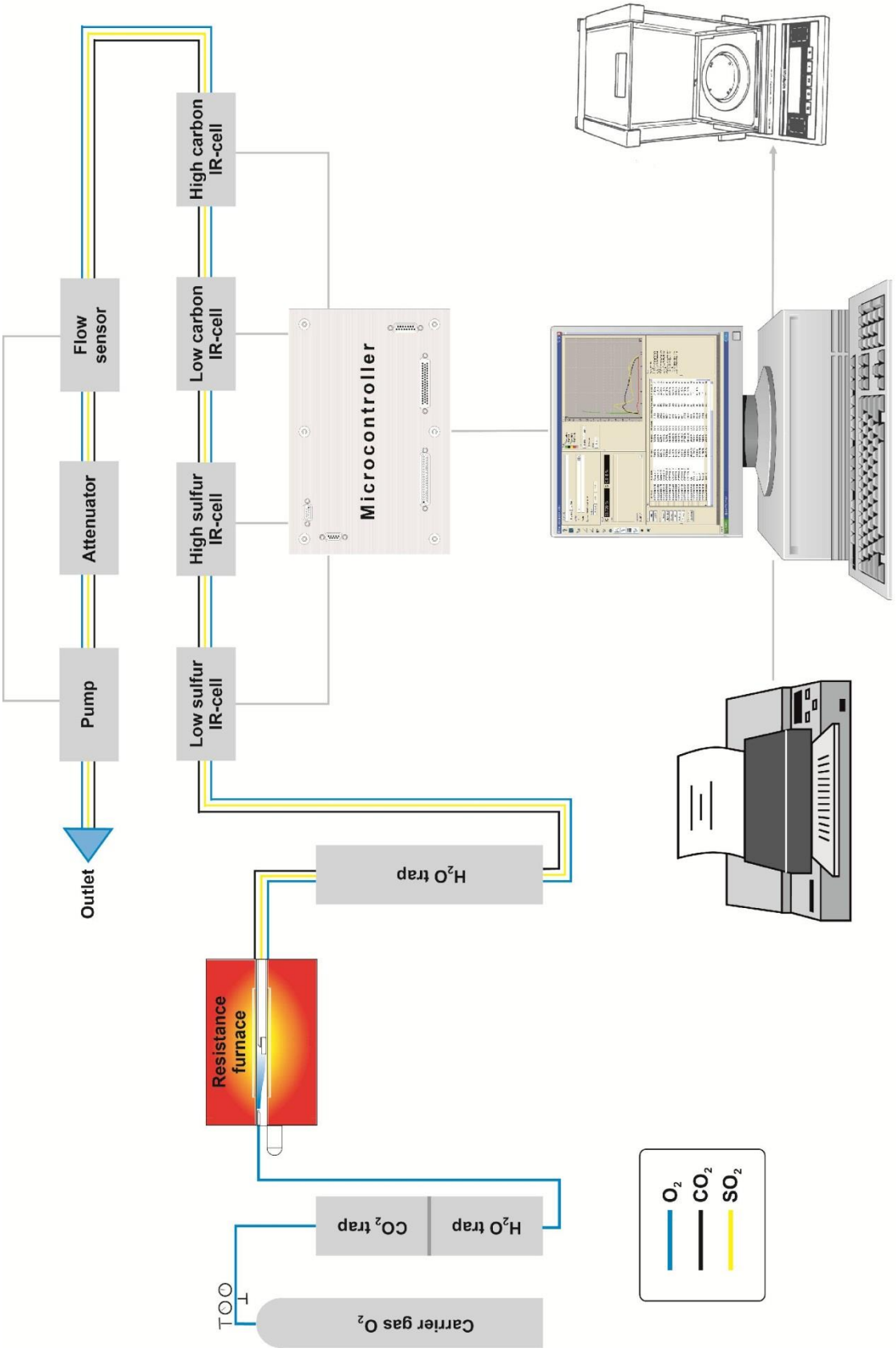
8.2 Gas flow system



1	Carrier gas inlet	**15**	Dust filter cartridge
2	Pressure regulator	**16**	Pressure regulator
3	Oxygen stop valve (power switch control)	**17**	Flow adjustment restrictor
4	Pressure switch and pressure gauge	**18**	Gas flow meter
5	Oxygen stop valve (software controlled)	**19**	Infrared cell
6	Flow adjustment restrictor	**20**	Gas flow meter
7	Carrier gas flow meter	**21**	Attenuator before the pump
8	Gas pre-cleaning unit	**22**	Gas flow pump
9	Oxygen diverting valve	**23**	Attenuator after the pump
10	Flow adjustment restrictor	**24**	Microcontroller
11	Gas flow meter	**25**	Computer
12	Upper furnace closure assembly	**26**	Monitor
13	Flow adjustment restrictor	**27**	Printer
14	Moisture trap	**28**	Balance

