Technical Data

AOX analyzer
multi X 2500

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General

- The multi X 2500 is more than an AOX analyzer. It is suitable for the determination of AOX, EOX, and POX, as well as for the determination of TOC in water samples and for total chlorine (TX) determination in solid and liquid samples.
- An innovative concept - double furnace technology combines horizontal and vertical combustion in a single instrument! The advantages of both are combined at the highest level.
- Sophisticated sample feeding systems allow both, fully and partially automated AOX determination in connection with diverse combinations of sample preparation.
- Straightforward operation, rapid operational readiness, and a minimal amount of maintenance are only a few of the many advantages the multi X 2500 has to offer.
- The analyzer works in conjunction with numerous relevant standards such as DIN, EN, ISO, ASTM.
- The multi X 2500 is suitable for most diverse analytical requirements; in addition the system can be extended and modified on an individual basis.

Highlights at a glance

- **Uniquely wide application spectrum** – AOX, EOX, POX, TOC, TX/TOX analysis
- **Free selection of operating mode** – vertical and horizontal sample feeding in one system
- Analysis of the AOX samples using the column and the batch method in the containers, or directly after push-out of the activated charcoal from the columns – **with a single system**
- **Versatile sample feeding systems** – automation with unique throughput for all parameters using only one auto sampler
- **Effective analysis** – high sample throughput, precise measurements, low operational costs
- **Unique wide-range coulometer** - for precise measurements in the range of ng to mg
- **High performance gas-box -** maximum flexibility in personal method development and optimization, inclusive integrated flow meter for system tightness check by the operator, for ultra-high operating safety and reliable analysis results
- **Self Check System (SCS)** - temperature, gas flow, pressure and tightness control for trouble-free operation and highest ease of use combined with low maintenance effort
- **Flame sensor technology** (optional) for trouble-free, matrix-optimized combustion of EOX samples as well as organic solids and liquids for TX/TOX determination in horizontal mode
- **Intuitive user guidance** by multiWin software avoids operator mistakes
- **Minimal amount of maintenance**

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Optimal adjustment for each sample matrix – efficient combustion

The innovative **double furnace technology** combines vertical and horizontal combustion in a single instrument. This allows optimal adjustment of the combustion process to the requirements of diverse samples or parameters.

Digestion temperature

Up to 1,100 °C in vertical or horizontal operating modes are possible.

Required gases

For AOX only systems

- Oxygen (e.g., 99.995 % [4.5]; 99.5 % [2.5]) recommended; alternative synthetic air for AOX determination in vertical as well as horizontal mode

For combined systems with AOX and TOC option

- Oxygen (99.995 % [4.5]) recommended; alternative synthetic air for AOX and TOC determinations

For multi-parameter systems with AOX and/or EOX and/or POX and/or TX/TOX in liquids and solids

- Oxygen (e.g., 99.995 % [4.5], 99.5 % [2.5]) recommended, additionally argon 99.996 % (4.6) in vertical and horizontal mode

For EOX only systems

- Oxygen (e.g., 99.995 % [4.5], 99.5 % [2.5]) and additionally argon 99.996 % (4.6) in vertical and horizontal mode

Combustion in the vertical operating mode

- Outstandingly suited for AOX using the batch or column method
- Optimal for AOX direct feeding
- Also suited for EOX, POX, and TOC determinations
- Rapid analyses
- Small space requirement
- Low operational cost

In many laboratories the vertical arrangement of the AOX systems has proven itself to be very successful. The extremely uncomplicated sample feeding over a gas lock - manually or automated - takes place simply

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by gravity. This allows without complicated mechanics a secure and very fast measurement process and is also fully maintenance-free. Regardless of whether the samples are enriched using the batch or column method - a single autosampler can handle both - within one sequence. A special quartz container technology protects the activated charcoal from environmental influences. Additional flushing of the sample tray with inert gas is not necessary thus further reduces operational costs.

If necessary, sample throughput can be increased with the optional push-out technology. Through direct pushing out of the activated charcoal from the columns, one can use the combustion chamber to its maximum and work even more effectively.

For EOX applications, an auto injector (for small sample series) or an autosampler (for maximum throughput) is available for the vertical operating mode, which can also be used for the automated TOC analysis (according to NPOC method) – an optional application for the multi X 2500.

For the fast and safe determination of purgeable organic bound halides the optional POX module is available.

