TGA Thermostep | TGA Thermochain

ELTRA
ELEMENTAL ANALYZERS

Thermogravimetric Analyzers

TGA Thermostep | TGA Thermochain

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ELTRA
ELEMENTAL ANALYZERS

Specialists for Elemental Analysis

For more than 30 years ELTRA has been one of the leading manufacturers of elemental analyzers. Starting with combustion analyzers for carbon and sulfur determination ELTRA has extended its product range over the years with analyzers for oxygen, nitrogen and hydrogen as well as thermogravimetric analyzers. ELTRA instruments are used in industries such as steel, mining, automotive and aviation, construction materials and in universities for Research & Development.

ELTRA is synonymous with high quality, customer-oriented solutions and efficient products. Thousands of satisfied customers worldwide are proof of the reliability of ELTRA analyzers.

Thermogravimetric Analysis

Thermogravimetric analysis is used to determine the mass loss of a sample as a function of the temperature. Suitable instruments include standard laboratory ovens and muffle furnaces with a fixed temperature and subsequent weighing, as well as TGA analyzers with integrated balance and a variable temperature range. ELTRA's TGA Thermostep combines the drying and ashing process with integrated weighing. For the determination of various thermogravimetric parameters in one analysis cycle, the software allows to define different temperatures and gases (e. g. oxygen or nitrogen) for each analysis step.

Thermogravimetric Analyzers

For organic and inorganic samples

TGA Thermostep **04**

In the TGA Thermostep up to 19 samples with a maximum weight of 5 g each can be analyzed fully automatically in one analysis cycle for their thermogravimetric parameters. The analyzer is ideally suited to characterize organic (such as coal), synthetic (such as plastics) and inorganic samples (such as cement).

TGA Thermochain **10**

The TGA Thermochain represents an efficient combination of the TGA Thermostep with automated sample feeding and transfer.

ELTRA also provides analyzers for:

CS in inorganic samples

The **CS-800** is ideal for the quick simultaneous determination of carbon and sulfur in steel, cast iron, nonferrous metals, carbides, ceramics, glass, cement and other inorganic samples.

CHS in organic samples

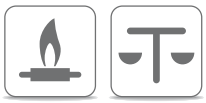
The **CHS-580** is used for the quick simultaneous determination of carbon, hydrogen and sulfur in samples such as coal, coke, ores, minerals, slag, and many more.

ONH in inorganic samples

The **ONH-2000** is ideally suited for the quick simultaneous determination of oxygen, nitrogen and hydrogen in steel, cast iron, molybdenum, nickel, copper, zirconium, titanium, ceramics and other inorganic samples.

Thermogravimetric Analyzers

TGA Thermostep



Resistance furnace

Integrated balance

TGA Thermostep

TGA Thermostep – reliable and flexible

Benefits

- Measurement of up to 19 samples in one analysis
- Sample weights of up to 5 g
- Fast heating rates, accurate temperature control
- High-performance, precise weighing cell
- Automatic placing and lifting of crucible covers
- Robust design allows for use in laboratories and production

ELTRA TGA analyzers are an ideal alternative to standard laboratory ovens and muffle furnaces for thermogravimetric analysis. Thanks to a programmable furnace that is connected to an integrated balance, heating and weighing are combined in one instrument. This saves time-consuming manual work and allows for high sample throughput. In addition, typical parameters such as moisture, ash and volatiles can be determined in one analysis run.

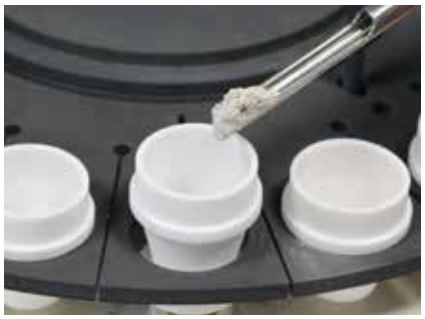
The TGA Thermostep processes up to 19 different samples, typically weighing between 500 mg and 5 g, in one analysis cycle. The surrounding atmosphere and temperature of up to 1,000 °C within the heating chamber can be freely defined by the user during analysis to create a standard operating procedure. The crucible lids, covering of the samples, can be raised or lowered at each stage of the analysis, thus allowing for safe and ASTM-compliant determination of volatiles in coal samples.

