



Elemental Analysis: CHNS/O characterization of compost

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Keywords

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Goal

This application note reports data on CHNS/O and TOC determination of compost for quality control purposes, performed with the FlashSmart EA.

Introduction

Production of compost is one of the most efficient ways of recycling waste. Due to the heterogeneity of the material used, accurate control of parameters such as nitrogen, total carbon, total organic carbon (TOC) and sulfur content in the recycled waste is a key factor to ensure the quality of the final product. High quality composts can then be used as fertilizers in agronomy. Using elemental analysis and heat value determination, it is possible to establish whether the compost to be burned is able to maintain the incinerator temperature or if it has to be mixed with other materials.

As the demand for compost testing has grown in the last years, the classical analytical methods showed to be no longer suitable, for their time-consuming sample preparation and for their use of hazardous reagents. For this reason a simple and automated technique is the requirement for modern laboratories dealing with routine analysis.

The Thermo Scientific™ FlashSmart™ Elemental Analysis (Figure 1), based on combustion method, allows the quantitative determination of the elements in a large range of concentration, without the need for sample digestion or toxic chemicals, providing advantages in terms of time and automation.

This note presents data on CHNS/O determination in compost samples to show the performance of the system and to show the reproducibility of the results obtained.

Method

The fully automated workflow allows unattended analysis of up to 125 samples without matrix effect, from a few mg to large sample sizes. The modularity of the FlashSmart EA allows NC determination in less than 5 minutes, simultaneous CHNS determination in less than 10 minutes, sulfur only characterization in less than 4 minutes, and analysis of oxygen in less than 5 minutes. The same analytical conditions can also be used for the determination of TOC, analyzing the sample after acidification (to eliminate the carbonates). For CHNS determination the FlashSmart Elemental Analyzer operates according to the dynamic flash combustion of the sample. Samples are weighed in a tin containers and introduced into the combustion reactor via the Thermo Scientific™ MAS Plus Autosampler together with oxygen. After combustion, the resultant gases are carried by a helium flow to a layer filled with copper, then swept through a GC column that separates the combustion gases and is finally detected by a Thermal Conductivity Detector (TCD) (Figure 2).

For oxygen determination, the system operates in pyrolysis mode. Samples are weighed in silver containers and introduced into the pyrolysis chamber via the MAS Plus Autosampler. The reactor contains nickel coated carbon at a temperature of 1060 °C. The oxygen in the sample, combined with the carbon, forms carbon monoxide which is chromatographically separated from other products and detected by the TCD Detector (Figure 2).

A complete report, including the option for calculating the relative Heat Values is automatically generated by the Thermo Scientific™ EagerSmart™ Data Handling Software.

Results

Different compost samples were chosen to evaluate the CHNS and oxygen configurations. The samples were homogenized using a rotor speed mill and a ball mill. BBOT* (2 - 3 mg) was used as standard to calibrate the system in CHNS configuration, while benzoic acid was used as standard in oxygen configuration.

* BBOT: 2,5-Bis (5-tert-butyl-benzoxazol-2-yl) thiophene



Figure 1. FlashSmart Elemental Analyzer.

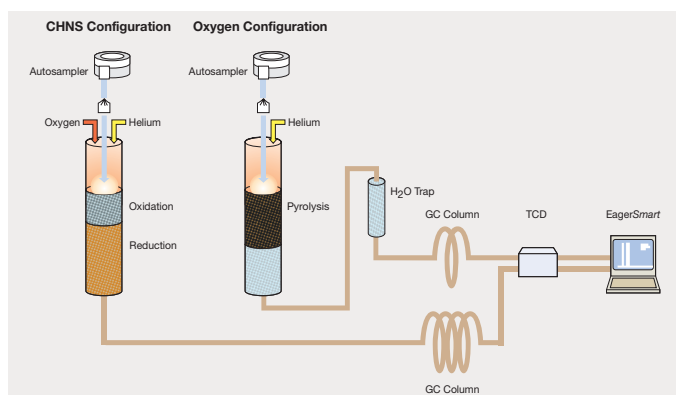


Figure 2. CHNS/O configuration.

Table 1 shows the data obtained by CHNS/O analysis. Samples were analyzed three times to evaluate the reproducibility of the system.

Table 2 shows the CHNS/O data and the Heat Value calculation of a compost sample. The Heat Values are calculated automatically by the EagerSmart Data Handling Software).