Combustion in the horizontal operating mode

- Outstandingly suited for EOX determination
- Also for AOX or determination of TX/TOX in solid and liquid samples
- Flame sensor technology prevents effectively soot formation with challenging samples

With a predominant number of EOX samples, the horizontal operating mode with boat injection and flame sensor-controlled combustion offers analytical advantages: residue-free combustion, long lifespan of the injection needles and septa and perfect measurement results.

Naturally, the horizontal arrangement also allows the analysis of AOX samples. The enriched activated charcoal can be delivered either in container form (as a column) or directly on a filter (batch method) with a manual or automatic sample supply for combustion.

The principle here is “one for all.” A single auto sampler establishes the dosage for EOX extracts and other liquid samples or entering of solids as well as AOX samples – independent of whether the samples were enriched using the column or batch method.

For solids (e.g., derived fuels) and liquids (e.g., palm oil or used oil) the content of total chlorine (TX/TOX) can be determined as well in the horizontal operating mode.

Detection

Microcoulometry for AOX, EOX, POX, and TX/TOX determination:

- Patented, lightproof coulometer cell with combi-electrode based on modern ceramic technology
- Compact, robust coulometer cell, equipped with self-cleaning for the silver anode
- Combi-electrode combining indication electrodes and generator cathode – no diaphragms and electrolyte junction – fast readiness for operation and minimum maintenance effort
- Unique wide-range coulometer enables the chlorine determination from ng (advantageous for EOX determination) up to 1 mg (advantageous for TX in solids determination)
- Extremely wide dynamic measurement range, no „exhausting" of electrolyte solution in case of unexpected high Cl contents
- Integrated cell cooling – for superb sensitivity and long-term stability during big sample series

Wide-range NDIR

(none dispersive infrared detector) for the TOC determination

The detector is part of the optional TOC module, enabling TOC (according to NPOC method) in water determination with the multi X 2500. The samples are dosed directly by means of a syringe, no error-prone valve-technique is used. To increase the throughput the autoX 112 can be used for injection of up to 60 water samples into the combustion tube.

Operation range: 0–10.000 mg/L C

Measurement Time

AOX/EOX/TX:

approx. 8-10 min depending on concentration and application

TOC:

approx. 3-5 min depending on concentration and application

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Sample feeding

The multi X 2500 can be operated manually but also fully automated equipped with the suited automatic sample supply systems.

AOX sample feeding – variable

- **Combustion in container** for precise determination of the smallest AOX contents in samples using column or batch methods; the sample is optimally protected from environmental influences; this technology ensures a long lifespan of the combustion chamber due to the protecting function of the used quartz container.
- **Direct feeding of the activated charcoal** for very high sample throughput of AOX samples using the column method in vertical operation.
- **Vertical:** Via a maintenance-free gas lock, outstandingly suited for simple automation of the sample feeding (using the column or batch method).
- **Horizontal:** Using a manual or automatic boat drive, whereby the AOX samples can be placed in a quartz boat (using the column or batch method).

AOX sample feeding for vertical operation

autoX 36, autoX 36d, autoX 112

autoX 36: For small sample series, with 36 positions – allows automatic feeding of AOX samples in containers using the column and batch method in a single sample cycle, no additional flushing with inert gas is necessary

autoX 36d: For the direct dosing of activated charcoal with 36 positions for AOX determination using the column method or feeding of AOX samples in containers with an additional sample tray (optional)

autoX 112: For large sample series using the direct dosing of activated charcoal from a maximum of 112 columns for AOX determination using the column method – maximum sample throughput guaranteed

AOX sample feeding for horizontal operation

autoX 112

autoX 112: Guarantees in combination with an automatic boat drive fully automated feeding of up to 35 boats, which can be used with AOX samples using the column method (container) or the batch method (polycarbonate membrane filter)

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EOX sample feeding – variable

- **Vertical:** Via direct injection into the combustion tube using a microliter syringe, semi-automated (auto injector) or automated (autoX 112).
- **Horizontal:** Using the automatic boat drive, whereby the EOX extract is dosed in a quartz boat. The dosing into the boat can be done manually or automatically.
- **Semi-automatic:** Using an auto injector for secure dosing of EOX samples with constant, selectable injection speed in vertical operation.
- **Automated:** With auto sampler autoX 112 for a maximum of 112 EOX samples in vertical or horizontal operation.