Typical sample materials

Coal, coke, secondary fuels, gypsum, flour, plastics, ceramics and many more

Simple operation yields quick results: TGA Thermostep

Operation of the TGA Thermostep is simple, convenient and safe. After selecting the Standard Operating Procedure (SOP) in the PC, the sample ID's can be entered into the software. The samples are then weighed in the crucible at the position assigned to the sample ID in the carousel. After one sample has been weighed, the carousel automatically rotates to the next position and the next registered sample can then be weighed in the crucible. Alternatively, a carousel filled with samples which has been weighed externally, can be placed into the analyzer. It is also possible to position a second carousel with crucible lids above the crucibles. Once the analysis is finished, a new cycle can be started after a short cool-down period.



Weighing the sample

Option: Crucible lids

Display of analysis results

ELTRA TGA Models
TGA Thermostep, TGA Thermochain and TGA Automation

ELTRA thermogravimetric analyzers are available in various configurations to serve the different requirements of laboratory and production applications. All TGA models are controlled via PC and use a heated furnace which is connected to an integrated balance. Similarly, all TGA analyzers are supplied with approximately 15 ccm ceramic crucibles.

The sample feeding for the **TGA Thermostep** is done manually. After selecting the SOP in the software the pre-defined temperatures and gases are applied to the sample to determine the various thermogravimetric parameters.

The **TGA Thermochain** operates at a fixed furnace temperature required for the determination of a single thermogravimetric parameter. The samples are fed to the analyzer by an external autoloader and are ejected after the measurement, allowing for a high throughput. It is also possible to transfer a sample from one TGA Thermochain to another which operates at a different temperature. By using several TGA Thermochain analyzers in a row, it is possible to determine various parameters

The **TGA Automation** is the basic model of a thermogravimetric analyzer which can be used in an automated process.

For more information please refer to page 10.

NEW
With encapsulated weighing cell
TGA Thermostep

High-performance analysis technology

The TGA Thermostep is a powerful thermogravimetric analyzer characterized by robust design, high precision and flexibility. It is possible to apply different atmospheres and to use sample weights of up to 5 g. The Thermostep reliably and efficiently measures parameters such as moisture, ash and volatiles according to a user-defined SOP.

NEW: Encapsulated weighing cell

Benefits

- Precise measurements
- Long-term stability
- Low maintenance
- Long operating life

The latest TGA Thermostep generation features an encapsulated weighing cell with 0.1 mg resolution providing highly precise measurements. The encapsulation isolates the weighing cell from the ambient atmosphere and is extremely stable. The weighing cell is connected to the furnace by a ceramic spindle with pedestal on which the crucibles are placed.

Graphic:
Encapsulated weighing cell

High-capacity heating elements

The latest TGA Thermostep generation utilizes three heating elements with an improved capacity of 1800 W each (5400 W total power). The result is a faster heating rate and improved stability, especially at high temperatures. The heating elements, located in the upper and lower furnace, provide homogeneous temperature distribution.

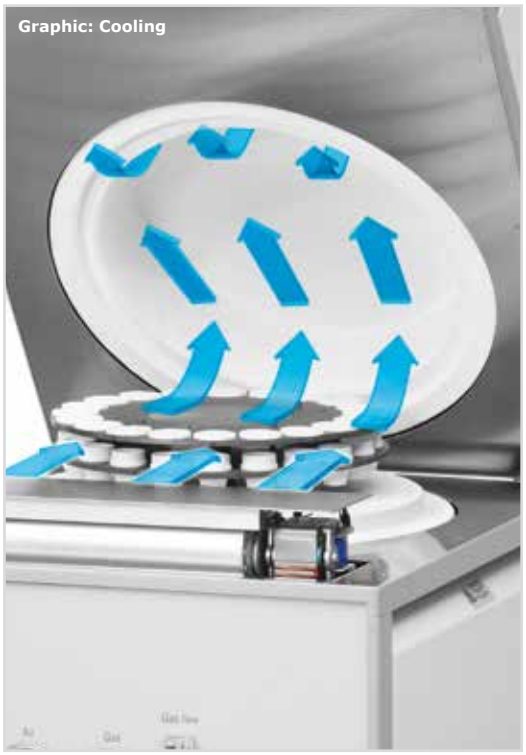

Graphic: High-capacity heating elements

Temperature control

The furnace temperature is monitored by two thermocouples which are not encapsulated. One thermocouple monitors the temperature inside the furnace, the other monitors the temperature within the heating element. Due to the absence of the encapsulation the heating can be controlled quickly and precisely.

