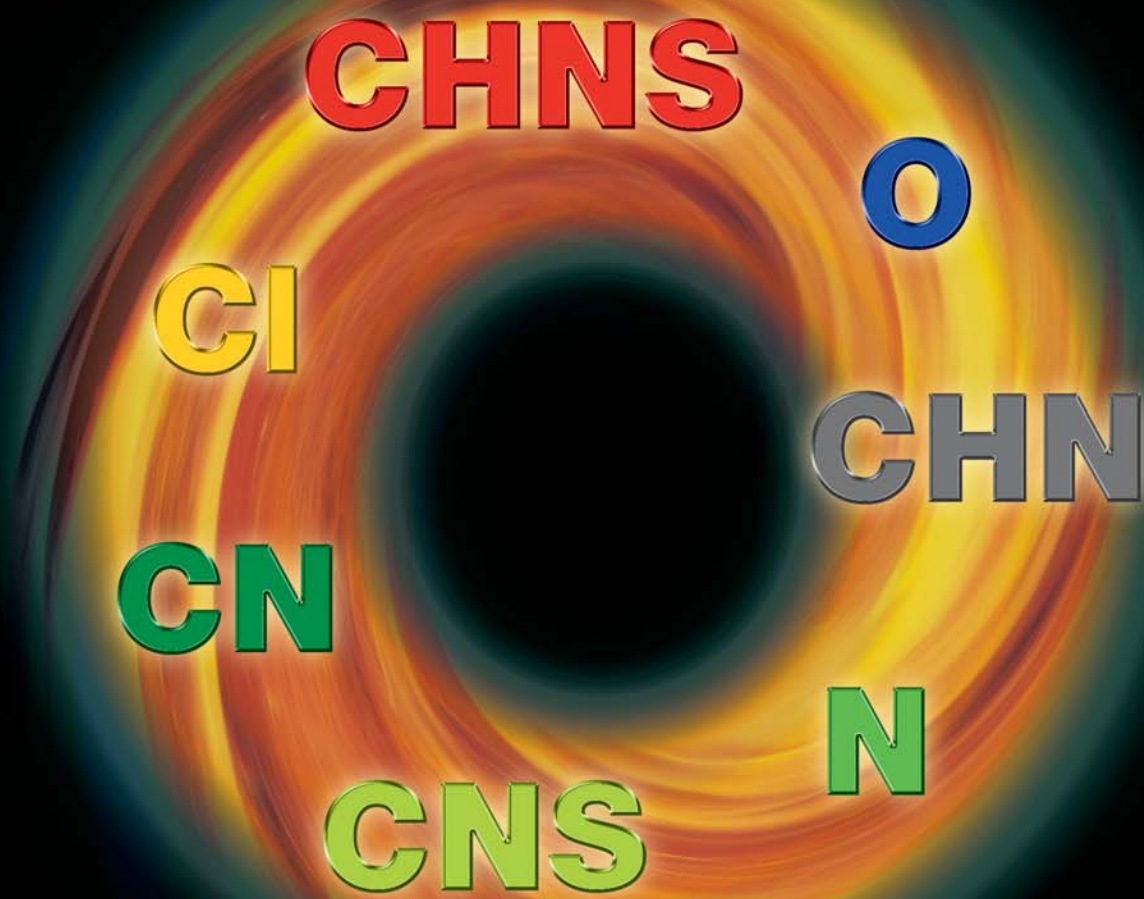


vario MACRO

Elemental Analyzers



The universal way of macro analysis



elementar
Analysensysteme GmbH

German Technology
for quality and environment control



Micro and Macro

vario MACRO

In 1923 Fritz Pregl received the Nobel prize in chemistry for developing the methods for the elemental micro analysis of organic substances.

We are proud that he worked with apparatus manufactured by Heraeus in Hanau which later became the origin of the product line of Elementar Analysensysteme.

Elementar made significant new developments that also added elemental analysis of macro samples – for good reasons:

- Apart from the analysis of synthesis products in the chemical or pharmaceutical lab, the analysis of CHNS today is just as important for agricultural products, environmental samples like sludge or solid waste, soil samples, industrial products or crude oil.
- Representative quantitative analysis of such inhomogeneous samples requires the direct determination of larger sample amounts or laborious homogenization.

- Low concentrations, e.g. of nitrogen or sulfur in natural substances like soil or plant material require also large sample weights for reliable determination.
- Large sample weights connected with easy sample handling are precondition for the routine analysis in close to process quality control.

