Tech Note

multi N/C x300 Series – Wide Linear Dynamic Range

Demonstration of the wide linear dynamic range up to 30,000 mg/L TOC enabled by the FR-NDIR detector and VITA flow management system

Introduction

Non-dispersive infrared spectrometry (NDIR) is the most widely used detection method employed by commercially available TOC analyzers in the laboratory. On the one hand, this detection technique offers high sensitivity to determine reliably low TOC concentrations close to the limit of detection. On the other hand, it should provide also the possibility to determine very high TOC concentrations – e.g. for wastewater - with high accuracy. For TOC analysis in the concentration range > 1,000 mg/L, samples typically must be diluted during sample preparation. Due to the very good linearity of the FR-NDIR detector of the multi N/C x300 series throughout the entire working range up to 30,000 mg/L, such samples can be analyzed without an additional dilution step.

Your Benefits

- Wide dynamic working range combined with maximum sensitivity
- No sample dilution required
- Linearity of calibration over the entire working range

Application

The standards used for calibration were prepared from solid potassium hydrogen phthalate (p.A.). The analysis were carried out by multi N/C 3300 and the used method parameters are listed in Table 1.

Table 1: Method parameters on multi N/C 3300

Parameter	Values
Method	NPOC
Injection volume	100 µL
Furnace temperature	750 °C
Number of replicates	3-4

Linearity

The linearity of the detector was demonstrated by a calibration in the range from 1,000 to 30,000 mg/L TOC. The calibration range was divided into two sections to ensure the most accurate determination possible over the entire range. The calibration parameters are shown in Table 2.

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Table 2: Calibration parameters

Range	k0	k1	R^2	Limit of Detection [mg/L]	Limit of Quantification [mg/L]	Range borders [µg]
1	16237.14	1202.29	0.99977	168.2	692.0	100 to 750
2	83554.68	1151.86	0.99870	842.5	2989	750 to 3000

Both calibration ranges show very good coefficients of determination (R^2), and the slopes (k1) of the linear regressions are comparable. The calibration curves for both ranges are shown in Figure 1.

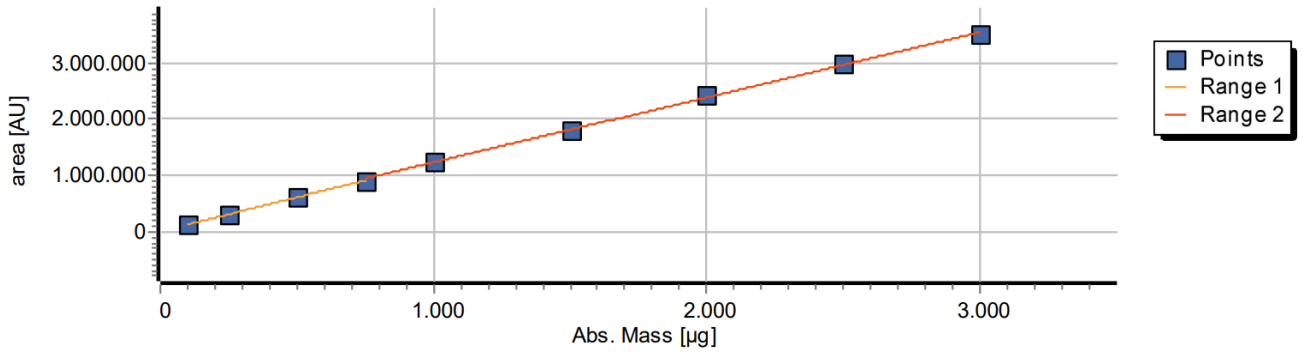

Figure 1: NPOC calibration curve

The deviation of all individual calibration points from the calibration curve is very low, the biggest deviation is around 3 %. In addition to the good R^2 values, this also shows the quality of the calibration. There is no trend towards decreasing linearity at one end or the other. The single calibration points are shown in Table 3.

Table 3: Linearity of calibration points

Split point	Avg. integral net [AU]	c(target) [mg/L]	Concentration [mg/L]	c delta [%]
no	132756	1,000	969	-3.18
no	323822	2,500	2,558	2.28
no	613010	5,000	4,964	-0.73
yes	919032	7,500	7,509	0.12
no	1234825	10,000	9,995	-0.05
no	1810908	15,000	14,996	-0.03
no	2441443	20,000	20,470	2.30
no	2986408	25,000	25,201	0.80
no	3491201	30,000	29,584	-1.41

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Recovery

For QC the measurement of a 20,000 mg/L TOC standard was carried out. Measurement data are shown in Table 4.

Table 4: Measurement results QC standard (20,000 mg/L TOC)

Meas. Parameter	Avg. integral net [AU]	Avg. concentration [mg/L]	SD [mg/L]	RSD [%]	Recovery [%]
NPOC	2400578	20,115	137	0.57	100.6

The recovery of this QC standard with 100.6 % shows the validity of the linear calibration. Also, the reproducibility of the individual determination is very good, with a relative standard deviation of 0.57 %. Figure 2 shows the measurement curve of the QC standard.

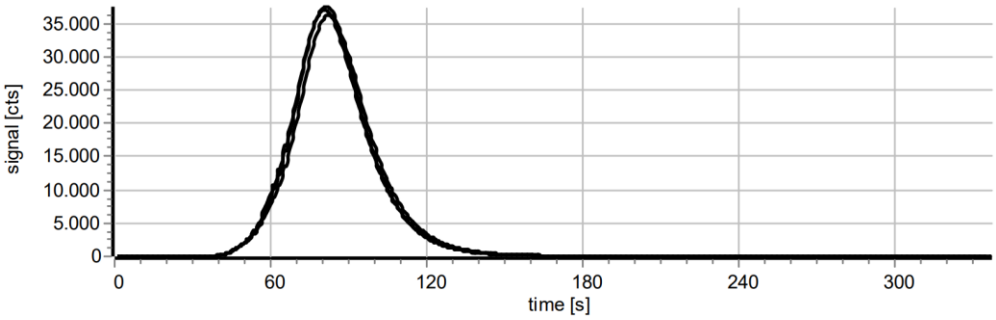

Figure 2: Measuring curve of the QC (20,000 mg/L TOC)

Conclusion

The FR-NDIR detector shows excellent linearity over the entire working range up to 30,000 mg/L TOC. Both low and extremely high concentrations can be determined with high accuracy. Due to the possibility of dividing the calibration range into different sections, it is also possible to analyze samples of very low and very high concentrations with one calibration.

No additional sample preparation is required to dilute high concentrated samples. Even if these samples have a high particle content, they can be analyzed undiluted using the tubing and valve-free direct injection technique of the multi N/C 2300 or the sample loop injection technique of the multi N/C 3300.

Reference: TechNote_multiNC_0002_en_Wide Dynamic Range

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