The analyzer is operated with pure oxygen. A purity of 99.5% is sufficient. It is normally available in steel bottles. CO2 and H2O impurities in the oxygen are trapped in the trap (8). The upper half of the trap is filled with CO2 absorber and the lower half with moisture absorber. Magnesium perchlorate (anhydrone) acts as a H2O absorber.
Sodium hydroxide acts as CO2 absorber, preferably with an indicator, so that the degree of saturation can be seen from the coloration.
The oxygen inlet pressure should be 2 to 4 bar, which is then regulated inside the analyzer to 1.5bar, as shown on the pressure gauge (4). Any pressure fluctuation of the external oxygen supply has no influence on the accuracy of the measurements.
A pressure switch (4) becomes conductive at around 1 bar (15 psi). This information is passed to the software which energizes the valve (5) and starts the gas pump (22) as long as the pressure is higher than 1 bar. This ensures that the pump runs only when sufficient pressure of oxygen is available, so that no air enters the gas flow system, if there is no input oxygen pressure.
With the help of the adjustable restrictor (6) the inlet flow is set at a level of at least 200 l/h. The flow rate is shown on the lower flow meter (7) on the front panel. This flow rate enters the furnace. During analysis when the furnace is closed, the inlet flow rate is split. One part enters the furnace top to exit the lance over the crucible. This flow is shown on the middle flow meter (11). The rest of the oxygen flow enters the furnace at the low end. The ratio of the two flows can be adjusted with the restrictors (10) and (13).See chapter ”Adjusting gas flow”.
The flow at the outlet of the furnace is created by a pump (22) at the end of the gas flow system, which sucks a flow of 180L/h out of the furnace.
A tube connects the furnace outlet with the moisture trap (14). The gases that come out of the furnace normally contain some moisture. This particularly happens when analyzing coal samples. The dried gases pass thru the dust filter (15) and then enter the Infrared cells which are accommodated in the cell module (19), where the measurements of CO2 and SO2 take place.

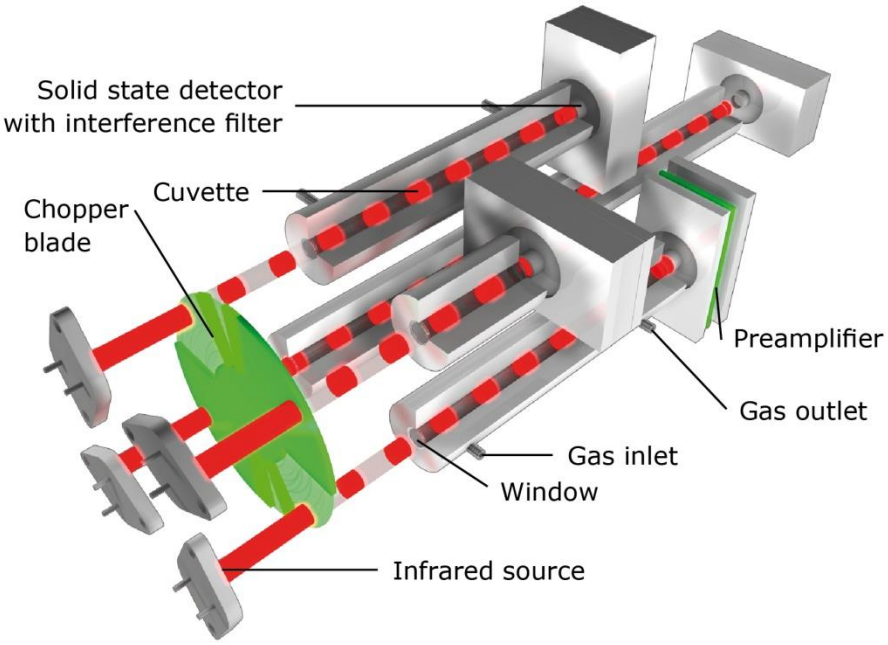
The gas flow through the cells is shown on the upper flow meter (20) on the front side of the analyzer. The displayed value must be at constant 180 l/h. The attenuator (21) makes the pulsing flow of the pump (22) smooth. The flask (23) is a silencer for the pump exhaust.