The key of our success in the analysis of macro samples is the complete and controlled combustion and the gas separation by means of the "purge-and-trap" method that we are using exclusively for elemental analysis. This has brought us into a position to further increase the already large dynamic range of the successful vario EL analyzers again by a multiple. The result is the vario MACRO line.

The worldwide first family of elemental analyzers for macro samples covering the complete range of elements.



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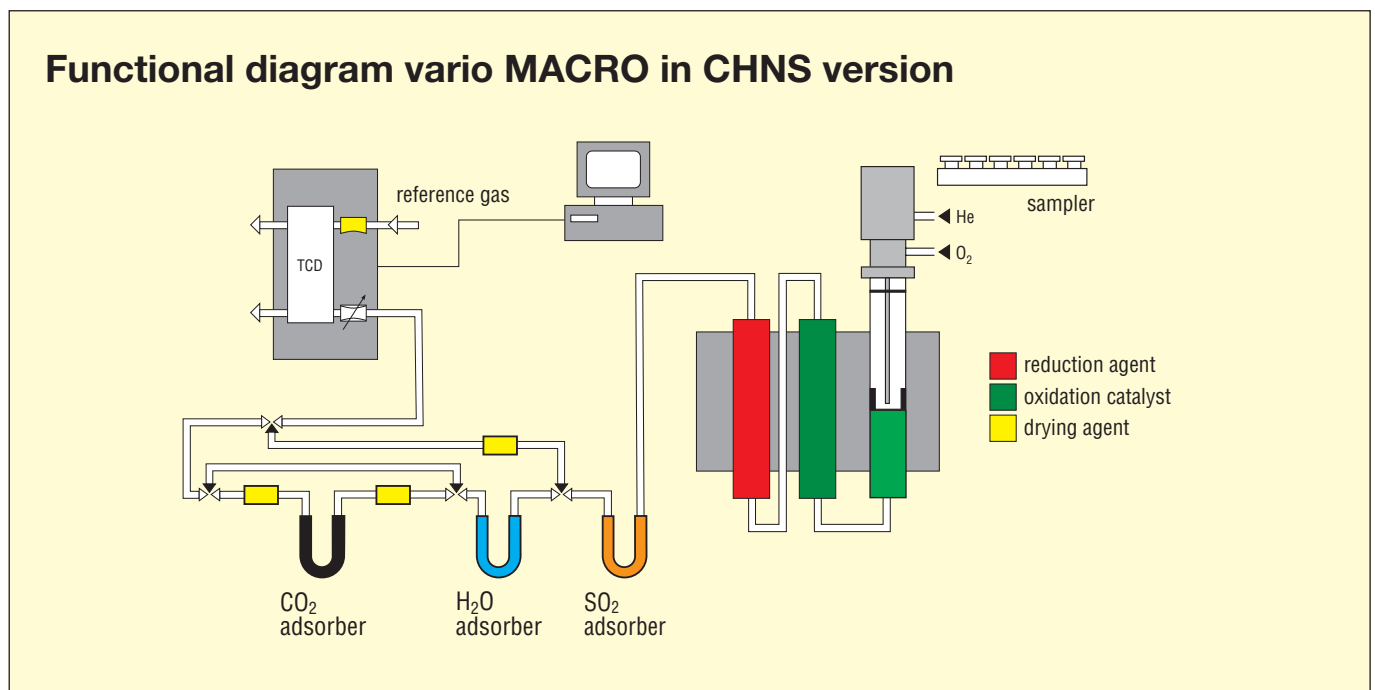
Basics

The instruments of the vario MACRO line are based on the 1000-fold proven platform of the successful CHNOS universal analyzer vario EL and its derived modifications.

By means of the technical features and performances of the vario EL III the largest element concentration to be detected and sample amount has been further increased by a factor of 3-4. This allows analysis of approx. 1 g soil or 500 mg organic substance while at the same time also being able to analyze just a few mg of sample.

Measuring method

The basic principle of operation is high temperature digestion of the sample at 800°C to 1200°C with subsequent scrubbing of non-analytes from the combustion gases. The analyte gases are transported in helium carrier stream. After reduction of formed nitrogen oxides the gas mixture is separated in its components which are sequentially released to a detector (TCD). Furthermore, percent contents of the elements are calculated from the detector signal in connection with the sample weight and the stored calibration curve.



