



vario TOC  CUBE



Clean analysis for a clean environment

The advantages for our nature are evident

Water is the prerequisite for life on our planet. In times of growing environmental problems the measurement of the water quality as well as for solids such as soils are vital.

The measurement of all organic pollutants by means of their content of organically bound carbon (TOC) serves as the analysis method for fast and highly sensitive determination of the total pollution load.

Crucial advantages compared to the classical wet chemical Chemical Oxygen Demand (COD) procedures are:

- Decrease of the analysis time from hours to minutes
- Omission of pollutants like Cr^{6+} or concentrated sulphuric acid
- Completely safe and automatic operation
- No measuring result falsification by inorganic substances
- Additional possibility to measure bound nitrogen (TN_b) instead of the also environmentally problematic Kjeldahl method

TOC by experience

As the successor of Heraeus, Elementar has a more than 100 years tradition in developing and manufacturing analyzers for the “organic“ elements such as carbon and nitrogen by means of high temperature digestion.


This concept was already used in 1976 in the first fully automatic TOC analyzer. The vario TOC cube is the very latest development of TOC/ TN_b analyzers by Elementar. This top of the line analyzer is a totally new concept. It combines the advanced water analysis with the elemental analysis of solids based on the special experience of Elementar for both these areas of instrumental analysis.

Liqui TOC 1976 (Heraeus)





 elementar

vario TOC  cube

The basic concept decides

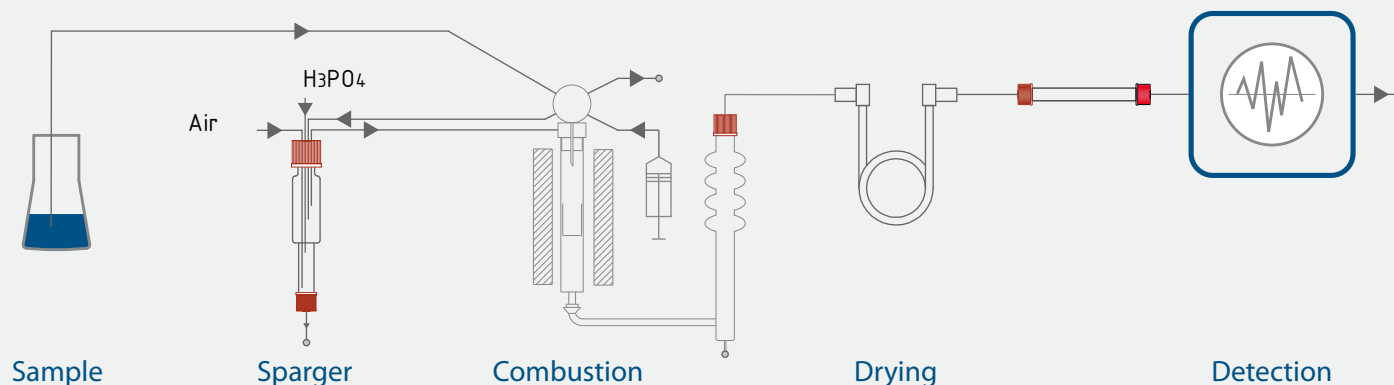
The measuring principle is based on the high temperature digestion of the sample in an air/O₂ stream at 850°C. For special applications with thermally stable solids, digestion temperatures of permanently up to 1200°C or temporarily 1800°C can be achieved. Totally bound carbon is converted into CO₂ which is quantitatively determined by means of a NDIR detector. The advantage of this method as opposed to the wet chemical UV/persulfate digestion is the absolute assurance that even stable compounds, particles or salt containing solutions will be completely detected. Additionally the high temperature method makes the determination of bound nitrogen (TN_b) possible.

The liquid sample is aspirated via a dosing syringe and directly injected into the combustion tube where catalytic oxidation takes place. Alternatively, solid samples are inserted via a ball valve. Water vapor is removed in a 3-stage drying process, “rock steady” flow rate is maintained in the presence of varying pressure conditions by a digital mass flow controller, resulting in the most accurate measurement of the total carbon (TC) content by NDIR detection.

A connected PC calculates the carbon content from the sample volume and/or weight and the detector signal based on a calibration curve.