Purging gas

The TGA Thermostep is very flexible with regards to the purging gas used. At each stage of the analysis either nitrogen, oxygen or surrounding atmosphere can be selected. In the latter, the surrounding atmosphere penetrates into the TGA Thermostep, gently oxidizing the samples.


Graphic: Cooling

Cooling

At the end of each analysis cycle, the cool down process starts. It is possible to program the automatic opening of the TGA furnace lid as a function of the temperature to support the cool down process. For example, the Thermostep can be programmed to open the furnace lid at 650 °C halfway and at 500 °C completely. In addition, at 300 °C an integrated fan is automatically started.

Intelligent Crucible Management

Benefits

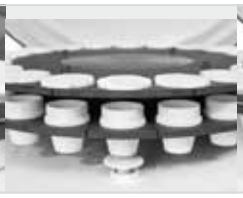
- A maximum of 19 samples plus 1 reference crucible
- Automatic, integrated weighing
- Separate carousel for crucible lids

Sample carousel and reference crucible

The metal sample carousel accepts up to 19 ceramic crucibles. Position no. 20 is reserved for the reference crucible which is part of every measurement. It is used to compensate for weight loss in the crucible, a physical effect which could lead to measurement errors at high temperatures.

Carousel for lids and samples

Weighing the crucible



PC-controlled application of crucible lids / crucibles open

PC-controlled application of crucible lids / crucibles closed

Sample weighing

The samples are weighed automatically in the TGA Thermostep. The analyzer allocates the positions of the crucibles in accordance with the number of samples to be measured to ensure the best possible stability during weighing. The software then connects to every occupied position and weighs one sample after the other.

Optionally, an external weighing station is available. Thus it is possible, for example during the final stages of cooling down of the TGA Thermostep, to weigh in a new sample carousel and introduce it to the analyzer with one single movement. This procedure helps to reduce waiting times between two analysis cycles.

Crucible lids

For applications such as the precise and ASTM-compliant analysis of volatiles in coal or of very reactive sample materials, it is essential to cover the crucibles. The TGA Thermostep is equipped not only with a sample carousel but with a second carousel for the crucible lids. A software-controlled mechanism integrated in the carousel holder lifts and lowers the lids without interrupting the analysis by opening the TGA.

ASTM-compliant working with TGA Thermostep

ASTM compliance for the measurement of ash, moisture and volatiles

Standard	Material to be analyzed	Standard title
D7582 - 12	Coal and Coke	Standard Test Methods for Proximate Analysis of Coal and Coke by Macro Thermogravimetric Analysis
D7348 - 08e1	Solid Combustion Residues	Standard Test Methods for Loss on Ignition (LOI) of Solid Combustion Residues

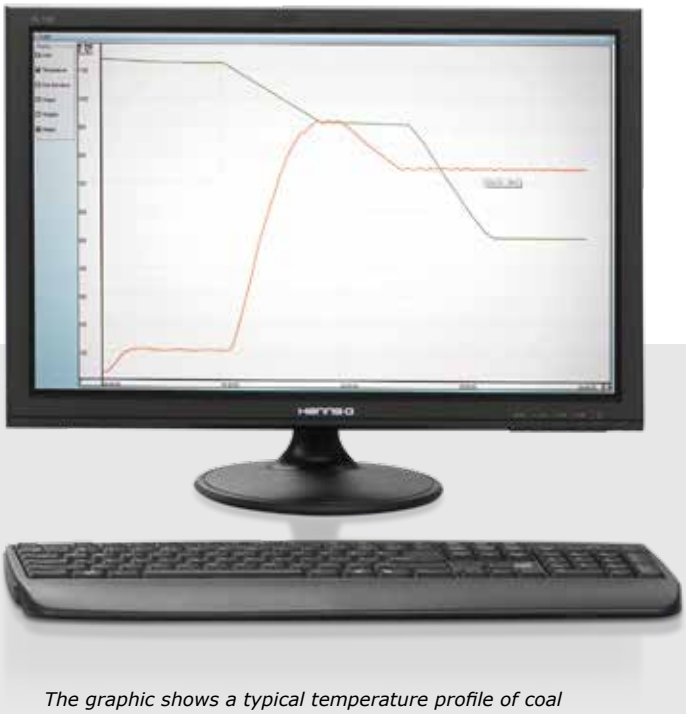
PC control with Windows®-based software

ELTRA's instrument software ensures convenient control and operation of the analyzers. It is multilingual, easy to understand and provides the following features:

- Custom layouts: user-defined display of windows and storage of different layouts
- User profiles with multi-level access: creation of different hierarchy levels with different authorizations
- Storage of analysis results in data base:
- The data of each analysis is stored and can be called up later
- Graphic display of temperature profile and mass loss
- Individual, customer-specific calculations based on the raw data
- Retrieval of sample-related information from any given time during analysis
- LIMS communication and data export
- Applications memory and display of maintenance intervals: individual configuration of maintenance intervals
- Extensive diagnostics function

Customized visualization of measurement results

- Display of measurement results after each analysis step
- Individual calculations possible
- Ash content can refer to dry or moist samples
- Export and printing of measurement results

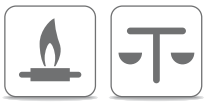


The graphic shows a typical temperature profile of coal measured with the TGA Thermostep. The flexibility of the Thermostep Software allows for a variety of modifications.

Once a standard operating procedure has been defined it can be selected in the software for further analyses.

The Standard Operating Procedure

Determination of thermogravimetric parameters with the TGA Thermostep requires the definition of a standard operating procedure (SOP). The conditions for each analysis step are defined in the software. A full range coal analysis, for example, consists of the determination of moisture, volatiles and ash content. An analysis step includes start and end temperature, purging gas, heating rate and end condition. A condition for ending the analysis step can be a defined period of time as well as the obtained mass stability. Moreover, the placement of the crucible lids can be defined for each analysis step.



Benefits

- Fully automated analysis
- Integrated Autoloader with 36 positions
- Wide range of applications thanks to various models

NEW: TGA Thermochain for high sample throughput

The TGA Thermochain is designed to meet the requirements of routine applications with high sample throughput. When analyzing a large number of samples the use of temperature ramps is not very effective as this involves not only the actual analysis time but also the time needed for heating and cooling down. The TGA Thermochain consists of a furnace with a freely selectable temperature which is fixed during analysis. It is equipped with an Autoloader with 36 positions. By combining up to 4 furnaces with different temperatures, it is possible to measure a variety of thermogravimetric parameters quickly and reliably.

Automated sample handling

The samples are registered in the software and placed on the 36 positions provided by the Autoloader. The samples are transferred to the furnace through an opening in the cover of the TGA Thermochain. The surrounding atmosphere (nitrogen or oxygen) as well as the applied temperature (up to 1,000 °C) can be freely selected. The TGA Thermochain analyzes up to 20 samples simultaneously. As soon as the end condition (such as analysis time or constant weight) is achieved, the sample is automatically removed, dropped into a collecting vessel and the next sample is introduced into the furnace. This procedure allows for convenient continuous thermogravimetric analyses with high sample throughput.

TGA Thermochain

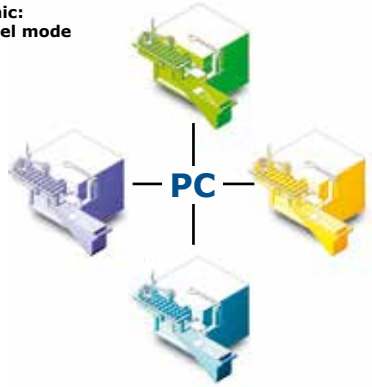
Model variations

It is possible to combine a number of TGA Thermochain analyzers to determine various thermogravimetric parameters with high sample throughput. Two different operation modes are available.

Parallel Mode

One PC controls up to four furnaces with Autoloader, and records the results of every sample. Each sample is registered in the software only once but the individual sample weight is entered for each furnace. In the first furnace, for example, the moisture content is analyzed, and in the following furnaces the ash content, volatiles etc. Each unit is equipped with an Autoloader and a collecting vessel so that different analysis times can be conveniently handled.