TX/TOX sample feeding – horizontal

- **Manual:** by means of the automatic boat drive
  The automatic boat drive combined with flame sensor enables the quantitative, matrix and time-optimized combustion of difficult solid and liquid samples and thereby significantly reduces the maintenance effort.
- **Automatic:** with auto sampler autoX 112, combined with the automatic boat drive the automated dosing of up to 35 solid resp. 112 liquid samples for TX determination is possible

TOC sample feeding – vertical

- **Manual:** via direct injection with a microliter syringe into the combustion tube
- **Automated:** by means of the auto sampler autoX 112 via direct injection into the combustion tube, for up to 60 water samples for TOC determination (acc. NPOC method)

POX sample feeding - vertical

Manual: via the direct introduction of the sample gases, which were purged out by the aid of a carrier gas (POX module, optional), into the combustion tube.

Sample Preparation – Towards a Higher Throughput

Flexible sample preparation modules for individual demands regarding sample number and preparation method are available. These modules are characterized by minimum maintenance effort.

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Batch method

- **AFU 3:** Filtration unit for semi-automatic, simultaneous processing of 3 samples acc. to batch method. The system is a cost-effective alternative compared to the classic batch method with membrane filtration – costly utilization of polycarbonate filters is redundant. Filtration is carried out directly by aid of frit containers. Thanks to an accessory kit the AFU 3 can be extended to enable simultaneous preparation of 3 samples acc. to column method.

Column method

- **APU sim:** The sample preparation unit APU sim is a robust adsorption system for the sample preparation for AOX determination using the column method in accordance with ISO 9562. Up to six samples can be simultaneously processed in three separate adsorption channels. Sample volume, washing volume and adsorption speed are individually adjustable. Intuitive user menus and a clearly arranged display guarantee easiest operation. Also samples with particle load can be adsorbed to columns of diverse dimensions.
- **APU 28:** Fully automatic sample preparation unit for AOX determination using the column method in accordance with ISO 9562 for the enrichment of up to 28 particle containing samples. The robust system operates without complex valve technology and is characterized by minimal maintenance effort. It allows individually preprogrammed sample and washing volumes and also automatic sample processing even in overnight operation.
- **APU 28 SPE:** allows fully automatic enrichment of up to 28 saline samples according to SPE-AOX method without any manual intervention and is suitable also for common AOX sample preparation.
- **APU 28 S:** A revolutionary two-channel system allowing simultaneous processing of two samples. Thus, the sample throughput can be doubled, since in comparison to sequential working single-channel systems, the same sample number can be enriched in half the time.
- **AFU 3:** Automatic filtration unit for the semi-automatic simultaneous processing of three samples using the column or batch method.

Column flexibility

AOX columns of other dimensions

Thanks to optional accessories, the systems of the APU 28 family and the APU sim can be used in combination with different AOX columns with dimensions (40 x 9(3) mm or 47 x 6(3) mm).

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AOF columns for AOF/EOF sample preparation:

For the adsorption step for AOF or EOF determinations, adsorption columns of different sizes are available. They are characterized by ultra-low fluorine blank and high product quality. Besides AOF/EOF adsorption they are suited for AOX standard applications as well.

Available types:

- 40 x 9(3) mm (Analytik Jena [APU 28 flexi, APU sim] and sample preparation units of other brands)
- 18 x 6 mm (Analytik Jena [APU 28, APU 28 flexi, APU sim])

Higher sample throughput - highest productivity

The multi X 2500 achieves high productivity using state-of-the-art automation technology – both during the sample feeding and the analysis. Coordinated concepts minimize idle times between sample enrichment and combustion and increase the AOX sample throughput to a maximum.
The combination of APU 28 S and automatic AOX analysis with the autoX 112 (vertical mode) allows a continuous AOX determination 24 hours a day. With this, the times for manual intervention by the user are reduced to sample preparation. This saves valuable work time, freeing resources for other laboratory duties. A fully automated workflow - AOX determination, almost on its own!

Self Check System - SCS

Easy to use: The multi X 2500 is equipped standard with a Self Check System so that maximum operating safety can be ensured with minimum operating effort.
The system autonomously checks all relevant parameters, thus ensuring failure-free, fully automatic operation.