The instrument line

For the first time, a complete family of macro elemental analyzers is available that covers the entire range of elements and their combinations.

- Versions for **N/protein, CN, CNS, CHN** and **CHNS**
- Each version can be optionally equipped for the **analysis of oxygen or chlorine**.
- Furthermore, there is the **opportunity of a later upgrade** into other versions (N to CN, CN to CNS, CHN to CHNS).

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Sample preparation

Weights of macro samples up to 1.5 g or an absolute carbon content of 100 mg can be analyzed. They are wrapped in tin foil or capsules for liquids (option capsule sealing press) up to 1 ml volume. Even samples with large volume or volatile samples **can be sealed gas tight**. A low cost 0.1 respectively 0.01 mg balance can be used for macro samples instead of an expensive micro balance.

Automatic sampler

The sampler is integrated in the instrument and can accommodate either 39 samples up to 1.5 g weight or 1 ml volume or alternatively 79 samples up to approx. 150 mg weight. The samples are transferred from the carousel to the blank free valve (in use in over 1,000 instruments). This proven sampling system assures **trouble free operation** for no worry night time unattended operations.

High temperature combustion

The **3-tube-furnace** allows permanent combustion temperatures of up to **1200°C**. This high temperature is especially critical for S, O and Cl analysis. Electronic mass flow controlled oxygen injection directly at the spot of combustion as well as post combustion and reduction in spacious separate tubes allow quantitative macro analysis. Tube exchange in seconds and use of robust steel combustion tubes for N, CN and CHN are further characteristic features of the combustion technology.

Like all of Elementar's elemental analyzers, the vario MACRO analyzers come with a **10 years furnace guarantee**.

Effective gas drying

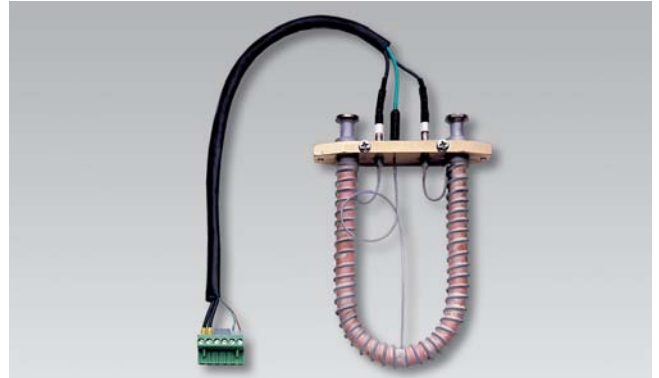
A multi stage gas drying is used in the non-hydrogen and sulfur modes (N and CN). Drying is achieved by means of a **counter flow membrane** followed by dessicant for trace moisture removal. This allows for the analysis of a large series of macro samples without the necessity of frequent exchange of drying agents.



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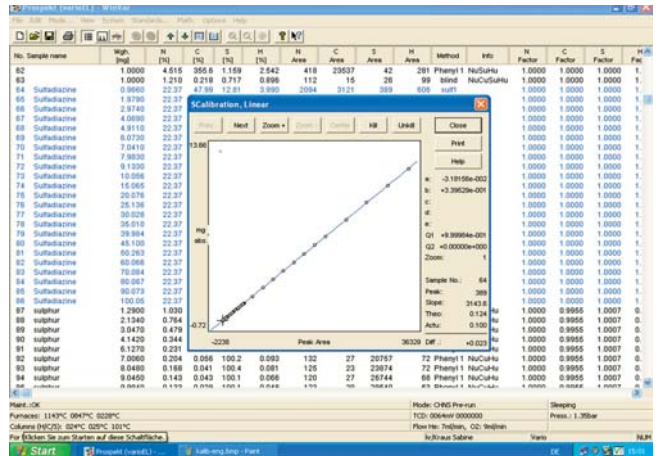
Purge & trap gas separation

The gas separation is performed by computer controlled ad/desorber tubes that are specifically adsorbing the analyte gases H₂O, CO₂ or SO₂ and release them by the increase of temperature. This leads to an **enormous dynamic concentration** and an **overlap-free peak separation**. It is the key to macro analysis of all combustion gases with optimal separation performance and sensitivity. **Furthermore, it is essential for simultaneous analysis of sulfur.**