Inorganic carbon (carbonate), may be automatically determined as TIC after acidification and purging in the sparger. The TOC is calculated from TC-TIC. A direct non purgable organic carbon (NPOC) determination is also possible after external TIC removal (typically in the sample carousel). The sparger may also be used for direct determination of purgable or volatile carbon compounds (VOC or POC). Thus, all relevant parameters of TOC analysis are accessible with one instrument and without extensive modifications.

The use of NO specific detectors extends the application area to the TN_b analysis of bound nitrogen. The total concept is enhanced due to short gas and liquid pathways and a minimum number of valves. This results in shorter analysis times, lower detection limit as well as the ability for measurement of particle and salt containing samples.





Superior – the sum of the Good

Variable sample feeding

The vario TOC has the capability for integrated automatic sample feeding of liquids, particulate containing liquids, semi-solids and even solid samples. For liquid samples the well proven digitally controlled syringe aspirates all aliquots of sample required for the number of replicates from the sampler vial all at once. The transfer tubing is rinsed with the sample itself, and then each aliquot is sequentially injected into the combustion tube. This procedure eliminates replicate variability due to atmospheric CO₂ after the septum is pierced. Variable injection volumes, from 50 µl to 2 ml, allow multi-point calibrations from just one calibration solution over a very large dynamic range. Analyses of particulate containing samples benefit from a single ceramic manifold valve and short tubing paths.

For solid sampling, Elementar has incorporated its well proven solid sampling technology utilized in organic elemental analysis. The samples are weighed into tin capsules and automatically transferred to the combustion tube via the patented ball valve of Heraeus. This allows for virtually any type of sample to be analyzed, from just a few µl of a liquid, large particulate containing samples, semi-solids to actual solid samples. Automatic sample feeding of up to 120 samples is possible, with analysis times of only 2-3 minutes.

High temperature digestion with matrix separation

A high combustion temperature is vital for a quantitative oxidation of bound carbon to CO₂ and a precondition for the digestion of stable compounds and particles. The vario TOC cube can be operated at a permanent furnace temperature of up to 1200°C. In solids mode the combustion enthalpy of the tin capsules results in a temporary temperature increase

of up to 1800°C. This allows the analysis of even refractory samples. Quartz ash crucibles are used for the separation and collection of combustion residues. The combustion takes place in the crucible, and non volatile or incombustible materials, such as salts, remain behind. This is the first use of ash crucibles for matrix separation in TOC determinations (patent applied for). Thus, contamination of the catalyst can be prevented and the residues can be easily removed from the crucible. Therefore it is possible to work above the melting point of NaCl.

Highly stable operation and results

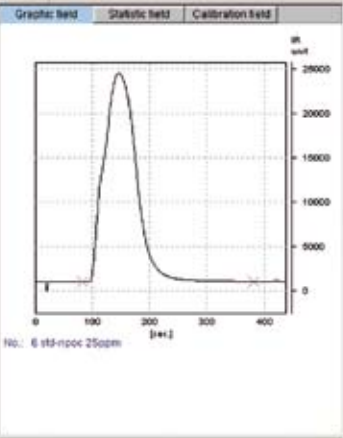
Long term stability and high sample throughput are imperative if TOC analysers are to be effectively used for screening purposes. The vario TOC sets new standards in this regard. Even with large injection volumes the highly effective 3-stage drying system is working almost maintenance free. Fluctuations in the gas stream caused by sample injection and evaporation are controlled electronically and reliably with a digital mass flow controller. The ability to separate sample matrices from analyzed gases results in long uninterrupted measuring periods even for highly contaminated samples.

NDIR detection of the next generation

A completely new high performance detector for CO₂ is used in the vario TOC cube. The actual realization of the non dispersive infrared (NDIR) principle means a minimization of spectral interferences and a vastly low-noise characteristic. A dynamic detection range for TOC from ppb into the percentage range is achieved by the 24 bit digital resolution of the measuring signal without the need for measuring range gain adjustments. Unique is the possibility to also measure TN_b by means of NDIR detection.

