ELTRA
ELEMENTAL ANALYZERS

S

Carbon / Sulfur Analyzers

CS-800 | CS-2000

Unique

ELTRA
Dual **F**urnace
Technology

CS-2000

ELTRA CS 2000
Carbon Sulfur Determin
PC controlled

C

part of **VERDER**
scientific

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 thermo-gravimetric analyzers. ELTRA instruments are used in industries such as steel, mining, construction materials, automotive and aviation, and in universities for Research & Development.

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

ELTRA Carbon / Sulfur Analysis

The determination of the carbon and sulfur content in solids is a routine application in laboratories and production. Depending on the sample material, different analyzers are used. Organic samples are usually characterized by a high carbon content (60 – 100 %) and combustibility (e. g. coal, coke, wood). The complete release of carbon and sulfur takes place at temperatures of approx. 1,300 °C (or less). For this purpose analyzers with a resistance furnace are most suitable.

Inorganic sample materials, however, have a considerably lower carbon content (from a few ppm to a max. of 10 %) and are usually not combustible. Carbon / sulfur is released at high temperatures above 2,000 °C which can only be achieved with an induction furnace.

Carbon / Sulfur Analyzers

for inorganic sample materials

CS-800 04

The CS-800 is a carbon / sulfur analyzer with induction furnace for analyzing inorganic sample materials (e. g. steel, cast iron, refractory metals, ceramics).

for inorganic and organic sample materials

CS-2000 06

The CS-2000 is the only carbon / sulfur analyzer in the market equipped with both an induction and a resistance furnace (**EDF Technology**). It is suitable for the analysis of inorganic sample materials (e. g. steel, cast iron, refractory metals, ceramics) as well as organic sample materials (such as coal, coke, oil).

ELTRA also provides analyzers for:

CHS in organic samples

The **CHS-580** is used for the quick simultaneous determination of carbon, hydrogen and sulfur in sample materials 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 and nitrogen as well as hydrogen in steel, cast iron, molybdenum, nickel, copper, zirconium, titan, ceramics and other inorganic samples.
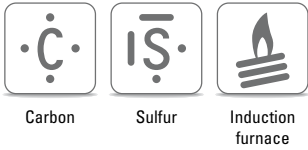
Thermogravimetry

The **Thermostep** analyzer allows for determination of different sample parameters such as moisture, volatiles, and ash in one single analysis cycle.

Carbon / Sulfur Analyzer

CS–800

For inorganic samples!

Carbon   Sulfur   Induction furnace

The perfect analyzer for inorganic sample materials

Benefits

- Up to four independent infrared cells with flexible measuring ranges
- Precise and quick measurement
- Automatic furnace cleaning
- Powerful (2.2 KW) induction furnace for temperatures above 2,000 °C
- Effective, easily accessible dust trap

The CS-800 is ideally suited for the simultaneous determination of carbon and sulfur in inorganic samples. It provides quick and precise analysis results and can be used for a variety of applications.

The CS-800 is equipped with up to four independent infrared (IR) cells which allow for precise simultaneous analysis of high and low carbon and sulfur concentrations in one measurement. The sensitivity of the cells can be customized individually by selecting the length of the IR-path to ensure the optimum measuring properties for each application.

Typical sample materials

Steel, cast iron, refractory metals, carbides, glass, ceramics, and many more.

CS-800 with sample loader

Operation CS-800

Operating the CS-800 is simple and safe. After weighing the sample in a ceramic crucible, the weight is transferred from the interfaced balance to the PC. If required, sample weights can also be entered manually. Then an accelerator (such as iron or tungsten) is added and, after having placed the crucible on the pedestal, the analysis starts. The analysis time is 40 to 50 seconds. The detector signals and instrument parameters are displayed during analysis. Evaluation of the signals and display of the results are done automatically; the data can be transferred to a laboratory information management system (LIMS). The CS-800 requires minimum maintenance. The particle filters and chemicals which need to be maintained are easily accessible.