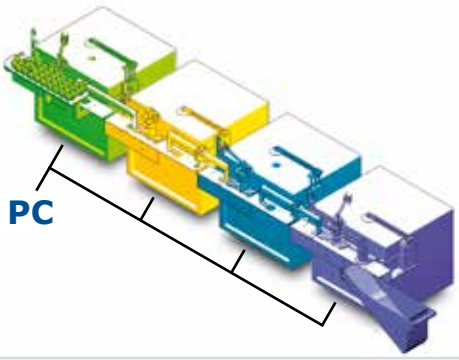
Graphic: Parallel mode



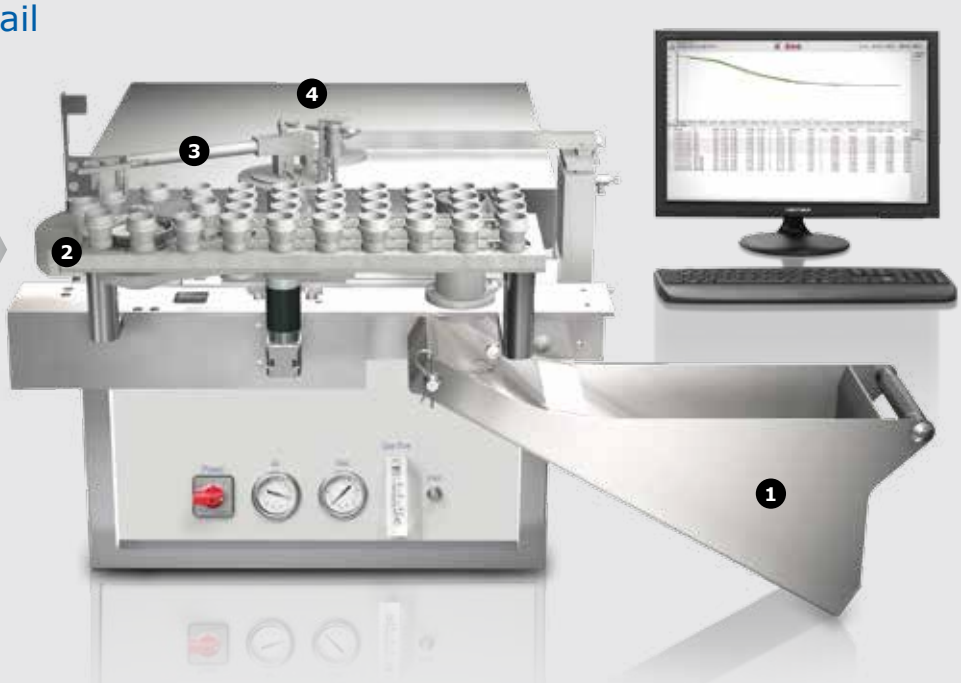
Sequential mode with sample transfer

This model allows for the combination of up to four analyzers through transfer stations. Only the first furnace is equipped with the Autoloader with 36 positions. Each sample is registered in the software only once and then passes one furnace after the other. When the analysis time in the first furnace has expired, the sample is transferred to the next furnace via a slide. At the same time, a finished sample is removed from the second furnace and transferred to the third unit. At the end of the chain, the sample is dropped into the collecting vessel.

Graphic: Sequential mode



TGA Thermochain in detail



1. *Collecting vessel*
2. *Autoloader with 36 positions*
3. *Crucible gripper*
4. *Resistance furnace for 20 samples*

The TGA Thermostep applies temperatures of up to 1,000 °C under inert or oxidative atmosphere. It allows for flexible and cost-effective thermogravimetric analysis of a great variety of sample materials.