080107 NO-Cal (1mg) (varioTOC) - RAS verno TOC Liquid

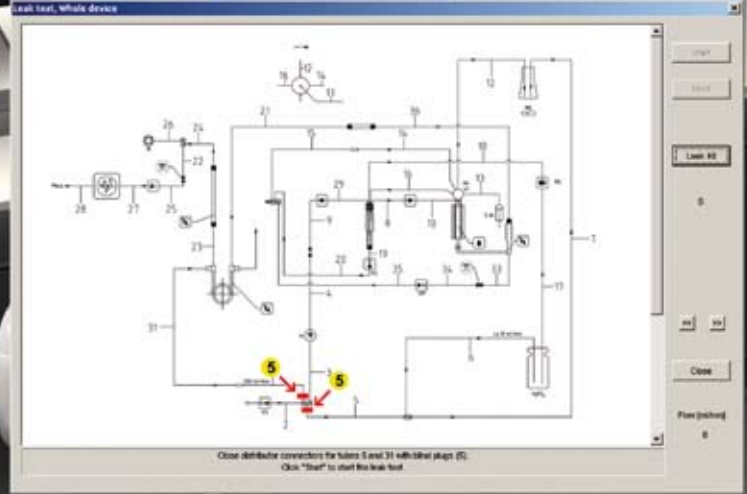
No.	Hole Pos.	Name	Method	TOC-Vol [ml]	TOC Area	TOC [mg/l]	Det. Fact.
1	1	std-epoc 25ppm	TOC7thb	1.000	57.656	25.000	1
2	1	std-epoc 25ppm	TOC7thb	1.000	57.779	25.000	1
3	1	std-epoc 25ppm	TOC7thb	1.000	57.974	25.000	1
4	2	std-epoc 25ppm	TOC7thb	1.000	57.840	25.000	1
5	2	std-epoc 25ppm	TOC7thb	1.000	58.008	25.000	1
6	2	std-epoc 25ppm	TOC7thb	1.000	57.706	25.000	1
7	3	std-epoc 50ppm	TOC7thb	1.000	113.876	50.000	1
8	3	std-epoc 50ppm	TOC7thb	1.000	114.063	50.000	1
9	3	std-epoc 50ppm	TOC7thb	1.000	113.926	50.000	1
10	4	std-epoc 100ppm	TOC7thb	1.000	227.483	100.000	1
11	4	std-epoc 100ppm	TOC7thb	1.000	228.508	100.000	1
12	4	std-epoc 100ppm	TOC7thb	1.000	229.195	100.000	1
13	5	std-epoc 150ppm	TOC7thb	1.000	345.275	150.000	1
14	5	std-epoc 150ppm	TOC7thb	1.000	345.995	150.000	1
15	5	std-epoc 150ppm	TOC7thb	1.000	345.228	150.000	1
16	6	std-epoc 200ppm	TOC7thb	1.000	461.390	200.000	1
17	6	std-epoc 200ppm	TOC7thb	1.000	461.659	200.000	1
18	6	std-epoc 200ppm	TOC7thb	1.000	460.910	200.000	1
19	7	std-epoc 250ppm	TOC7thb	1.000	578.489	250.000	1
20	7	std-epoc 250ppm	TOC7thb	1.000	578.633	250.000	1
21	7	std-epoc 250ppm	TOC7thb	1.000	578.482	250.000	1
22	8	std-epoc 300ppm	TOC7thb	1.000	689.689	300.000	1
23	8	std-epoc 300ppm	TOC7thb	1.000	689.337	300.000	1



24. Name: std-npoc 300ppm TOC [mg/l]: 300.000

Process	Detector	Temperature [°C]	Flow [ml/min]	Press [bar]
Stability	IR	Comb. tube	MRG	Press
	IR temp.		Flow	Maintenance
				1.7%

For help, press F1.



Logbook for month 06 / 2008

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04.06.2008 15:22:13 ID=1050 easuser@easuser (varioTOC superuser)
Load file: "080107 NO-Cal (1mg)"

04.06.2008 15:21:36 ID=1050 easuser@easuser (varioTOC superuser)
vario TOC program start offline
Analyse mode: Liquid
Version list:
vario TOC SW: V1 3.0 29.06.2008
vario TOC version: V1 3.0 29.06.2008
Serial No.: 470

04.06.2008 15:21:17 ID=1050 easuser@easuser (varioTOC superuser)
User log-on

03.06.2008 11:46:53 ID=1024 easuser@easuser (varioTOC superuser)
Log-off

03.06.2008 11:16:39 ID=1024 easuser@easuser (varioTOC superuser)
vario TOC program start offline
Analyse mode: Liquid
Version list:
vario TOC SW: V1 3.0 29.06.2008
vario TOC version: V1 3.0 29.06.2008
Serial No.: 470

03.06.2008 11:16:18 ID=1024 easuser@easuser (varioTOC superuser)
User log-on
  
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Micro electronics as the decisive factor

In our time an analytical instrument can only be as good as its micro electronics and software.