8.3 Infrared cell

The measuring principle is based on the infrared radiation absorbing properties of many gases. Each of these gases absorbs specific characteristic spectral wavelengths of infrared radiation. The absorption spectrum is determined by the number, configuration and type of the atoms in the gas molecules.

Graphic: Infrared cells with flexible measuring range



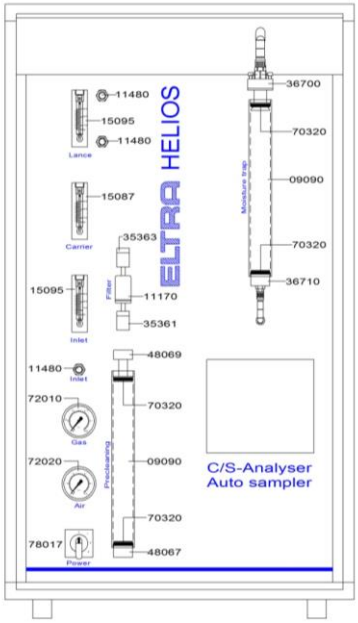
An infrared source is electrically heated emitting wide band infrared radiation. The radiation beam is interrupted by a rotating chopper blade, resulting in alternating light. The rotary speed of the chopper is crystal controlled, so that the chopper frequency is very stable. The infrared radiation then passes through the measuring IR-paths, through which a mixture of combustion gases and carrier gas flows.
Depending on the composition of the gas mixture, certain frequencies of the infrared spectrum are absorbed. The rate of absorption depends on the concentration of the gases.
As the infrared beam leaves the IR-path, it passes through an infrared filter, which allows only a certain narrow band infrared radiation to pass. This narrow band must correspond to the IR wavelength for which the gas to be detected has its maximum absorption capability.
The intensity of the radiation after the filter thus corresponds to the concentration of a specific gas in the path. The beam finally strikes a solid state infrared sensor, giving an electrical signal corresponding to the intensity of the beam.
As the beam is interrupted by the rotating chopper, the detector receives an alternating radiation creating an AC electrical signal. Temperature and aging influences of the detector, as well as noise are thereby strongly reduced. The signal obtained is amplified, rectified and passed thru a low pass filter so that it leaves the infrared cell as a DC voltage.
The infrared cells utilize solid state sensors combined with infrared filters.
The lengths of all four cells can be individually optimised to obtain maximum precision for the target analysis levels of each customer. Each of the cells can be installed with infrared absorption lengths ranging from 1mm to 320mm. The infrared cell rack is temperature controlled so that the sample gas flowing through it is kept at a constant temperature.

8.4 Micro-controller unit and PC Software

The microcontroller unit (MCU) contains all components for signal processing and control sequencing. It is working under the control of the PC software, collecting and processing signals and sending data to the PC-software. The communication between MCU and PC is taking place via USB interface.
The first stage of signal processing in the PC is the linearization. This is necessary because the output signal of the IR cells as a function of the sample gas concentration have an exponential characteristic.
The linearization produces a correction which is exactly opposite to the characteristic of the detector, so that a linearized analysis signal is available.
The second stage is integration. It starts at the beginning of the combustion and it ends after a pre-set minimum time. In case the combustion takes longer, the integration is prolonged. Then, the detector signal is compared to a comparator level. The integration continues as long as the IR-output signal is higher than the comparator level. When it comes down below this level, the integration is stopped. Should the IR-signal remain above the comparator level, the analysis is interrupted by a set maximum time. Then the integration is terminated.
The integrated value is directly proportional to the SO_2 resp. CO_2 content in the combustion gases. The blank value is deducted from the integrated value.
The integrated value is then multiplied by the calibration factor. After dividing by the sample weight, a result is obtained which does not depend on the sample weight.
With the multipoint calibration the results can be calculated to match exactly the values of certified standard materials.
Finally the results are directly shown as % S or % C on the PC screen.
For instructions of operating the PC-software, please refer to the Help-function of the Software.