Weighing in the sample

Placing the sample on the pedestal
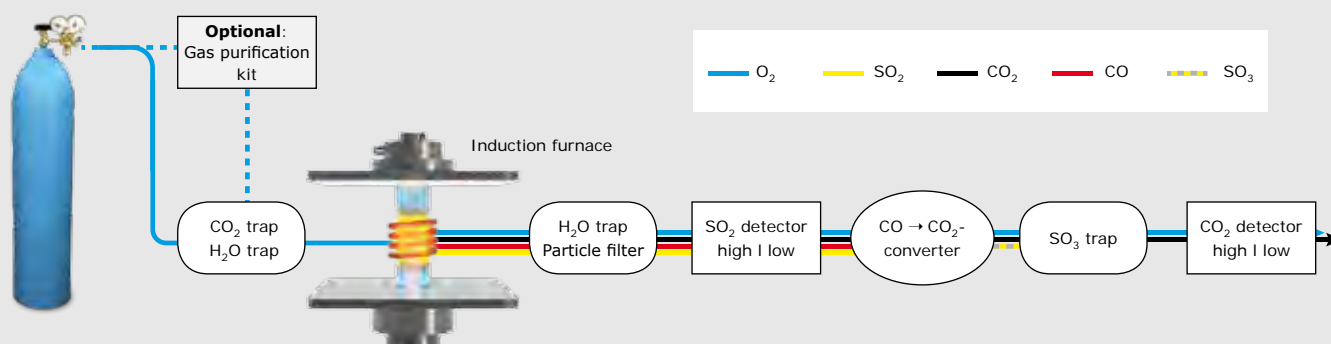*Optional automatic sample loader available*

Display of analysis results

Measuring Principle CS-800

In the induction furnace the sample is melted in a pure oxygen atmosphere, causing sulfur to react to sulfur dioxide (SO_2) and carbon to a mixture of carbon monoxide (CO) and carbon dioxide (CO_2). The combustion gases pass through a dust filter and moisture absorber for purification. In the next step the sulfur dioxide is detected in infrared cells. In the CS-800 infrared cells with different sensitivities (high/low) can be adapted according to the user's requirements. Oxidation of both, carbon monoxide to carbon dioxide and sulfur dioxide to sulfur trioxide follow the sulfur measurement. The SO_3 gas is removed with cellulose wool; the carbon content is detected by infrared cells which can be individually customized. ELTRA analyzers can be equipped with up to 4 independent infrared cells.

Optional: Gas purification kit

—— O_2 —— SO_2 —— CO_2 —— CO   ---- SO_3

Induction furnace

CO_2 trap H_2O trap

H_2O trap Particle filter

SO_2 detector high I low

CO → CO_2-converter

SO_3 trap

CO_2 detector high I low

Carbon / Sulfur Analyzer
CS–2000

Carbon Sulfur Induction furnace Resistance furnace

Reliable elemental analysis of inorganic and organic sample materials

Benefits

- Full flexibility due to combined induction and resistance furnace
- Analysis of organic and inorganic samples
- Up to four independent infrared cells with flexible measuring range
- Temperature of resistance furnace adjustable up to 1,550 °C, in steps of 1 °C
- Effective, easily accessible dust trap

The CS-2000 is the only analyzer on **the market for the determination of carbon and sulfur in organic as well as inorganic samples. For this purpose, the CS-2000 is equipped with both an induction and a resistance furnace (ELTRA Dual Furnace Technology), covering the full range of carbon and sulfur analysis.**

The CS-2000 is available with up to four independent infrared cells allow for precise simultaneous analysis of high and low carbon and/or sulfur concentrations. The sensitivity of the cells can be customized individually by selecting the length of the IR-paths to ensure the optimum measuring range for each application.

Typical sample materials

Induction furnace: steel, cast iron, refractory metals, carbides, glass, ceramics, and many more

Resistance furnace: coal, coke, oil, lime, gypsum, soil, waste, and many more

Operation CS-2000

In addition to the induction furnace (see CS-800) the CS-2000 also features a resistance furnace. The temperature can be selected in steps of 1°C up to 1,550 C. The samples (such as coal) are weighed in ceramic boats. The weight is transferred from the interfaced balance to the PC or can be entered manually. The sample is then placed directly in the furnace for combustion, no accelerators are required. The typical analysis time is 60 to 180 seconds depending on the sample material. The combustion gases pass through the infrared cells for detection. There the signals are evaluated and the results are displayed automatically. Connection to a laboratory information management system (LIMS) is possible. The CS-2000 requires minimum maintenance and the chemicals which need to be maintained are easily accessible.