Typical sample materials

Coal, coke, secondary fuels, paper, flour, plastics, ceramics



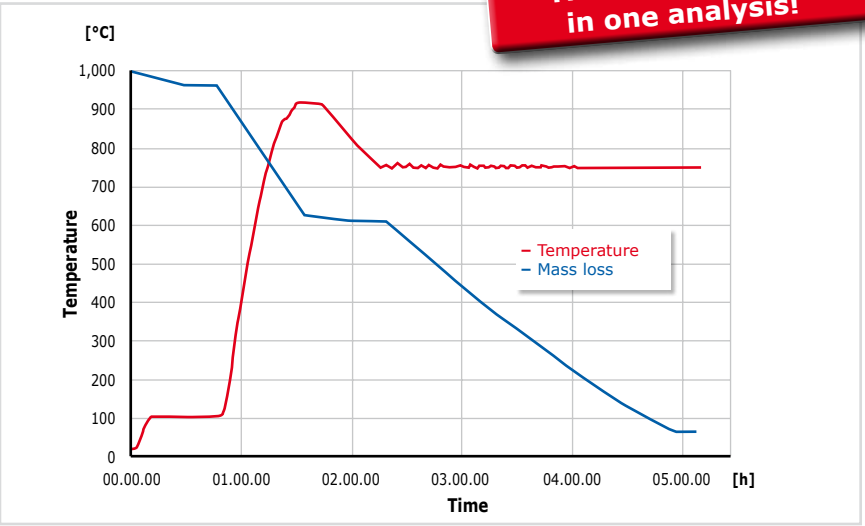

Example:

Analysis of coal

The determination of moisture, ash and volatiles in coal is a routine application in coal-fired power plants. This can be done manually with various muffle furnaces or in a TGA Thermostep. The optional automated crucible lid management of the Thermostep ensures reliable determination of volatile components. In contrast to analyzers of other manufacturers, it is not necessary to open the Thermostep or run a second anaylsis cycle to determine the volatiles.

The TGA Thermostep meets the requirements of, for example, **ASTM Norm D7582.**

Three parameters in one analysis!

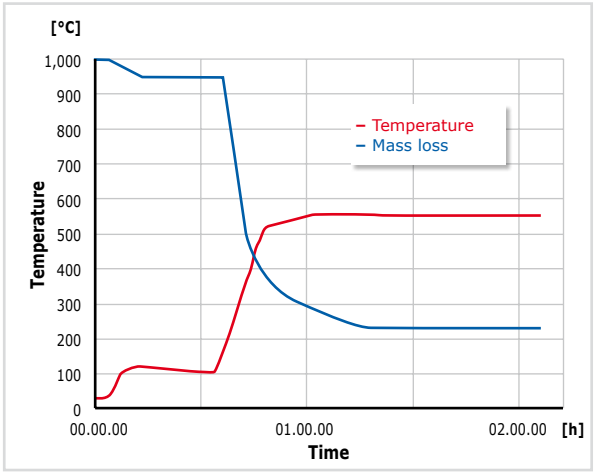


ELTRA coal calibration standard		
19 samples / average weight: 1.1 g coal / analysis time: 5 hours		
Parameters	**Mean value**	**Standard deviation**
Moisture	0.32 %	0.08
Ash	6.6 %	0.05
Volatiles	9.1 %	0.3

Example:

Analysis of ash and moisture content in paper

To determine the content of inorganic components, such as filler material or pigments, ash and moisture are measured in one analysis cycle. For the analysis of moist waste paper, for example, no drying is required:

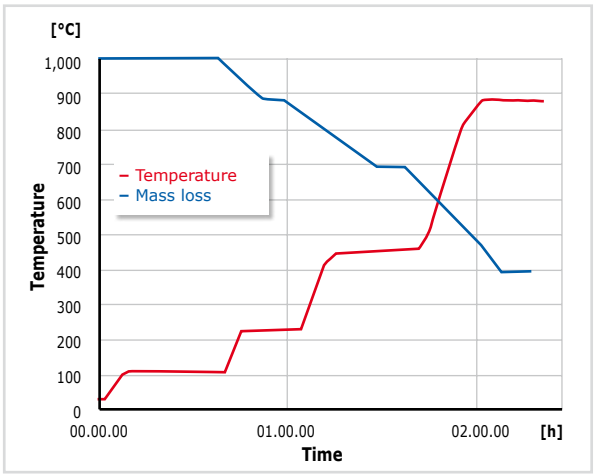


Typical results paper		
19 samples simultaneously / average weight: 500 mg / analysis time 2 hours		
Parameters	**Mean value**	**Standard deviation**
Moisture	4.9 %	0.1
Ash	23.3 %	0.07

Example:

Analysis of chemicals

The TGA Thermostep is ideally suited to determine the various degrees of decomposition of chemicals at different temperatures. The example shows calcium oxalate; the moisture content was analyzed at 105 °C, the mass loss at 200 °C, 450 °C and 850 °C.