9 Ordering numbers

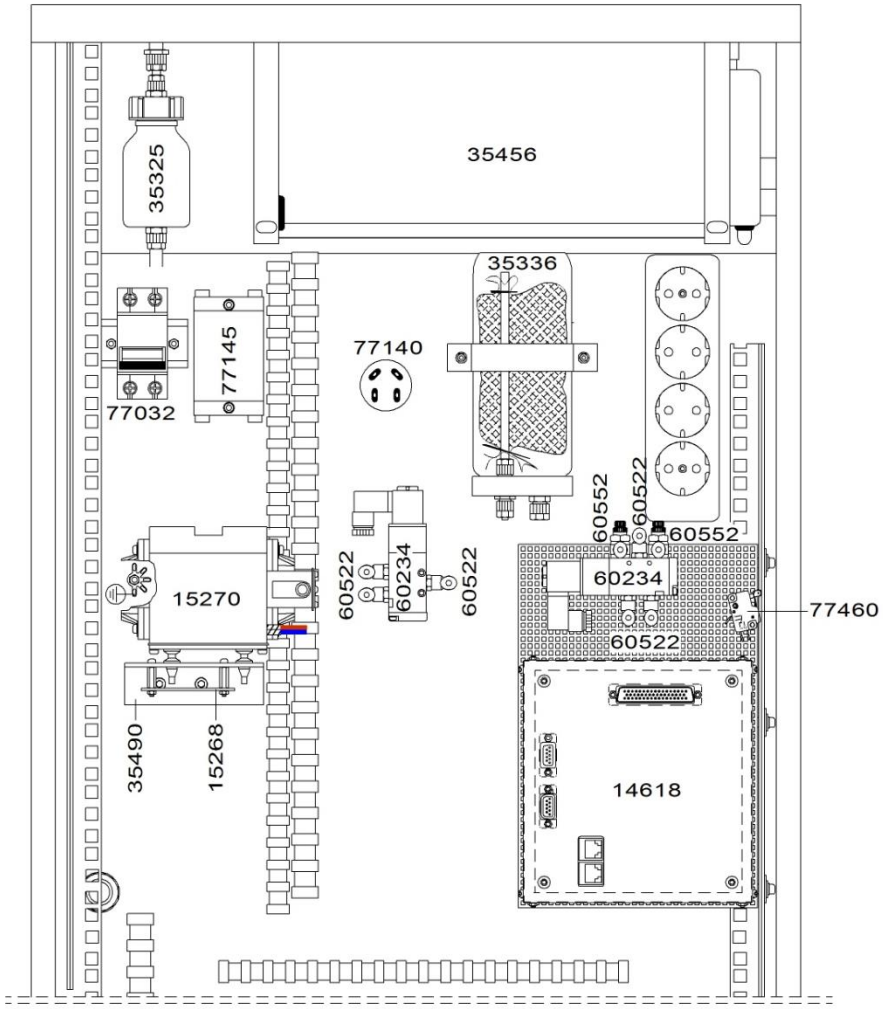
9.1 Analyszer front view



Part Nr.	Description
09090	Reagent tube
11170	Dust filter cartridge
11480	Adjustable restrictor
15087	Flow meter 300l/h
15095	Flow meter 600l/h
36700	Upper reagent tube holder
36710	Lower reagent tube connector
48067	Lower reagent tube connector
48069	Upper reagent tube connector
70320	O-ring
72010	Pressure gauge 2.5 bar for oxygen
72020	Pressure gauge 10 bar for compressed air
78017	Mains power switch

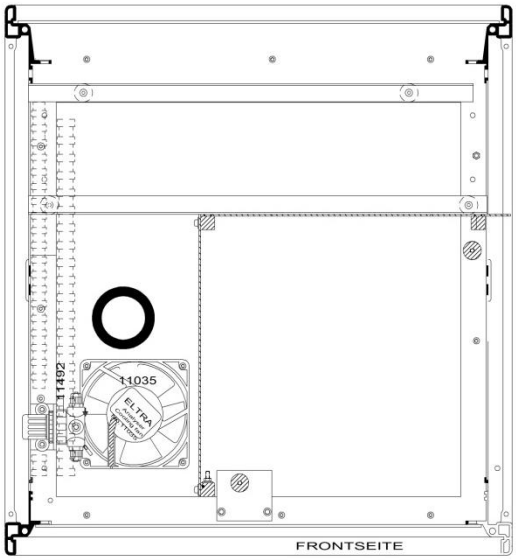
As a moisture trap, instead of the narrow reagent tube 09090, further reagent tubes with a larger filling quantity for magnesium perchlorate are available.