Weighing in the sample

Placing the sample in the induction furnace (left) or the resistance furnace (right)

Display of measuring results

Unique

ELTRA
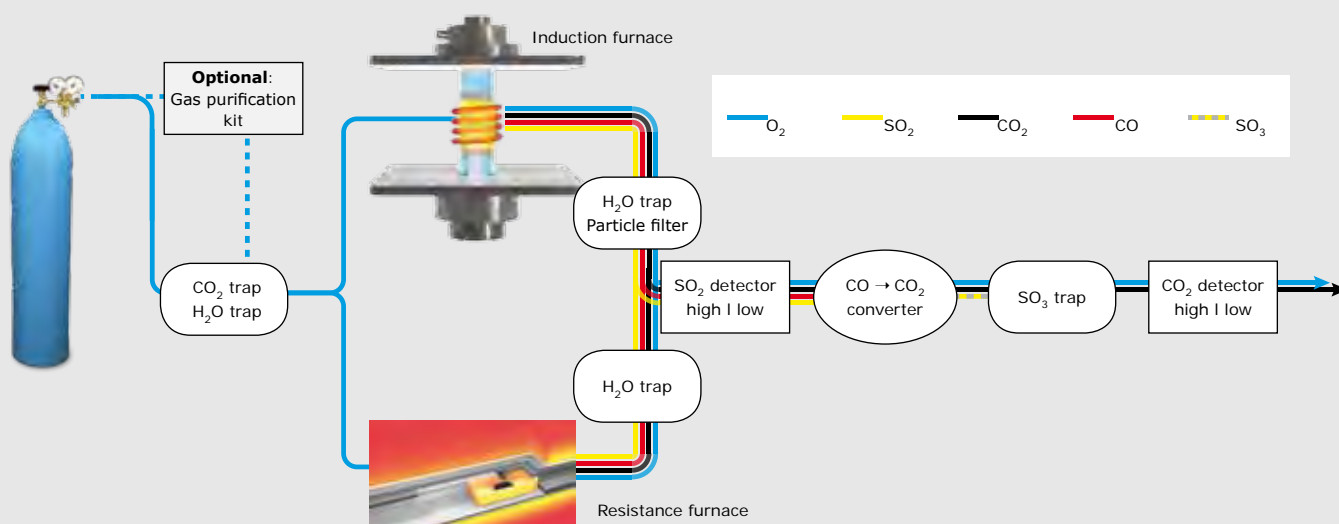**D**ual **F**urnace
Technology

CS-2000

CS-2000 with optional sample loader for the induction furnace

Measuring principle CS-2000

The measuring principle of the induction furnace corresponds to that of the CS-800. In the additional resistance furnace of the CS-2000 the sample is combusted in a pure oxygen stream, causing sulfur to react to sulfur dioxide (SO_2), and carbon to react to carbon dioxide (CO_2). Any moisture in the combustion gas is removed by magnesium perchlorate and the gas then passes into the detection unit. There the detection of the sulfur dioxide takes place in infrared cells. The CS-2000 allows for the combination of cells with different sensitivities (high/low) which makes it easily adaptable to the user's requirements. After oxidation of sulfur dioxide to sulfur trioxide, SO_3 gas is removed with cellulose wool. Subsequently the carbon content is determined by infrared cells with customized measuring ranges.

Induction furnace

—— O_2 —— SO_2 —— CO_2 —— CO --- SO_3

Optional:
Gas purification kit

H_2O trap
Particle filter

CO_2 trap
H_2O trap

H_2O trap

SO$_2$ detector
high I low

CO → CO$_2$
converter

SO$_3$ trap

CO$_2$ detector
high I low

Resistance furnace

The optimal analyzer equipment:
ELTRA accessories

For the CS-800 and CS-2000 a wide range of instrument options are **available to provide optimum solutions for quality control in the laboratory. For applications with a high sample throughput both models can be equipped with various types of** sample loaders **and** dispensers**. For the measurement of element concentrations in the low ppm range ELTRA offers a** purification furnace **for cleaning the carrier gas and a** high-temperature furnace **for preheating the ceramic crucibles. The CS-2000 can be additionally equipped with a module for the determination of Total Inorganic Carbon** (TIC module)**.**

Automatic sample loader „Autoloader" for the induction furnace (CS-800 and CS-2000)

Benefits

- ◻ Great reliability
- ◻ Easy placement of crucibles
- ◻ Analysis of samples outside the sequence possible
- ◻ Can be retrofitted
- ◻ Robust design

For automatic sample feeding the induction furnace can be supplied with the optional Autoloader which accommodates 36 or 130 crucibles and allows for hours of unattended operation.