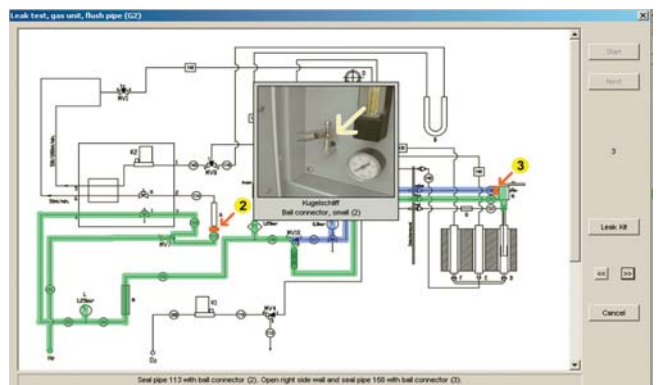
Large range detection

The thermistor based thermo-conductivity detector has a dynamic range of >10⁵, it is **noise-, destruction- and drift-free** and usually does not need maintenance in the long lifetime of the instrument. With automatic gain control and in connection with the particularly precise electronic gas flow control **the basic instrument calibration is stable for months and years.** This allows a safe analysis of milligram or gram sample amounts. For specific measuring tasks like oxygen or chlorine special detectors like coulometer or IR photometer can be used.



Instrument control and data processing

The complete control and data processing is performed by a **PC under Windows®**. A matter of course are features like automatic maintenance control, leak test, sleep/wake up and statistics functions or implementation into LIMS and other data networks. Regarding electronic data safety and validation all requirements of the FDA according to **21 CFR Part 11** are met.



Highest safety standards

The full compliance with safety standards like CE, DIN or EMC are a matter of course. Significant for the user safety is that the whole instrument incl. the furnaces operate on low voltage. This results in increased furnace life. Even in the case of mains failures in the electricity or with the fan operation, the furnace area will not be damaged.



Tailormade Solutions

vario MACRO



vario MACRO N

For the Dumas combustion type N/protein analysis as a fast, safe and environmentally friendly alternative to the Kjeldahl method. E.g. for food and feed like grain and grain products, dairy products, meat products, baby food or for the brewing industry. Easily upgradable from N operation to CN operation.



vario MACRO CN

In addition to the Dumas protein analysis in agricultural products, the CN content provides important information in the plant research or for soil fertility. The total content of N and C also plays a role in the contamination analysis of environmental samples like sewage sludge or highly contaminated waste waters. Easily upgradable to CNS operation.



vario MACRO CNS

The sulfur contents often provide important additional information for agricultural and environment related investigations of soil and plants. The high sample weight allows reliable analysis even for low sulfur contents.

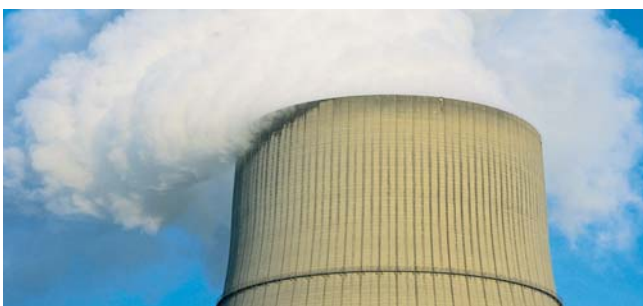
Alternatively, also CN operation is possible (option).



vario MACRO CHN

CHN analyses are standard methods for characterization of fossil fuels like coal, peat or heavy oil but also for renewable primary products like biomass or combustible solid waste. Sample weights of 100 mg and more allow the analysis of low CH contents, e.g. in slag or ash.

Easily upgradable to CHNS operation.



vario MACRO CHNS

The first macro analyzer for the simultaneous determination of carbon, hydrogen, nitrogen and sulfur, e.g. for the analysis of fuels, environmental samples or industrial products with lower homogeneity or low concentrations.

Like all other vario MACRO versions, optionally also useful for oxygen and chlorine analysis.

vario MACRO

vario MACRO is today's most universal analyzer for macro samples. This statement is based both on the number of elements which can be determined, as well as the ability to determine more elements simultaneously.

Even on introduction, many applications have been identified which benefit from the powerful specifications of the vario MACRO. Some examples are listed below.

