A Close Look at the Specialists: TOC and TN_b in Every Matrix

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For several decades, the TOC parameter has stand for the total of all organic contaminants in water samples, soils, sediments and construction rubble. Since it is often impossible or simply unnecessary to record the many possible organic compounds separately in a single substance analysis, the TOC sum parameter provides a quick and cost saving alternative for recording a sample's total organic contamination. For this purpose the TOC sum parameter uses the common property of all organic compounds – carbon atoms represent an integral part of every organic compound and can be quantitatively converted into carbon dioxide under defined oxidation conditions and selectively detected. This is done either according to the principle of catalytic high temperature combustion in the oxygen flow or via wet chemical UV oxidation with the help of oxidation agents. Optional solids modules also enable through a robust catalytic-free high temperature combustion the combination of solid and liquid TOC in one device.

The TOC has successfully made its way into a number of application fields. In the field of environment analytics, ground, drinking, surface water (river, lake and sea water) and waste water as well as waste and soil eluates are analysed. But also in several industries, the TOC is used as a process control parameter. In the field of power plants, for example, TOC monitoring is vital in the controlling of the corrosion effects of boiler feed water and cooling water circuits. In pharmaceutical industry, TOC threshold values are established for ultrapure water, water for injection purposes (WFI) and for cleaning process control in pharmaceutical manufacturing (cleaning validation). On top, it is indispensable in the chemical and electroplating industry for the contamination control of acids, base, salts and brines where the ruggedness of the instrument technology is of special interest.

What is the difference between common TOC analysers? Are all devices suitable for this wide range of application fields?

Beside price and quality of the equipment components, the biggest differences consist in the area of sample feed to the reactors as well as in digestion and detection technology. However, it is important to choose the right solution because the differences in these details are crucial. If you want a tailor-made TOC analyser for the specific application, you need a specialist in his field.

The variety of application and benefits of the TOC and TN_b sum parameters as well as the applied analyser technology are shown by the selected examples below.

Waste water and solids using the suspension method

The standard DIN EN 15936 'Sludge, treated biowaste, soil and waste – Determination of total organic carbon (TOC) by dry combustion' published in November 2012 with the suspension method contained in informative annex C bring new challenges for liquid TOC analysers.

Both sample matrices have in common that they are solids suspensions with sometimes high contents of particles. DIN EN 1484 defines the TOC as being the sum of dissolved and particle-bound organic compounds. Thus, in the case of TOC analysis it is of special importance to transfer the sample with its solid contents into the reactor in a representative way.

In addition to an effective sample homogenisation on the sample tray of the autosampler, this notably requires a sample introduction technique where particles neither "get lost" on the way nor do very large particles lead to system failure due to blockage or increased wear is to be expected.

In the case of multi N/C® analysers, this is ensured by standard large inner diameters of the sample introducing components as well as by specific rinsing techniques. The principle of direct injection in the case of multi N/C® 2100 especially convinces by its short sample paths without any hoses and valve technology. The wastewater specialist realises the most direct transfer of the sample into the combustion system in combination with a septum-free pneumatic furnace head.

The following original measurement table shows the TOC/TN_b results as they occur each day in municipal treatment plants at the measurement of inflows and outflows. Special emphasis was put on the particle handling capacity of the measuring device as well as the recovery of the many included control standards.

Table 1. Display of the measured NPOC/TN_b values after triplicate determination with the corresponding relative standard deviation