The Autoloader is ergonomically designed and requires only little additional space.

Further optional accessories include dispensers for the addition of metal accelerators. Depending on the application, a maximum of two units can be connected to the analyzer, for example, one for tungsten and one for iron. The dispensers are software-controlled.

Sample loader for 36 samples

Sample loader for 130 samples

Solutions for low carbon concentrations: Preheating furnace HTF-540 and gas purification for CS-800 and CS-2000

To successfully determine the carbon content in a low ppm range, it is necessary to reduce the blank values of the crucibles. This is achieved by preheating the crucibles in the HTF-540 furnace at approx. 1,350 °C. This process and storage of the crucibles in a desiccator substantially reduce the blank values.

An additional option is to clean the incoming oxygen by means of an external purification furnace. Through oxidation and subsequent cleaning traces of hydrocarbon are removed from the carrier gas.

Preheating furnace HTF-540

TIC Module for CS-2000

The modular system of the CS-2000 enables the installation of a module for the determination of total inorganic carbon (TIC). The TIC module can be placed between the resistance furnace and the analyzer. TIC and total carbon (TC) are alternately analyzed without modifications of the gas flow system. For TIC analysis the sample is treated with acid in an Erlenmeyer flask inside the TIC module. The infrared cells of the CS-2000 detect the carbon dioxide released during analysis. The results are displayed by the connected PC.

Modular system CS-2000

1. *Resistance furnace*
2. *TIC module*
3. *Induction furnace*
4. *Sample loader*
5. *Balance*
6. *PC/Software*

ELTRA's advanced analyzer technology

Depending on the sample material, different temperatures are required for correct carbon and sulfur determination which can be achieved by using different furnaces. The CS-800 and the CS-2000 use an induction furnace with temperatures above 2,000 °C, the CS-2000 is additionally equipped with a resistance furnace with adjustable temperatures up to 1,550 °C (EDF Technology). This makes the CS-2000 a highly efficient analyzer, suitable for a wide range of samples.

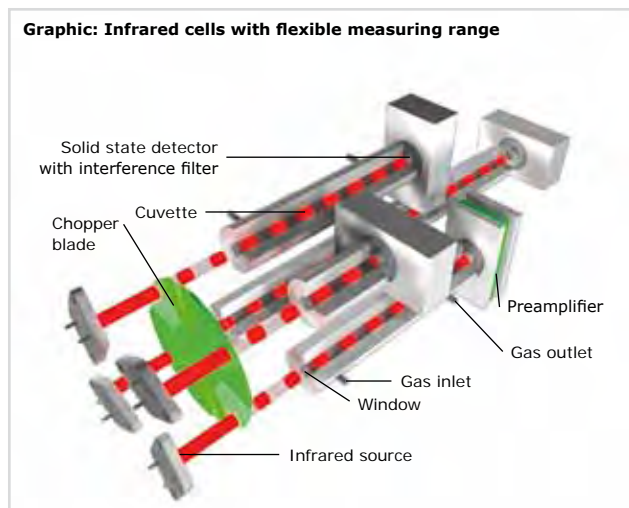## Up to four independent infrared cells

Benefits

- ☐ Long term stability
- ☐ Low maintenance
- ☐ High operation life

The design of the CS-800 | CS-2000 infrared cells is proven to be robust. The use of a constant radiant IR source combined with a chopper blade is historically proven to be extremely reliable, offering a significantly longer operating time when compared to the chopper-less flashing IR source.

The stability of the baseline, as well as the thermo control of the IR cells is monitored by the software. The analysers can be supplied with up to four independent IR cells. The length of each cell can be manufactured to give the optimum measuring ranges.

Graphic: Infrared cells with flexible measuring range

Solid state detector with interference filter
Chopper blade
Cuvette
Preamplifier
Gas outlet
Gas inlet
Window
Infrared source

Easily accessible particle filters and chemicals

All particle filters and chemicals which need to be changed on a regular basis are clearly assembled, easily accessible from outside and quickly exchangeable. The open assembly also allows for convenient visual control.