The vario TOC cube design utilizes the latest micro electronic technology in which all instrument functions are digitally controlled and monitored. This results in completely new possibilities in automatic operation, optimization as well as remote control and diagnosis over the internet.

The basis for this is the use of a new micro processor generation with 24 bit signal processing and electronic sensors for all gas flows and pressures.

The vario TOC cube's firmware (internal software of the analyzer) is stored on flash EPROMS, which can be easily updated via PC or the internet. The critically important fast signal communication between components in the analyzer (such as the detector signal) is handled by the fail-safe CAN bus technology.

A commercial PC or laptop serves as the user interface for control and evaluation. Our software runs under the Windows operating system and offers features and capabilities too numerous for a complete listing here.

Design and operation of the Windows based software is a key component of our whole system. The vario TOC cube software is written and developed at our own premises by our own personnel according to strict ISO 9001 requirements.

The software allows for a continual monitoring of real time conditions of the analyzer in both numerical and graphical forms, easy and efficient input of run information with automated functions, cut and paste data to or from Excel, as well as statistical analysis options.

The system is designed for intuitive operation, but content sensitive help is just a click away. Automatic optimization of parameters, monitoring of maintenance intervals and service messages, LIMS data transfer are all integrated into the system. Graphical leak checking with pictorial guides for each step are a new favorite feature of users.

We also feature our unique browser based 3D pictorial parts list, with drill down operation and exploded component diagrams.

Data safety and validity can be assured with the available 21 CFR Part 11 compliant option.

Liquid measurements		TOC, TIC, TC [mg/l] *		Solid measurements		TC [%] *		
Pure water		TOC	0.069	± 0.006	River sediment (Elbe)		8.496	± 0.136
Measurements:	10				Measurements:	5		
Volume:	2 ml				Weight:	20 mg		
Drinking water (Hanau)		TOC	0.634	± 0.009	River particulate (Elbe)		5.396	± 0.088
Measurements:	10				Measurements:	5		
Volume:	0.6 ml				Weight:	20 mg		
Well water		TIC	20.04	± 0.25	Soil standard 2 (0.732% C)		0.714	± 0.010
Measurements:	5	TC	21.53	± 0.12	Measurements:	5		
Volume:	0.8 ml				Weight:	20 mg		
River water (Elbe)		TOC	39.10	± 0.40	Soil standard 1 (3.5% C)		3.514	± 0.039
Measurements:	5				Measurements:	5		
Volume:	0.8 ml				Weight:	20 mg		
Municipal waste water		TOC	27.96	± 1.32	Filter dust		2.157	± 0.040
Measurements:	5				Measurements:	3		
Volume:	0.8 ml				Weight:	20 mg		
Galvanic waste water		TOC	3.776	± 0.133	Langbeinite with additive		34.23	± 0.0034
Measurements:	10				Measurements:	3		
Volume:	0.8 ml				Weight:	200 mg		
Sea water (Red Sea)		TOC	0.858	± 0.013	Nitrogen measurements		TN_b [mg/l] *	
Measurements:	10				Mixed standard NH₄/NO₃		100.0	± 0.3
Volume:	0.5 ml				Measurements:	6	Detector	CLD
					Volume:	0.05 ml		
Brine (36 % NaCl / 1:1)		TOC	1.006	± 0.022	Sea water (Valencia)		1.84	± 0.25
Measurements:	20				Measurements:	8	Detector	CLD
Volume:	0.2 ml				Volume:	0.5 ml		
Brine (Bad Soden Salm.)		TIC	112.0	± 4.6	Nitric acid (approx. 5%)		10,455	± 450
Measurements:	5	TC	116.3	± 2.9	Measurements:	12	Detector	NDIR
Volume:	0.25 ml				Volume:	0.1 ml		
Hydrochloric acid (3.2 %)		TOC	1.379	± 0.033	Standard (100 ppb)		0.091	± 0.013
Measurements:	20				Measurements:	8	Detector	NDIR
Volume:	0.5 ml				Volume:	2 ml		
Industrial waste water		TOC	41.84	± 0.81				
Measurements:	5							
Volume:	0.25 ml							