9.2 Rear side (outside view)



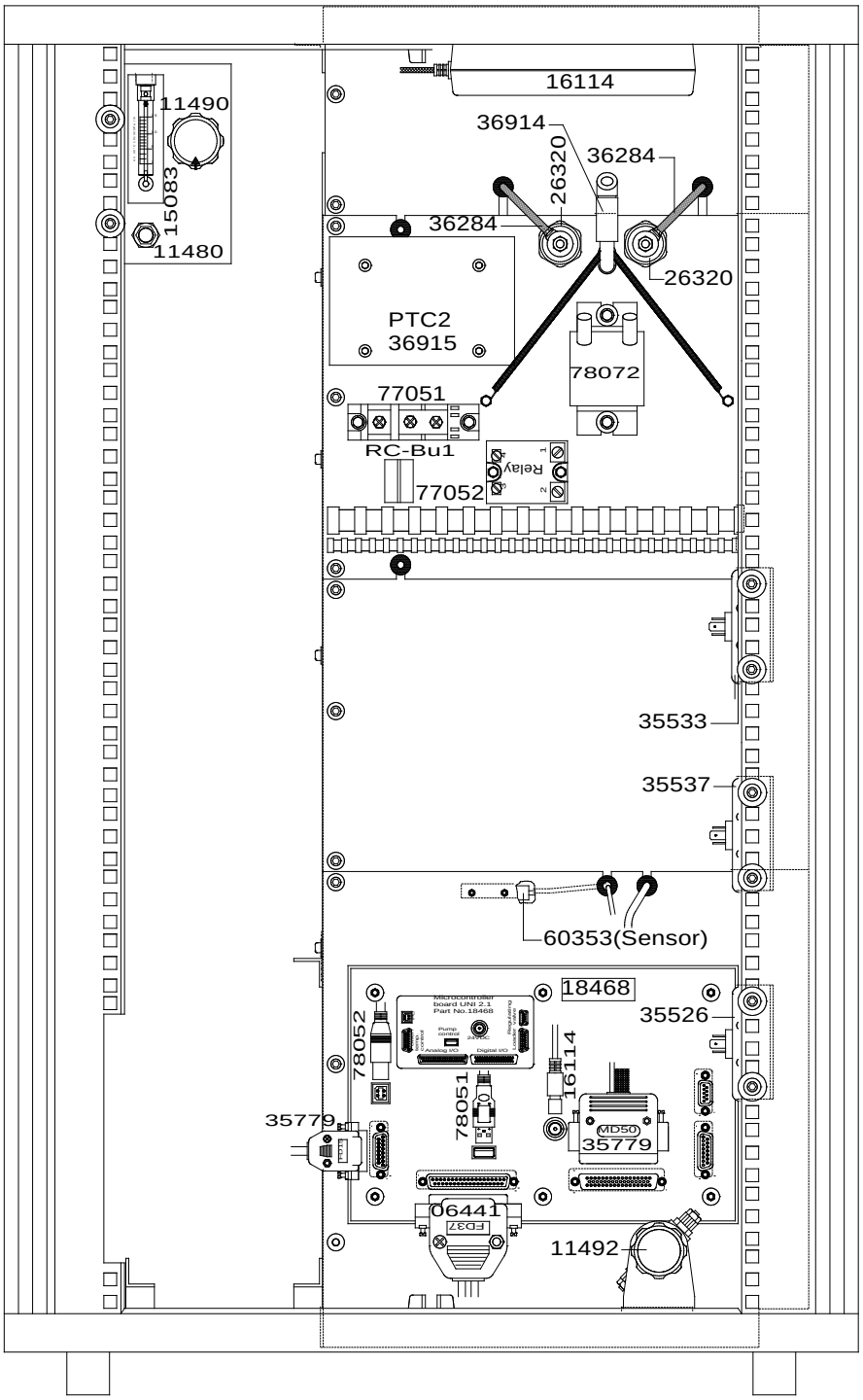
Part Nr.	Description
14618	Microcontroller board UNI 1.4
15268	Pump control boart PC1
35490	Pump support
15270	Gas pump
35325	Attenuator volume
35336	Attenuator volume
35456	Blower
60234	Pneumatic valve
60522	Fitting 90°
60552	Adjustable restrictor
77032	Circuit breaker
77140	Mains power filter
77145	Mains power filter
77460	Switch