## CS-800 and CS-2000: Induction furnace for temperatures above 2,000 °C

Induction furnace

The induction furnace of the CS-800 | CS-2000 is the optimum solution for the determination of carbon and sulfur in inorganic samples (steel, cast iron, metals, ores, carbides, glass, and ceramics). An accelerator (such as tungsten "chips") is added to the sample which is melted in the electromagnetic field in an oxygen stream at temperatures above 2,000 °C.

The induction furnace of the CS-800 | CS-2000 is equipped with an **automatic cleaning device**. This brushes the dust which accumulates during combustion (mainly iron and tungsten oxides) out of the combustion chamber, thus ensuring exact and reproducible analysis results. Time-consuming manual cleaning is not required. Once the analysis is done, the crucible moves into a position below the furnace and the integrated brush cleans the combustion tube. This ensures a safe and efficient cleaning process. During both, elemental analysis and cleaning process the brush is protected by a ceramic heat shield.

Graphic: Combustion module CS-800

- Oxygen inlet
- Cleaning brush
- Ceramic heat shield
- Induction coil
- Combustion tube
- Carrier gas outlet
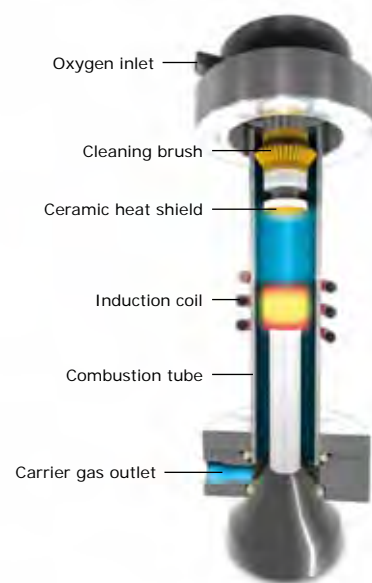
CS-2000: External resistance furnace up to 1,550 °C

Resistance furnace

The resistance furnace of the CS-2000 is equipped with a ceramic combustion tube and heating elements made of silicon carbide. Full electronic control of the furnace, including current limitation during cold start conditions, ensures maximum element life. A sensor monitors ambient temperature and provides data for automatic reference point compensation of the thermal element, ensuring that furnace temperature is not affected by fluctuations of ambient temperature.

The design of the resistance furnace boat stop forces the oxygen stream to penetrate into the crucible, thus ensuring efficient combustion. This design eliminates the need for fragile lances or foamed ceramics which are easily blocked with ash.

*CS-2000 with induction and resistance furnace*

PC control with Windows®-based software

ELTRA's instrument software ensures convenient control and operation of the CS-800 and CS-2000 analyzer. 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

- Sample ID memory and serial numbering of samples

- Storage of analysis results in data base: the data of each analysis is stored and can be called up later for reviews, reports, statistical calculations or recalculation of results with modified parameters

- Programmable data base filter: user-defined selection of existing analysis data by sample name, date, ID or other parameters

- Visualization of statistical data and results consistency

- Peak separation calculation for fractional analysis

- LIMS communication and data export

- One point or multi point calibration

- Barometric pressure compensation

- Simultaneous calibration of more than one measuring range

- Automatic linearity correction

- Applications memory and display of maintenance intervals: individual configuration of maintenance intervals