Sample	Mode	Weight approx. [mg]	Element content [%]			
			N	C	H	S
mixed fodder	N	150	3.175 ± 0.019			
wheat flour	N	500	1.698 ± 0.006			
wheat flour	N	100	1.686 ± 0.007			
soil	CN	100	0.125 ± 0.001	0.162 ± 0.004		
sludge	CN	400	0.186 ± 0.006	1.969 ± 0.054		
soy meal	CN	200	5.992 ± 0.026	48.99 ± 0.09		
spruce needles	CNS	200	1.829 ± 0.017	49.62 ± 0.054		0.230 ± 0.009
soil	CNS	200	0.127 ± 0.005	1.341 ± 0.015		0.022 ± 0.001
biomass	CNS	70	3.56 ± 0.02	55.95 ± 0.22		2.12 ± 0.01
coal	CHN	100	1.710 ± 0.022	82.59 ± 0.024	3.930 ± 0.022	
ash	CHN	200	0.018 ± 0.004	0.854 ± 0.058	0.045 ± 0.006	
heavy oil	CHN	80	0.339 ± 0.050	84.47 ± 0.08	10.71 ± 0.01	
phenylalanine	CHN	5	8.513 ± 0.018	65.47 ± 0.055	6.719 ± 0.019	
NCS coal	CHNS	10	1.346 ± 0.052	78.38 ± 0.23	4.538 ± 0.150	1.313 ± 0.020
NCS coal	CHNS	100	1.346 ± 0.021	78.35 ± 0.07	4.537 ± 0.020	1.377 ± 0.006
waste	CHNS	60	0.843 ± 0.031	52.55 ± 0.06	7.415 ± 0.014	0.132 ± 0.009
benzoic acid	O (WLD)	5	26.21 ± 0.027 % O			
coal	Cl	40	72.2 ± 1.8 mg/kg Cl			
toluene	Cl	70	32.21 ± 0.63 mg/kg Cl			

500 mg or 100 mg wheat flour test results show the linearity of the system., as well as for the increased sample weight from 10 to 50 mg for NCS coal. 200 mg weight allows the analysis of only 200 ppm S in soil in the CNS mode.

The example of phenylalanine also is a proof that with homogeneous samples also micro weights of 5 mg allow very precise results, e.g. for CHN analysis.

Specification vario MACRO

Principle:	combustion method at 850°-1200°C (1800°C by combustion in tin boats) "Purge-and-trap" gas separation and TCD detection
Operation modes / versions:	N, CN, CNS, CHN, CHNS (upgradability N to CN, CN to CNS, CHN to CHNS) Options for the determination of O as well as Cl
in accordance with:	AOAC 990.03, AOAC 993.13, AOAC 968.06, AOAC 992.15, AOAC 992.23, ASBC, AACCC, (for fertilizer, meat, meat products, cereals, oil seeds, brewery grains, flour, feed) DIN 10 467 milk and dairy products EN 61010, DIN/ISO 13878 (soil), LUFA, MEBAK (breweries), ASTM D5373-93 (C, H, N in coal and coke) ASTM D5291-91 (C, H, N in oil products and lubricants)
in accordance with safety standards:	CE-label (EMC & and low voltage requirements) IEC 1010, DIN EN 50081-1/2, DIN EN 50082-1/2
Measuring ranges:	C: 0.002% up to 100% (or max. 100 mg abs.)* N: 0.004% up to 100% (or max. 100 mg abs.)* H: 0.015% up to 100% (or max. 15 mg abs.)* S: 0.004% up to 100% (or max. 15 mg abs.)* O: 0.05% up to 5 mg abs.* Cl: 0.1 – 50 µg abs.
Sample weight:	up to approx. max. 1.5 g respectively up to 1 g soil or 500 mg organic material*
Precision:	A 0.5% RSD (for 100 mg test substance, e.g. glutamic acid)
Analysis time:	self-optimizing, depending on element content and weight e. g. 4 min. for N in 100 mg glutamic acid, 6 min. for CN for 100 mg soil sample
Autosampler:	39 positions (standard), for sample volume up to 1 cm ³ 79 positions (optional) for approx. = 150 mg sample
Gases:	He: 99.995 % purity O ₂ : 99.995 % purity
Instrument control and evaluation data:	external PC under Windows®, automatic leak test, error diagnosis, maintenance cycles, statistics, sleep/wake-up function, LIMS compatible; in accordance with the requirements 21 CFR Part 11 (option)
Electrical connections:	110/230 VAC, 50/60 Hz, 1.8 KW
Dimensions:	78 cm x 56 cm x 62 cm (L X W X H)
Weight:	approx. 120 kg

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*depending on sample kind and size as well as operation mode



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