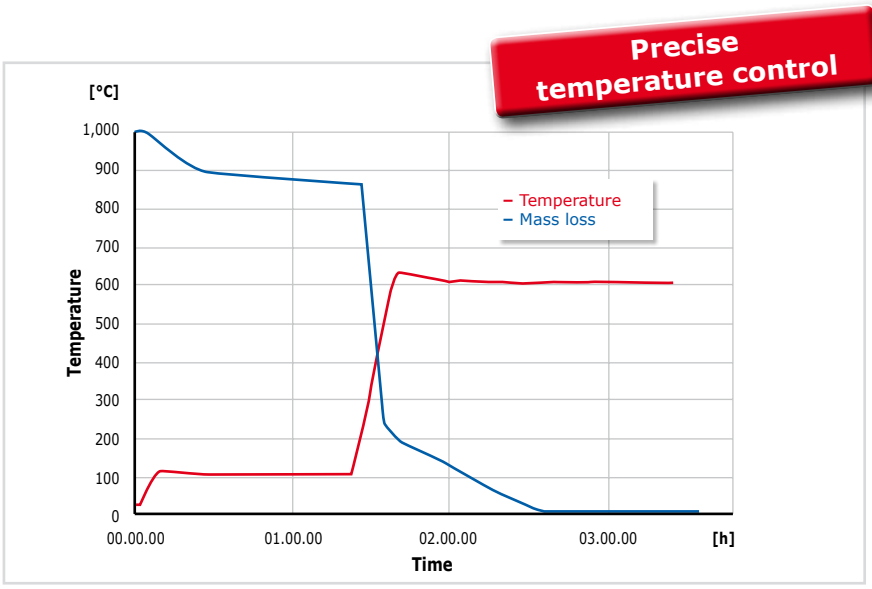


Typical results calcium oxalate		
10 samples / average weight: 500 mg / analysis time: 2.5 hours		
Temperature	**Mean mass loss**	**Standard deviation**
105 °C (moisture)	0.2 %	0.01
200 °C	12.2 %	0.02
450 °C	18.9 %	0.05
850 °C	29.8 %	0.03

Example:

Determination of ash and moisture in flour

The quality of flour is characterized by its mineral content. After gentle burning with air as purging gas, the mineral components of the flour remain as ashes in the TGA Thermostep. In the following application example the sample was reduced to ash at 600 °C. Depending on the lab regulations it is also possible to apply higher temperatures. For each flour type 5 different samples were analyzed.



Typical results for various flour types			
5 samples each / average weight: 1 g / analysis time: approx. 3 hours			
Parameters	**Flour type 405**	**Flour type 550**	**Flour type 1050**
Mean value (moisture)	13.5 %	13.6 %	12.7 %
Standard deviation	0.05	0.03	0.03
Mean value (ash)	0.41 %	0.56 %	1.1 %
Standard deviation	0.02	0.01	0.01

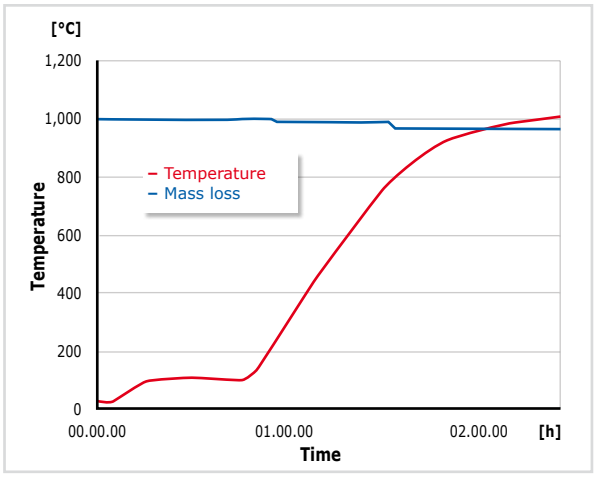
The determination of moisture and ash is considered to have ended when the difference between the last 2 weighings of each sample amounts to less than 1 mg weight change.