- Hardware diagnostics display and print-outs of technical reports
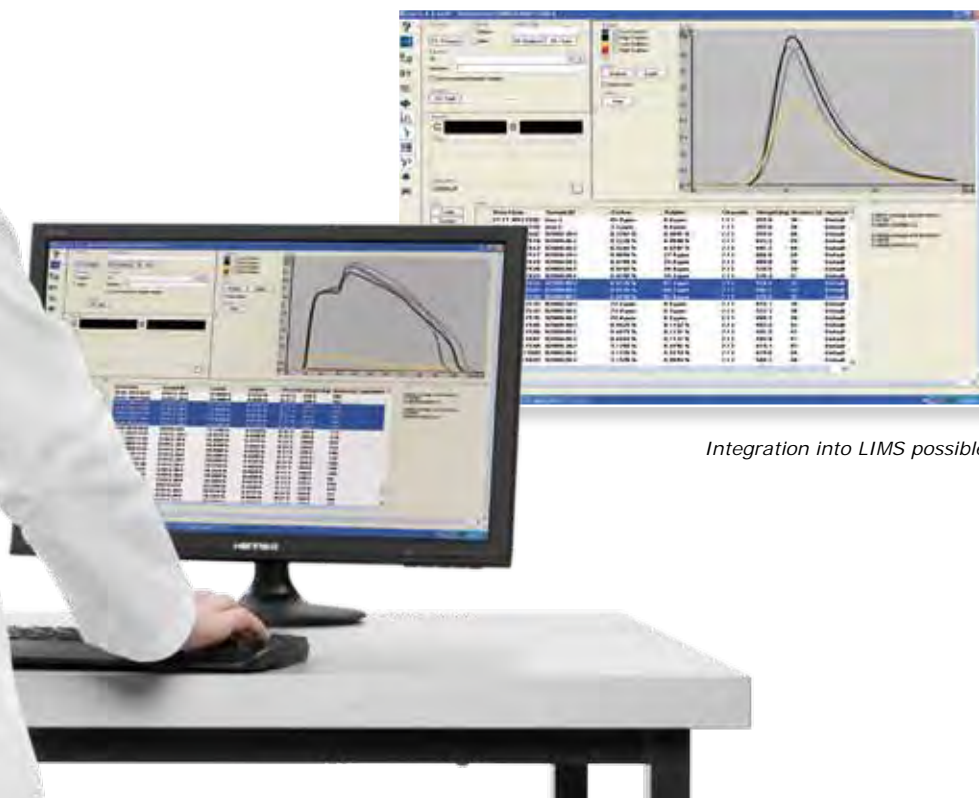
Integration into LIMS possible

ELTRA CS-800 | CS-2000 analyzers fulfill the requirements of all relevant standards

ASTM standard compliance with regards to carbon and/or sulfur determination

Standard	Material to be analyzed	Standard title
E-1019	Steel, iron, nickel, cobalt alloys	Standard Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel, Iron, Nickel, and Cobalt Alloys by Various Combustion and Fusion Techniques
E-1587	Nickel	Standard Test Methods for Chemical Analysis of Refined Nickel
E-1941	Refractory metals	Standard Test Method for Determination of Carbon in Refractory and Reactive Metals and Their Alloys by Combustion Analysis
E-1915-97	Ores and related materials	Standard Test Methods for Analysis of Metal Bearing Ores and Related Materials for Carbon, Sulfur, and Acid-Base Characteristics
D-1552	Oil and petroleum	Standard Test Method for Sulfur in Petroleum Products (High-Temperature Method)
D-4239	Coal and coke	Standard Test Method for Sulfur in the Analysis Sample of Coal and Coke Using High-Temperature Tube Furnace Combustion
D-5016	Coal and coke combustion residues	Standard Test Method for Total Sulfur in Coal and Coke Combustion Residues Using a High-Temperature Tube Furnace Combustion Method with Infrared Absorption
D-1619	Carbon black	Standard Test Method for Carbon Black – Sulfur Content

ISO standard compliance with regards to carbon and/or sulfur determination

Standard	Material to be analyzed	Standard title
9556	Steel and iron	Steel and iron – determination of total carbon content – infrared absorption method after combustion in an induction furnace
10694	Soil	Soil quality – determination of organic and total carbon after dry combustion (elementary analysis)
10719	Steel and iron	Steel and iron – determination of non-combined carbon content – infrared absorption method after combustion in an induction furnace
15349-2	Unalloyed steel	Unalloyed steel –determination of low carbon content – Part 2: infrared absorption method after combustion in an induction furnace (with preheating)
4935	Steel and iron	Steel and iron – determination of sulfur – infrared absorption method after combustion in an induction furnace
13902	Steel and iron	Steel and iron – determination of high sulfur concentrations – infrared absorption method after combustion in an induction furnace
4689-3	Iron ores	Iron ores – determination of sulfur content – Part 3: Combustion / infrared method
7524	Nickel, ferronickel and nickel alloys	Nickel, ferronickel and nickel alloys – determination of carbon content– infrared absorption method after induction furnace combustion
7526	Nickel, ferronickel and nickel alloys	Nickel, ferronickel and nickel alloys – determination of sulfur content– infrared absorption method after induction furnace combustion
15350	Steel and iron	Steel and iron – determination of total carbon and sulfur content – infrared absorption method after combustion in an induction furnace (routine method)

With the induction furnace of the CS-800 and CS-2000 the carbon and sulfur content of a variety of samples can be quickly and reliably determined. The analyzers are suitable for a vast range of inorganic solid sample materials.