Figure 3 shows the sample pre-treatment for the determination of total organic carbon. The sample is weighed in a silver container and introduced via the sample holder plate (Figure 4). The acidification with chlorhydric acid 1:1 eliminates the inorganic carbon as carbon dioxide. Dry in the electric heater at 65 °C and close the capsule for sample analysis.

Table 1. CHNS/O data of compost samples.

Sample	N%	C%	H%	S%	O%
1	1.500	40.874	5.683	0.510	34.482
	1.568	40.882	5.702	0.507	34.098
	1.552	40.770	5.664	0.471	34.083
2	1.864	40.037	5.224	0.590	31.157
	1.879	39.604	5.158	0.567	31.395
	1.823	39.938	5.193	0.592	31.504
3	2.196	39.724	5.137	0.560	31.425
	2.201	39.674	5.177	0.564	31.820
	2.176	39.680	5.109	0.597	31.112
4	2.296	41.400	5.620	0.660	32.798
	2.243	41.783	5.532	0.665	32.425
	2.297	41.399	5.611	0.688	32.352
5	2.237	41.858	5.553	0.710	31.673
	2.205	41.802	5.518	0.705	31.387
	2.283	41.607	5.478	0.714	31.475

Table 2. CHNS/O and Heat value data of a compost sample.

Element	N%	C%	H%	S%	O%	G.H.V.	N.H.V.
Data	13.0884	36.7927	5.1549	1.9008	30.8515	3525.02	3559.00
	13.2374	36.9949	5.2545	1.9000	30.8594	3524.68	3558.67
	12.8570	36.7172	5.1442	1.9242			
Average	13.0609	36.8349	5.1845	1.9083	30.8554	3524.85	3558.84
RSD	1.4676	0.3898	1.1733	0.7204	0.0181	0.0068	0.0074

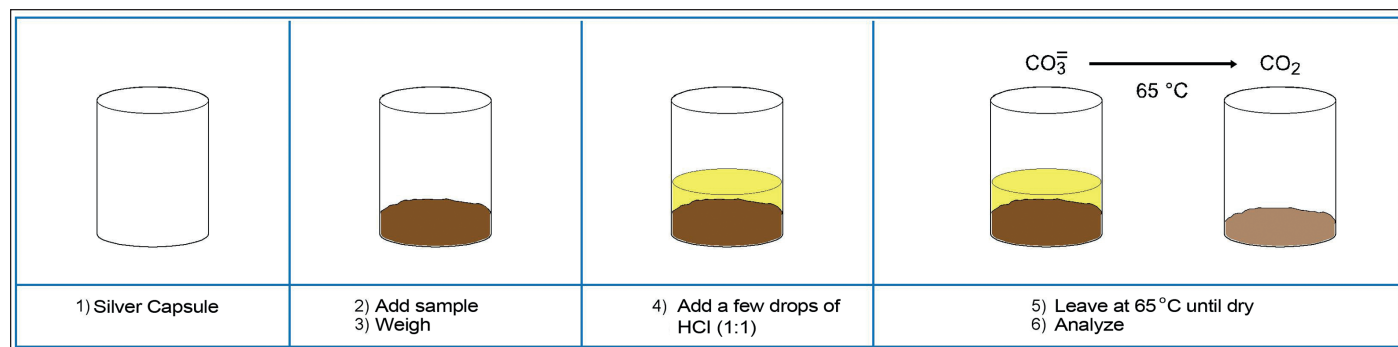


Figure 3. Sample pre-treatment for TOC determination.



Figure 4. Sample holder plate.

Table 3 shows the data of total nitrogen (TN), total carbon (TC) and total organic carbon (TOC) on compost samples. Both analyses (TC and TOC) were performed consecutively using the same analytical conditions.

Conclusions

The Thermo Scientific FlashSmart Elemental Analyzer enables to perform accurate and reproducible CHNS/O determination in compost samples.

The modularity of the FlashSmart Elemental Analyzer enables to perform CHNS determination in a single run, oxygen determination in a second run and TOC analysis without any modification of the analytical conditions, allowing high productivity for routine labs.

The Heat Values were automatically calculated, by the dedicated feature in the EagerSmart Data Handling Software.

The FlashSmart Elemental Analyzer meets laboratory requirements in terms of automation and high sample throughput.

Table 3. TN, TC and TOC in compost samples.

Sample	N%	TC%	TOC%
1	0.26	11.02	3.02
	0.25	11.19	3.06
2	0.80	10.55	2.08
	0.80	10.42	2.02
3	1.12	19.17	4.26
	1.11	19.16	4.23

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