9.3 Bottom (outside view)



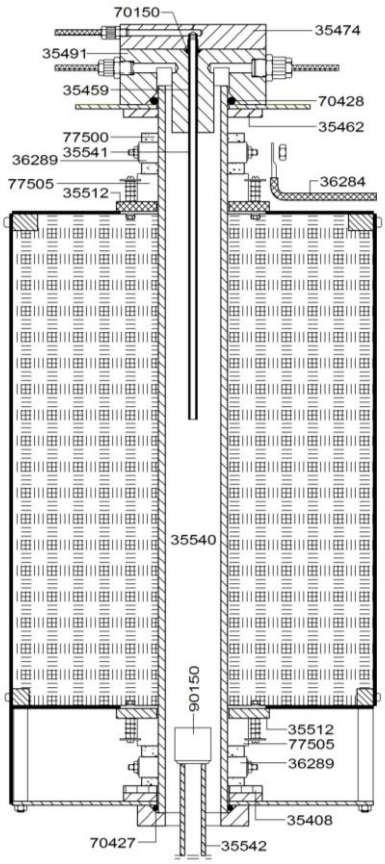
Part Nr.	Description
11035	Cooling fan
11492	Oxygen pressure regulator

9.4 Left side (inside view)



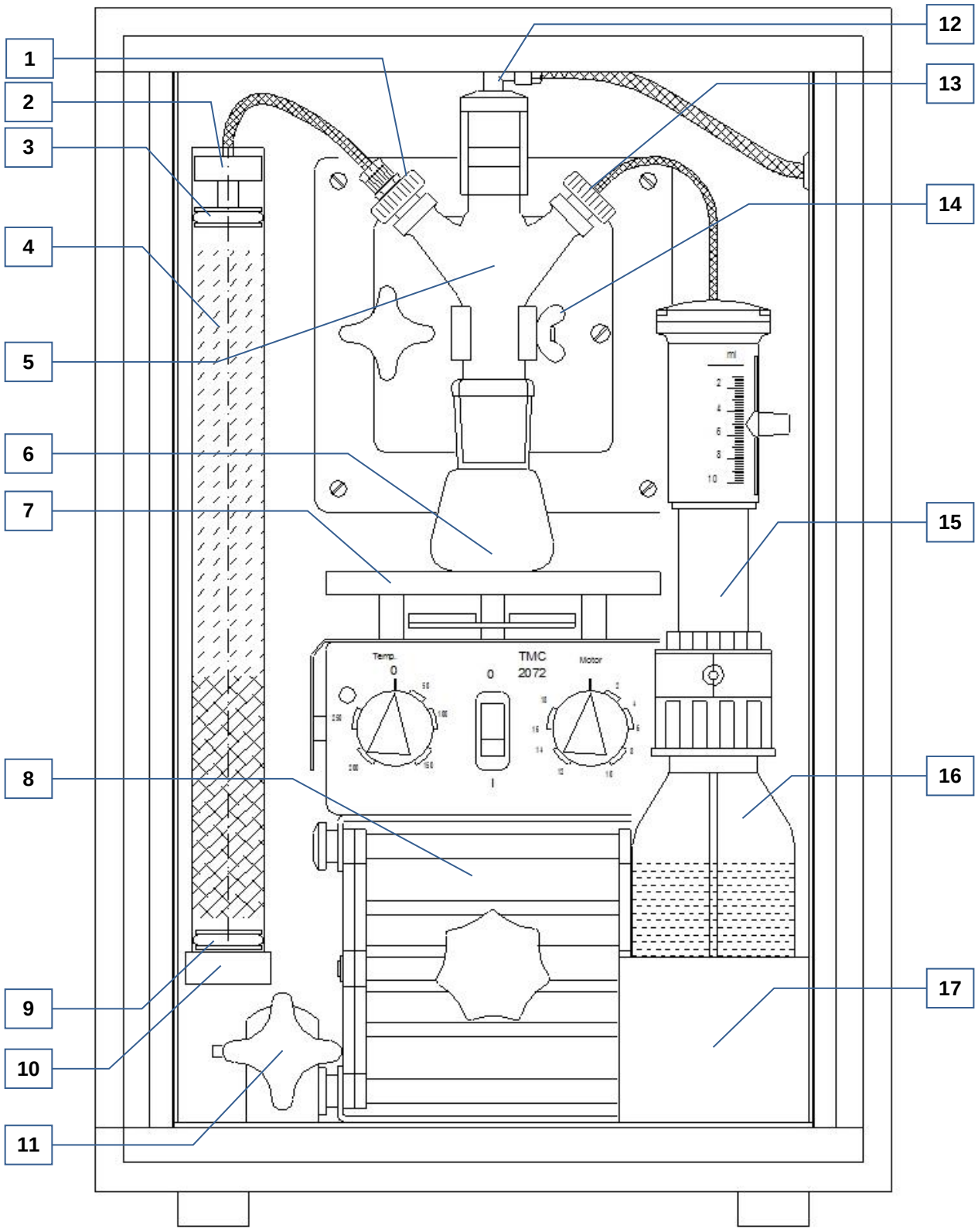
Part Nr.	Description
06441	IR module cable
11390	2/2-way valve 220VAC
11435	3/2-way valve 24VDC
11480	Adjustable restrictor
11490	Pressure regulator
11492	Oxygen pressure regulator
15083	Flow meter 15 L/h
16114	Power supply
18468	Microcontroller board UNI2
26320	Insulator
35536	2/2-way valve 24VDC
35779	Power/temperature control cable
36284	Heating element connector
36798	Transformer
36904	Temperature control board TH 44
36914	Thermocouple
36915	Power/temperature control board
60353	Piston sensor
77051	Thyristor block
77052	Solid state relay
78051	Pump control cable
78052	USB cable for PC interface
78072	Current transformer