Typical sample materials

Steel

Cast iron

Iron

Copper

Alloys

Ores

Cement

Ceramics

Carbides

Glass

Example:
Carbon and sulfur in steel

Sulfur and carbon considerably influence the material properties of steel, particularly its hardness, brittleness, malleability, suitability for welding and processability. Therefore determination of these element concentrations is a routine application in the steel industry.
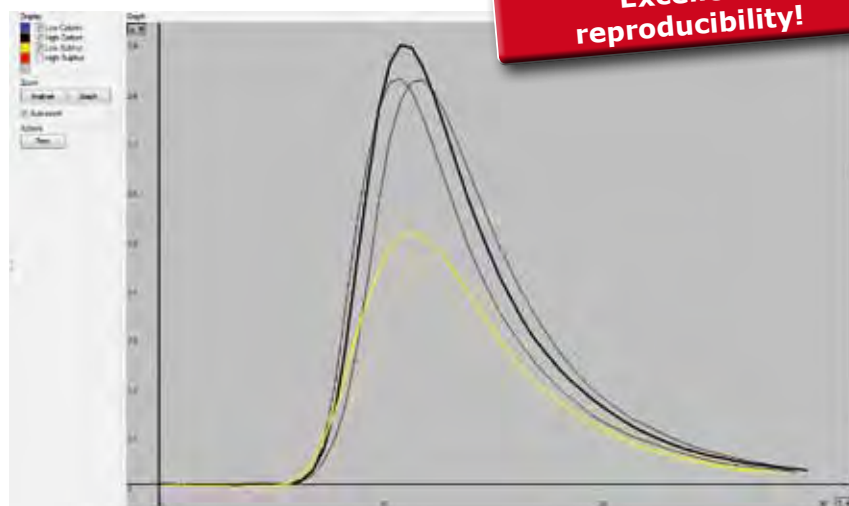
A typical steel sample can be analyzed directly in the induction furnace. Thus reproducible results are quickly obtained.

This method complies with the standards **ISO 9556 and ISO 4935.**

Excellent reproducibility!

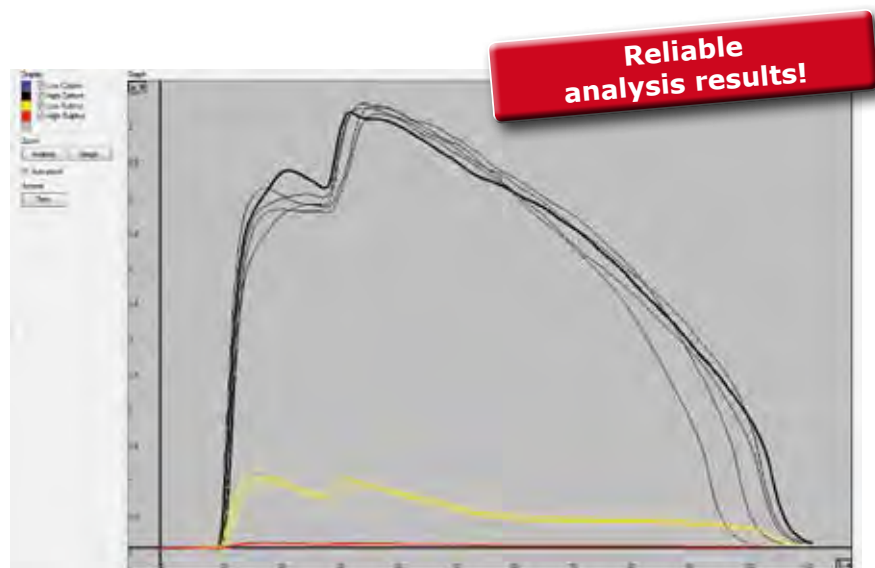| Typical results for steel			
Steel	530.2 mg	0.0233 % C	93.7 ppm S
Steel	528.5 mg	0.0236 % C	94.2 ppm S
Steel	537.7 mg	0.0235 % C	92.6 ppm S
Mean value:		**0.02346 % C**	**93.5 ppm S**
Standard deviation:		**0.000113**	**0.6**

Example:
Carbon and sulfur in coal

For optimum control of flue-gas desulfurization, precise determination of the sulfur content is crucial. The resistance furnace of the CS-2000 is also suitable for larger sample volumes (e. g. 400 mg) to compensate for the inhomogeneity of the sample. Even low sulfur concentrations (for example in biofuels) can be determined correctly and precisely by using larger sample volumes.
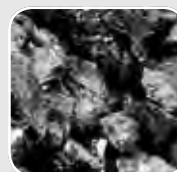
The method complies with the standards **ASTM D1552 and ASTM D4239**.