- **Automatic recognition:** After the system start, the SCS automatically recognizes the available instrument components and checks their proper functioning
- **Plug-and-Start:** For available sample feeding systems the active configuration is determined (tray size, gripper, push-out tool, syringe) and the correct methods are loaded
- **Permanent monitoring:** The gas supply, furnace temperature, cell temperature, detector signal, maintenance intervals
- **Automatic gas shut-off:** The carrier gas pump is automatically shut off at the end of a sample sequence, saving operating costs
- **Automatic standby function:** Saves operating costs due to lower temperatures of the furnace and assures fast operating readiness
- **Automatic system shut-off** in case of failure – highest operating safety

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Simple Analysis with multiWin

The self-explanatory multiWin software accompanies the user beginning with the system start to turning-off the analysis system at the end of a workday, with guidance through all the relevant menu points. multiWin monitors and regulates all important system parameters. The software immediately communicates any system configuration errors and the entry of unsuitable parameters so that unusable results can be prevented in advance. multiWin checks the system performance and the analytic quality and delivers a clear presentation of the measurement results in individual analysis reports, and much more besides.

Maintenance and Care

The maintenance and operating efforts are reduced to a minimum with the multi X 2500 and the sample preparation systems.

Features:

- Fast operational readiness
- Unparalleled easy access to all relevant components
- Easy exchange of components thanks to a modular design
- Simple exchange of the sulfuric acid
- Long lifespan of the electrolytes
- Robust construction due to the use of resistant materials with a long service life
- Self Check System for the monitoring of relevant instrument parameters, prevention of incorrect operation and for automatic safety shut-off
- Intuitive software navigation - monitoring of maintenance intervals

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Conformity to Standards

The multi X 2500 meets the requirements of a multitude of standards for AOX, EOX, TX/TOX, and TOC determination.

Adsorbable Organic Halides (AOX/TOX):

DIN EN ISO 9562, EN 1485 (H14)* – AOX in water samples

DIN 38409-22 (H22)* – SPE-AOX in water samples

DIN 38414-18 (S18) – AOX in sludge and sediments

DIN EN 16166 – AOX in sludge, treated bio-waste and soil

ASTM D4744, APHA SM 5320B – TOX/DOX in water samples

EPA 9020 B, EPA 1650 C, EPA 450.1 – AOX/TOX in water samples

Extractable Organic Halides (EOX):

DIN 38414-17 (S17) – EOX in sludge and sediments

OENORM M 6614 – EOX in water samples

EPA 9023 – EOX in solid samples

Total Chlorine (TX, TOX):

IP 9076 / EPA 9076 – TX in new and used mineral oil products

DIN EN 14077 – TOX in mineral oil products

UOP 779 – TX in mineral oil products

Total Organic Carbon (TOC):

ISO 8245 – TOC in water

EN 1484 – TOC in water

ASTM G144-01, ASTM D 2579 – TOC in water

EPA 9060, EPA 415.1 – TOC in water

APHA SM 5310B – TOC in water

* withdrawn

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	AOX/ EOX/ POX/ TX/ TOX determination	TOC determination
Detection	Microcoulometry	NDIR
Measurement Range*/**	up to 1,000 µg Cl absolute	up to 10,000 mg/l TOC
Detection limit*/**	10 ng Cl absolute	0.2 mg/l
Precision (reproducibility)*/**	better 2 % RSD at >5 µg Cl absolute, direct injection into the coulometer cell	better 2 % RSD at >10 mg/l TOC, 500 µl injection volume
Sample amount**	max. 100 µl for EOX extracts and TX for liquid samples max. 100 mg for TX in solid samples	max. 500 µl of the water sample
Analysis time**/***	8 – 10 min	3 - 5 min
Furnace temperature	max. 1,100 °C	max. 950 °C
Gas supply*	AOX: Oxygen (99.995 % [4.5] or 99.5 % [2.5]) or synthetic air EOX, POX, TOX/TX: Oxygen (99.995 % [4.5] or 99.5 % [2.5]) additional argon 99.996 % (4.6)	Oxygen 99.995 % (4.5) or synthetic air
Power supply	100 - 230 VAC; 50/60 Hz; max. 16 A	
Dimension, basic instrument (vertical operation)	approx. 810 mm x 460 mm x 550 mm (W x H x D)	
Dimension, basic instrument (horizontal operation, incl. ABD)	approx. 1400 mm x 460 mm x 550 mm (W x H x D)	
Additional TOC module	approx. 300 mm x 460 mm x 550 mm (W x H x D)	
Auto sampler autoX 112:	approx. 500 mm x 500 mm x 430 mm (W x H x D)	
Weight, basic instrument	approx. 30 kg	
Additional TOC module	approx. 8 kg	
Auto sampler autoX 112	approx. 8 kg	

* depends on the options / device configuration

** depends on the sample matrix and operating mode

*** depends on the concentration of elements

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