aj-Analyzer multi N/C 2100; multiWin 4.09; Serial No: N5-602/M

AnalysesTable

AnalysesTable: 2012_11_21

Sample ID	Method	TC/NPOC	TN
TC_10mgl	NPOC_TN_250	10.07mg/l ± 0.50%	283.0µg/l ± 1.79%
Cellulose	NPOC_TN_250	99.29mg/l ± 0.13%	113.6µg/l ± 2.26%
TC_150mgl	NPOC_TN_250	150.0mg/l ± 0.09%	174.2µg/l ± 3.11%
NO3_NH4_6mgl	NPOC_TN_250	815.0µg/l ± 9.50%	5.96mg/l ± 0.35%
TN_6mgl	NPOC_TN_250	11.68mg/l ± 0.83%	5.96mg/l ± 0.11%
TN_30mgl	NPOC_TN_250	51.17mg/l ± 0.30%	29.29mg/l ± 1.31%
[redacted]	NPOC_TN_250	93.79mg/l ± 2.08%	25.37mg/l ± 1.21%
[redacted]	NPOC_TN_250	250.7mg/l ± 0.68%	116.3mg/l ± 0.54%
[redacted]	NPOC_TN_250	160.2mg/l ± 1.41%	12.12mg/l ± 0.92%
[redacted]	NPOC_TN_250	125.2mg/l ± 1.44%	28.53mg/l ± 0.51%
TC_10mgl	NPOC_TN_250	10.40mg/l ± 0.49%	196.2µg/l ± 3.17%
Cellulose	NPOC_TN_250	106.6mg/l ± 0.48%	97.80µg/l ± 7.26%
TC_150mgl	NPOC_TN_250	151.4mg/l ± 0.17%	136.2µg/l ± 3.93%
NO3_NH4_6mgl	NPOC_TN_250	432.0µg/l ± 17.45%	6.07mg/l ± 0.34%
TN_6mgl	NPOC_TN_250	11.78mg/l ± 0.96%	6.01mg/l ± 0.93%
TN_30mgl	NPOC_TN_250	51.82mg/l ± 0.07%	29.71mg/l ± 0.94%
[redacted]	NPOC_TN_250	49.34mg/l ± 0.74%	22.52mg/l ± 1.33%
[redacted]	NPOC_TN_250	230.1mg/l ± 0.47%	93.07mg/l ± 0.71%
[redacted]	NPOC_TN_250	887.8mg/l ± 0.35%	59.52mg/l ± 0.75%
[redacted]	NPOC_TN_250	221.2mg/l ± 0.64%	116.2mg/l ± 0.51%
TC_10mgl	NPOC_TN_250	9.89mg/l ± 0.11%	145.4µg/l ± 5.26%
Cellulose	NPOC_TN_250	100.1mg/l ± 0.65%	141.3µg/l ± 1.91%
TC_150mgl	NPOC_TN_250	150.3mg/l ± 0.10%	93.88µg/l ± 2.42%
NO3_NH4_6mgl	NPOC_TN_250	375.6µg/l ± 5.64%	6.01mg/l ± 0.34%
NO3_NH4_30mgl	NPOC_TN_250	340.3µg/l ± 5.13%	29.40mg/l ± 0.06%
TN_6mgl	NPOC_TN_250	11.64mg/l ± 0.62%	6.02mg/l ± 0.90%
TN_30mgl	NPOC_TN_250	52.02mg/l ± 0.47%	29.76mg/l ± 0.67%
[redacted]	NPOC_TN_250	1.04g/l ± 0.30%	23.53mg/l ± 0.59%
[redacted]	NPOC_TN_250	104.5mg/l ± 2.25%	90.65mg/l ± 0.67%
[redacted]	NPOC_TN_250	996.7mg/l ± 0.77%	13.59mg/l ± 1.26%
[redacted]	NPOC_TN_250	284.7mg/l ± 0.86%	158.4mg/l ± 0.81%

TOC in the field of power plants

The challenge consists in the formation of corrosive organic acids and carbonic acid in the boiler feed water out of organic compounds, which are easily oxidised under high pressure and high temperature. TOC monitoring in the boiler feed water is crucial for controlling this process. This is a matter of trace contamination in the range below 1 ppm. Salts are often added as oxygen scavengers.

The wet chemical UV digestion technology is especially suitable due to its extraordinary measurement sensitivity and the gentle digestion method compared to the catalytic high temperature combustion. The large injection volume of samples up to 20 ml makes the multi N/C® UV HS one of the most sensitive TOC devices on the market. The multi N/C® UV HS especially stands out through its specifically designed UV reactor, which not only uses the common UV radiation of 254 nm but also the high energy short-wave radiation at 185 nm in order to oxidise organic compounds. This brings the advantage that no addition of the oxidation agent sodium peroxodisulphate, which is burdened by a TOC blank value, is required for the complete oxidation of ultrapure water. The UV radiation and the dissolved oxygen in the sample itself are sufficient to convert all organic compounds into CO_2. This allows extremely reliable TOC measurement results, unspoiled by blank values, in the boiler feed water and in other ultrapure waters up to drinking water analysis.

Table 2. The multi N/C® UV HS: lowest concentration at highest precision.

aj-Analyzer multi N/C UV HS; multiWin 4.05; Serial No: N6-022/G

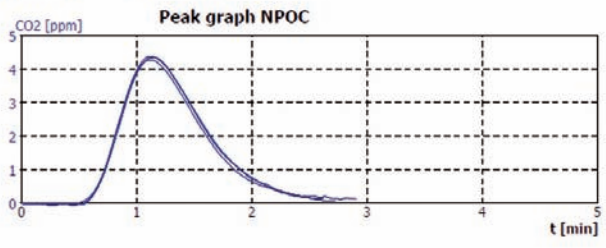
AnalysisReport

Sample ID:	Millipore_Water		
Time of analysis:	7/13/2011 7:11:16 PM	**Method:**	NPOC
User:	Admin	**Sample volume:**	10000µl
Sample type:	Sample	**Dilution:**	1 in 1
Status:	Measurement completed successfully	**Repetitions:**	3-4

	c	I eff	SD	CV	k0	k1	k2	DF
NPOC	25.66µg/l	418.6AU	765.0ng/l	2.98%	0	6.132E-4	-	1

Single replicates:

	Rep.	1	2	3
NPOC	c [µg/l]	24.78	26.08	26.13
NPOC	I [AU]	404.1	425.4	426.1



TOC and TN_b in smallest sample volumes

Especially in the field of research, when it comes to the determination of contaminations in glacial ice, connate water, soil extracts or rainwater, only small sample volumes (often no more than a few millilitres) are available for the TOC measurement, due to other different parameters to be done.

However, there is a very high number of samples to be analysed in the case of such environmental analysis in order to have an interpretable data base. This calls for automated TOC analysers that do not use the majority of the sample for the rinsing of hoses and valves but for measurement.

The determination of proteins according to Ph.Eur. 2.5.33 in the pharmaceutical industry, whether in vaccines or pollen suspensions, also has this requirement towards a modern analysis system.

The specialist in this field is definitely the multi N/C® 2100 direct injector which allows multiple determinations even with a sample volume of less than 1 ml due to its 100µl syringe. On top of that the 112 sample tray even provides magnetic stirring for an optimal sample homogenisation in the 2 ml vials.

multi N/C® – the right solution for every matrix and measurement task

Summary

As can be seen from the examples, many TOC/TN_b applications require the special capabilities of a field specialist to be able to do stable and successful analysis in the long term. The multi N/C® series by Analytik Jena AG provides you with the right analyser for each application. With the built-in Self Check System the devices are designed for maximised operation security and ease of use in unattended 24 hour operation. The associated high system availability essentially increases productivity in your laboratory and significantly contributes to the reduction of running costs.

Expanded Range of Analyses Services Offered for Extractables and Leachables

Schott AG has experienced a strong demand for laboratory services related to so-called 'extractables and leachables' and therefore continued to expand this range of analyses offered to its customers. Extractables and leachables are substances, which can be dissolved and released from the constituent parts – glass, metals, rubber, lubricants and adhesives– of the packaging materials that form the container system. To determine any possible interactions with the drugs and exclude them, pharmacists are obliged to perform extensive studies. This procedure is mainly intended for the protection of patients. "Through our extended service offering, we are now able to support pharmaceutical even more efficiently in the assessment of risks," said Dr Uwe Rothhaar, Director of Schott pharma services division. By strengthening the 'Extractables & Leachables' range of analyses, Schott pharma services underlines its position as an experienced partner for pharmacists who benefit not only from Schott's decades of expertise but also from a combination of laboratory services, which is unique in the market.

Since the Schott group started to produce pharmaceutical containers made of glass and also commenced to manufacture pharmaceutical packagings such as ampoules, vials, cartridges and syringes, the Company has built up comprehensive product and process know-how. Schott maintains a basic research centre for glass by itself. This know-how and these professional skills have been pooled in the Schott pharma services division and have also been available to enterprises outside the group. "An increasing number of drug manufacturers ask us to test their outer packages. The spectrum ranges from the analysis of interactions between drug and packaging materials to fracture and strength tests", stated Rothhaar. His team offers a wide range of analytical services based on the modern instruments of a laboratory whose state of the art is ensured by continuous investments of Schott. In addition, the resources of the central Research and Technology Development division of Schott can be called on as well. The entire laboratory as well as all lab operations and processes are accredited to DIN EN ISO 17025 and thus guarantee highest quality standards.

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New Cyclone Mill for Sample Preparation to NIR Analysis

Retsch's new cyclone mill TWISTER is specially designed for the processing of foods and feeds for subsequent NIR analysis. The optimised form of rotor and grinding chamber generates an air jet which carries the ground sample through the integrated cyclone into the sample bottle. The air jet prevents the material from heating up, thus preserving the moisture content. The provided sieves guarantee an optimum particle size distribution so that it is not necessary to recalibrate the NIR spectrometer. The rotor speed can be adjusted in 3 steps allowing for perfect adaptation to the sample requirements. Cleaning the mill is quick and easy as the air jet effects a complete discharge of the material from the grinding chamber.

This new cyclone mill in proven Retsch quality optimises the reproducible sample preparation to NIR analysis thus allowing for meaningful and reliable analysis results.

Benefits include: ideal for grinding feeds, grains, forage and similar products; 3 controlled speeds; including rotor, grinding ring and sieve sections (1mm and 2mm); cyclone separator with 250 ml collecting bottle for quick extraction of sample; no cross contamination thanks to easy cleaning; convenient operating panel; professional industrial design with long lifetime.

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