9.5 Furnace side (inside view)



Part Nr.	Description
35408	Lower plate insulation
35462	Upper plate
35512	Ceramic plate
35540	Combustion tube
35541	Ceramic lance
35542	Pedestal
36284	Heating element connector
36289	Heating element clamp
70150	O-ring
70427	O-ring
70428	O-ring
77501	Heating elements, 4pcs
77505	Ceramic spacer
90150	Crucible

9.6 TIC-module



1	**Glass stopper (connection to the analyzer)**	**38225**
2	Upper moisture trap connector	11042
3	O-ring 9*3	70230
4	Moisture trap	11064
5	Glass distributor	38200
6	50 ml glass flask	90090
7	Heater with magnetic stirrer	71070
8	Support with variable height	38400
9	O-ring 9*3	70230
10	Lower moisture trap connector	11045
11	Geared mechanism	38850
12	Glass stopper (connection to the furnace)	38227
13	Glass stopper (connection to the acid supply)	38220
14	Glass support	38340
15	Dispenser Assimat	71065
16	Acid bottle	71060
17	Bottle support	38677

10 Disposal

In the case of a disposal, the respective statutory requirements must be observed. In the following, information on the disposal of electrical and electronic devices in the European Community are given.

Within the European Community the disposal of electrically operated devices is regulated by national provisions that are based on the EU Directive 2012/19/EU on Waste Electrical and Electronic Equipment (WEEE).

Accordingly, all devices supplied after August 13th 2005 in the business-to-business area, to which this product is classified, may no longer be disposed of with municipal or household waste. To document this, the devices are provided with the disposal label.

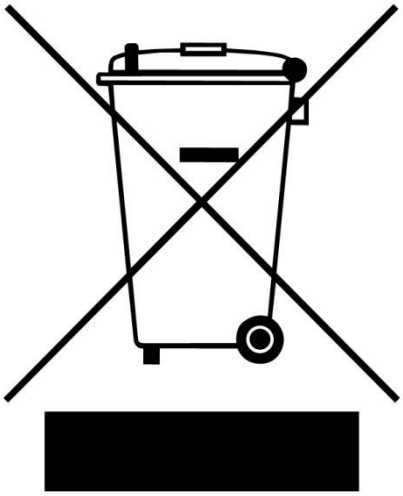


Fig. 1: Disposal label

Since the disposal regulations worldwide and also within the EU may differ from country to country, the supplier of the device should be consulted directly in case of need.

This labelling obligation is applied in Germany since March 23rd 2006. From this date on, the manufacturer must provide an adequate possibility of returning all devices delivered since August 13th 2005. For all devices delivered before August 13th 2005 the end user is responsible for the proper disposal.

ELTRA
ELEMENTAL ANALYSERS