* Element concentration in [%], Standard deviation in [%]

Even if it gets really tough

Pure water

In connection with an injection volume of 2 ml the highly sensitive NDIR detector allows the analysis of water qualities for pharmaceutical applications. A standard deviation of 6 ppb for a concentration of 70 ppb significantly exceeds the requirements of the Pharmacopoeia.

Drinking water

Even with high carbonate contents a very low TOC value is precisely measurable after acidification and purging of the TIC. Comparable conditions can also be found for well water.

Surface water

Water from rivers and lakes do not represent any difficulties for the vario TOC cube. Particles and suspended solids which are commonly present in these samples can be measured directly without any problems.

Waste water

The large dynamic measuring range offers advantages for strongly fluctuating TOC concentrations in municipal waste water. Even waste water from circuit board processing with high electrolyte contents such as sulphates are measured correctly due to the matrix separation and interference-free CO₂ detection.

Sea water

The salt content of the oceans is approx. 3.5% whereas the TOC content lies in the lower ppm range. The vario TOC cube is able to perform over 100 precise TOC measurements

before the separated salt has to be simply removed from the matrix separator. A special TIC only mode is very useful for sea water analysis.

Highly concentrated solutions

Brine is a saturated (36%) salt solution from processes like chlorine alkaline electrolysis. After a 1:1 dilution it is possible to measure 200 samples in series and to determine safely even 1 ppm TOC. Natural brine with 9.5% dissolved mineral content is one of the most concentrated in Germany and has a natural high turbidity. Even diluted mineral acids can be safely measured with vario TOC cube.

Solids

The integrated sampler in connection with the high temperature combustion allows TC analyses with tin capsules of up to 120 samples. Samples can range from true solids to heavy slurries to pasty semi-solids. This technique can also be used for liquid samples in which only a limited quantity exists (even several µl's). Carbon can even be determined from thermally stable carbide ceramics with a decomposition temperature of 1800°C with a 100% recovery.

Nitrogen measurements

vario TOC makes it possible to determine the chemically bound nitrogen (TN_b) which is gaining more interest in water analysis.

There are 3 detectors available for the detection of the formed NO. Using a NDIR detector, for example, a standard deviation of 13 ppb at 100 ppb as well as a large concentration range up to more than 50,000 ppm can be attained.



vario TOC cube – literally variable

Variability with a compact shape

vario TOC cube represents a complete line of TOC analyzers which can be configured for the individual user requirements. The modular system is based on a basic instrument which already includes the main functions:

- Automatic dosing and distribution of liquid samples
- Sparger for stripping of TIC as CO₂ or POC
- High temperature combustion for oxidation of TC/ NPOC or POC (VOC) to CO₂
- Measuring gas drying and electronic gas flow control
- CO₂ detection in the carrier gas stream
- Power, control and regulation electronics
- Instrument operation, control and measuring value processing is done via a connected PC or laptop

In connection with the basic instrument there are a variety of modules available to achieve various applications.

Selection of liquid sample feeding

Different modules allow the measurement of liquids either in single mode or with an automatic sample feeder for either 32, 50 or 80 samples. The sampler for 32 samples is especially suitable for 40 ml septum vials according to EPA. The sample can be stirred in each of the operation modes. Air purging for stripping TIC or POC (VOC) is also possible. All types of samplers will be integrated in the instrument and do not require any additional footprint. Random access to selected sample positions is also a feature of vario TOC auto samplers.

Selection of solid sample feeding

Different modules enable the measurement of samples in tin foils or capsules, either in single mode or with an automatic sampler for 80 or 120 samples. This is suitable for solid samples but can also be used for heavy particulate containing samples, viscous liquids, semi-solids or liquid samples of very small quantity. Sample as large as 300 mg can be accommodated in the 120 position sampler, and up to 1 g in the 80 position sampler.

Variable Configuration

The user can easily and quickly reconfigure the vario TOC cube between liquids or solid sampling.