Application steps			
Software setting			
Step	**End temperature**	**Time**	**Crucible lid**
Moisture	105 °C	1:10 h	no
Ash	600 °C	2:30 h	no

Example:

Analysis of residual moisture and LOI in cement

The **LOI test (loss on ignition)** is particularly important for inorganic materials. For this test the sample is quickly heated to a defined high temperature. This method is used to rapidly determine the volatile components without modifying the sample characteristics too much. To determine residual moisture in cement an intermediate step at 105 °C was added to the LOI test at 1,000 °C. The total analysis time for both parameters in a 1 g sample was 70 minutes.

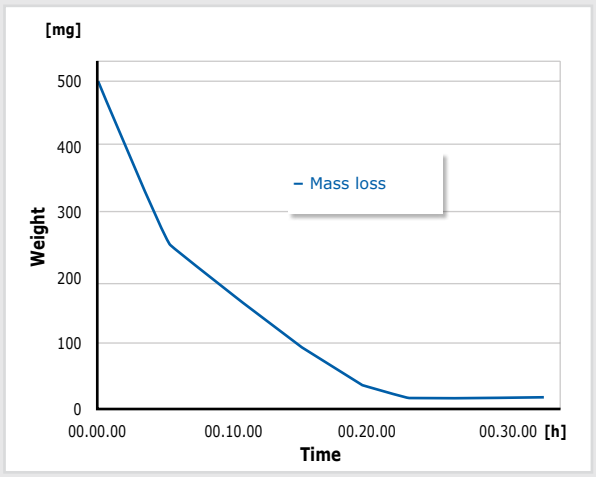


Typical results cement		
10 samples / average weight: 1 g / analysis time: 70 minutes		
Parameters	**Cement 1**	**Cement 2**
Moisture (105 °C)	0.07 ±0.01 %	3.0 ±0.02 %
LOI (1,000 °C)	0.08 ±0.01 %	1.9 ±0.01 %

Example:

Rapid coal ashing in the TGA Thermochain

The TGA Thermochain is ideally suited for the rapid ashing of coal. A temperature of 950 °C was applied and 36 coal samples were fed to the analyzer by the Autoloader. For a sample weight of 500 mg, the ash content is usually determined in less than 30 minutes. Thanks to the sequential loading of the Autoloader, the total ashing time for the 36 samples was approx. 1 hour. This allows continuous quality control in a short time, which is especially useful for laboratories with high workloads.



Results rapid ashing of coal	
36 samples / average weight: 500 mg / analysis time: approx. 60 minutes for 36 samples	
Parameter	**Coal**
Ash	1.12 %
Standard deviation	0.1

Technical Data

	Thermogravimetric Analyzers		
	TGA Thermostep	TGA Thermochain	TGA Automation
			
General data			
Sample weight	up to 5 g	up to 5 g	up to 5 g
Number of samples	19 (+ 1 reference sample)	56 (36 on Autoloader + 20 in the analyzer)	20
Number of sample carousels	2 (crucibles and lids)	1 (crucible)	1 (crucible)
Precision	0.02 %	0.02 %	0.02 %
Resolution of balance	0.1 mg	0.1 mg	0.1 mg
Furnace temperature	From room temperature to 1,000 °C	From room temperature to 1,000 °C	From room temperature to 1,000 °C
Temperature control	Precision: 2 % or ±2 °C / stability: 2 % or ±2 °C		
Gas flow rate	Adjustable from 1 to 10 l/min		
Gas pressure	Air 5 – 6 bar (75 – 90 psi) / nitrogen 2 – 4 bar (30 – 60 psi) / oxygen 2 – 4 bar (30 – 60 psi)		
Gas purity	Compressed air 99.5 % (oil and fat free) / nitrogen (99.9 %); oxygen (99.9 %)		
Operating temperature / humidity	10 – 35 °C / 20 – 80 % humidity (not condensating)		
Exhaust air	Connection torequired / fan included in delivery scope / 4 m^3 per hour / diameter of: 100 mm		
Power supply	230 V (±10 %) / one phase / 50/60 Hz / 32 A (analyzer) 230 V (±10 %) / one phase / 50/60 Hz / 2 A (PC, fan)		
Weight	65 kg	80 kg	65 kg
Dimensions (B x H x T)	55 x 52 x 62 cm	without crucible collecting vessel: 75 x 90 x 68 cm with crucible collecting vessel: 110 x 90 x 68 cm	75 x 90 x 68 cm
Interfaces	serial and USB		
Accessories	Computer, monitor, printer (exact specifications on request)		

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99000-0004/E-07-2014