The CS-2000 allows for precise determination of the carbon and sulfur concentrations in organic sample materials by using a resistance furnace. Applications include determination of these elements in solid and many liquid fuels.

Typical sample materials

Coal/coke

Oil

Wood

Substitute fuels

Lime/gypsum

Soils

Waste

Reliable analysis results!

Typical results coal			
Coal	221.5 mg	77.48 % C	0.379 % S
Coal	212.3 mg	77.57 % C	0.375 % S
Coal	226.9 mg	77.88 % C	0.374 % S
Coal	196.2 mg	77.17 % C	0.376 % S
Coal	223.1 mg	77.17 % C	0.370 % S
Mean value:		**77.45 % C**	**0.375 % S**
Standard deviation:		**0.299**	**0.003**

Technical Data

C, S measurement up to 100%!*

	Induction furnace CS-800 I CS-2000	Resistance furnace CS-2000
Measuring ranges	**500 mg sample**	**500 mg sample**
Low carbon measuring range	0.0001% – 0.1% (0.5 mg C abs.)	0.005% – 0.3% (1.5 mg C abs.)
High carbon measuring range	0.1% – 12% (60 mg C abs.)	0.3% – 40% (200 mg C abs.)
Low sulfur measuring range	0.0001% – 0.3% (1.5 mg S abs.)	0.005% – 0.3% (1.5 mg S abs.)
High sulfur measuring range	0.3% – 6% (30 mg S abs.)	0.3% – 6% (30 mg S abs.)
Sensitivity	**500 mg sample**	**500 mg sample**
Carbon measuring range	0.1 ppm C (0.05 µg)	10 ppm C (5 µg)
Sulfur measuring range	0.1 ppm S (0.05 µg)	2 ppm S (1 µg)
Accuracy[1]	**500 mg sample**	**500 mg sample**
Low carbon measuring range	±1 ppm C[2]; resp. ±1 µg C or ±0.5% of carbon content	±20 ppm C[2]; resp. ±10 µg C or ±1% of carbon content
High carbon measuring range	±10 ppm C[2]; resp. ±5 µg C or ±0.5% of carbon content	±300 ppm C[2]; resp. ±150 µg C or ±1% of carbon content
Low sulfur measuring range	±1 ppm S[2]; resp. ±1 µg S or ±0.5% sulfur content	±4 ppm S[2]; resp. ±2 µg S or ±1% sulfur content
High sulfur measuring range	±30 ppm S[2]; resp. ±4.5 µg S or ±0.5% sulfur content	±0.2% S[2]; resp. ±1 mg S or ±1% sulfur content

*) Depending on sample weight
[1] Whichever is greater
[2] With preheated crucibles and oxygen purification furnace

General data		
Standard sample weight	0.5 to 1 g for steel and cast iron	500 mg for coal
Analysis time	40 – 50 seconds	60 – 180 seconds
Furnace	Induction furnace 19.5 MHz with 2.2 kVA with automatic furnace cleaning; temperature above 2,000 °C	Resistance furnace with ceramic tube, temperature up to max. 1,550 °C; adjustment ±1 °C
Power supply	230 V AC ±10% 50/60 Hz max. 15 A 3,450 W	230 V AC ±10% 50/60 Hz max. power for heating-up 20 A
Weight	110 kg	36 kg
Dimensions (W x H x D)	55 x 80 x 60 cm	33 x 52 x 60 cm
Chemicals	CO_2 trap sodium hydroxide, H_2O trap magnesium perchlorate, catalyst copper oxide	
Measuring principle	Infrared absorption for carbon and sulfur	
Carrier gas	Oxygen 99.5%, 2 – 4 bar	
Compressed air	4 – 6 bar	
Interfaces	serial and USB	
Accessories	Balance ±0.1 mg resolution Computer, monitor, printer (specifications on request)	

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