Selection of the detections

Three different NDIR detectors are available for carbon determination.

- A standard wide range NDIR detector is suitable for almost all applications
- A trace version NDIR with double cuvette length is available for lowest detection limits.
- For very high carbon concentrations e.g. in solids, a special optional detector is available

The content of bound nitrogen (TN_b) can be optionally measured with 3 different detection types:

- Electrochemical cell (EC) as the most economic detection type
- Chemiluminescence detector (CLD) according to DIN 38409 H27
- Non dispersive IR detector for largest concentration range from 0.05 to more than 50,000 ppm.

Specifications vario TOC cube

Analysis method:	Catalytic high temperature combustion at 850°-950°C (max. 1200°C) Oxidation from C to CO ₂ which is quantitatively determined with a NDIR Optional detection of the formed NO with NDIR, CLD or EC		
Measuring parameters:	TC, TOC, DOC, NPOC, TIC, POC optional TN _b		
Norms and standards:	ISO 8245, EPA 415.1, European standard acc. to EN 1484, ENV 12260, European Pharmacopoeia 6.0, vol.1 (20244) 2008, p. 71, U.S.Pharmacopoeia-NF, USP 30 (643) 2007; DIN 38409		
Safety standards:	CE, IEC 1010, EMV		
Measuring range:	C	0 – 60,000 mg/l 0 – 100 %	in liquids in solids
	N	0 – 200 mg/l 0 – > 50,000 mg/l	(CLD) (NDIR)
Detection limits* (SD):	C	6 µg/l (ppb)	(3 µg/l (ppb) for trace version)
	N	0,02 mg/l (ppm)	(NDIR)
Precision* (RSD):	< 1%	at > 5 mg/l C	
Analysis time*:	3-4 min per parameter		
Sample quantity*:	liquid:	<50 – 2,000 µl variable	
	solid:	1 g soil sample or 10 mg C abs. (optional up to 50 mg C)	
Particle size*:	exceeds the requirements EN 1484 for 200 µm cellulose standard, with capsule technique no upper limit		

* depending on sample type and analysis mode

Specifications vario TOC cube

Analysis time*:	Approx. 4 min / parameter
Calibration:	Automatic multi point calibration
Sample feeding:	<ul style="list-style-type: none">• liquid samples manual• solid sample manual• automatic sampler for liquid samples with 32 (40 ml), 50 (12 ml) or 80 (6 ml) positions all positions can be stirred• automatic sampler for solid or particles containing samples with 120 or 80 positions depending on sample size
Instrument control	<p>Operation and control via PC under Windows®; All instrument functions are digitally controllable, the comprehensive operation software includes e.g. automatic leak test, extensive error diagnosis, monitoring of the maintenance cycles, sleep-/wake up function, statistical evaluation and almost unlimited memory capacity for analysis data incl. graphics.</p> <p>Integration in data networks like LIMS and the possibility of remote control and diagnosis via the internet.</p> <p>In full compliance with 21 CFR Part 11 (option).</p>
Gas:	Synthetic air (hydrocarbon and CO ₂ free) or oxygen (4.5), 200 ml/min
Electrical connections:	100/110/200/230 VAC, 50/60 Hz, 1.8 kW
Dimensions*:	48 × 55 × 57 cm (w × d × h)
Weight:	approx. 60 kg

* depending on sample kind and analysis mode

vario TOC cube is the universal analyzer for the sum parameter determination of TC, TOC, NPOC, TIC and POC and optional TN_b, for all sample matrices, from pure water to solids. Unique ability to analyze fully automated up to 120 solid samples or capsules with no limitation in particle size and sample matrix.



Water Analysis

Pure water, surface water, drinking water, well water, brine, etc.

Environmental Analysis

Industrial and municipal waste water, sewage sludge, solid waste, etc.



Pharmaceuticals

Injection water, cleaning validation, process water, etc.

Geochemistry, Oceanography

Sediments, suspended particles, sea water, glacier water, carbonate rock

Industrial Quality Control

Galvanic baths, brine, Bayer Liquor, salt, etc.



Special Applications

Isotope ratio analysis (IRMS), ceramics, etc.

T 0346 26 90 90	I www.salmenkipp.nl
F 0346 26 48 14	E info@salm-en-kipp.nl