

CHN/O Determination in Bioplastic

Tested with VELP Scientifica EMA 502 Elemental Analyzer CHNS-O (Code F30800100)



Introduction

In the quest for sustainable materials, bioplastics have emerged as a promising alternative to traditional petroleum-based plastics. Derived from renewable resources such as plant starches or microbial fermentation, bioplastics offer the potential to reduce our reliance on non-renewable resources and mitigate environmental impact.

As the demand for eco-friendly materials continues to grow, understanding the composition of bioplastics becomes paramount. The chemical composition of these products affects their properties in the final application and therefore it is important to monitor their composition to ensure the highest standards.

This application note explores an approach to the elemental analysis of bioplastics, focusing on key parameters such as carbon, hydrogen, nitrogen and oxygen. By employing combustion analysis, we aim to detect the elemental composition of bioplastics, providing valuable insights for researchers, manufacturers, and industries committed to sustainable practices.

CHNS determination

The CHNS analysis starts with the combustion of the sample inside the VELP combustion furnace at a temperature higher than 1000°C to obtain elemental compounds.

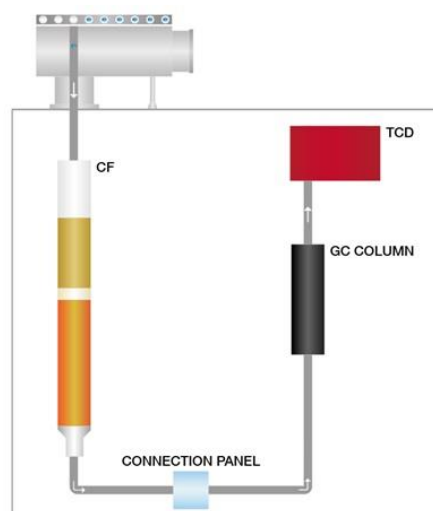
VELP Vcopper™, a formulation of highly active copper powder, is placed in the lower part of the reactor helps the reduction of NO_x into N₂.

The gas stream reaches the gas-chromatographic column and component are separated flowing out of the column with different retention times.

The innovative LoGas™ Thermal Conductivity Detector (TCD), with no requirement for a reference gas, enables the detection of all gases content.

The EMA 502 is controlled via PC through the intuitive EMASoft™.

The analysis is completed in few minutes.



Oxygen determination

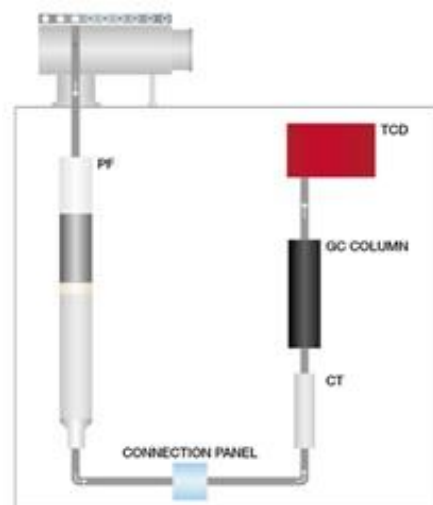
The sample is purged with carrier and conveyed to the reactor where pyrolysis happens.

The sample is converted into its elemental compounds at a high temperature (>1000°C).

The carrier with elemental gases reaches the chemical trap where all impurities are absorbed.

The flow reaches the gas-chromatographic column and component are separated flowing out of the column with different retention times.

The TCD (Thermal conductivity detector) enables the quantification of oxygen as carbon monoxide in few minutes.



EMA 502 Preliminary Operations (daily)

Follow the operating manual to start the EMA 502 and check that the following parameters are set:

Temperature CHNS furnace (Code A00000443): 1030 °C

Temperature GC Column Oven: 55 °C

Flow rate MFC1 He: 120 ml/min

Flow rate MFC2 He: 140 ml/min

Condition the system by testing 2 Sulphanilic acid standard (Code A00000434) and 2 to 3 empty tin foils (Code A00000436) as checkup. Verify the calibration curves with one or more tests as Standard by testing the same standard used for the curves' creation.

For Oxygen determination follow the operating manual to start the EMA 502 and check that the following parameters are set:

Temperature O furnace (Code A00000444): 1060 °C

Temperature GC Column Oven: 55 °C

Flow rate MFC1 He: 140 ml/min

Flow rate MFC2 He: 160 ml/min

Condition the system by testing 2 EDTA standard (Code A00000149) and 2/3 empty tin foils (Code A00000436) as checkup. Verify the calibration curves with one or more tests as Standard by testing the same standard used for the curves' creation.

Sample Preparation

The samples analyzed are a PHA resin and a blown film produced starting from PHA resin and other additives. The PHA resin is cut in small pieces and analyzed trying to take the most representative portion of the sample. The blown film has been cut to use the most representative portion for the analysis.

Analysis Procedure

The Complete analysis must be carried out in two different steps: CHNS configuration and Oxygen configuration.

CHN Analysis Procedure

Fill the following fields in the database: Sample name, Weight, Method, Sample type, Calibration number.

Use the **pre-installed coal method**:

Press Start to start the analysis.

Analysis time from 12 minutes for one run.

Oxygen Analysis Procedure

Fill the following fields in the database: Sample name, Weight, Sample type, Calibration number

Method: pyrolysis

Press Start to start the analysis.

Analysis time from 6 minutes for one run.

CHN/O Results

CH Calibration: the CH results have been obtained with the calibration curve using the certified standard Sulphanilic acid (code A00000434) (C% = 41.58 – H%= 4.04 – N%= 8.08 – S%= 18.48), using a range of about 0.200 – 9.000 mg.

N Calibration: the N results have been obtained with the calibration curve using the certified standard Atropine (N%= 4.84), using a range of about 0.050 – 0.500 mg.

Oxygen Calibration: the Oxygen results have been obtained with the calibration curve using the certified standard EDTA (code A00000149) (O% = 43.8), using a range of 0.500 – 7.000 mg of EDTA.

The tables below show the %C, %H, %N and %O results obtained by the **EMASoft™** using about 3.500 mg for both the samples.

Sample	Carbon %	Hydrogen %	Nitrogen %	Oxygen %
PHA Resin	60.3672	6.7322	0.1226	31.7839
	60.4642	6.7865	0.1206	31.9242
	60.3162	6.7545	0.1233	31.8644
Average %	60.3825	6.7577	0.1222	31.8575
SD %	0.0752	0.0273	0.0014	0.0704

Sample	Carbon %	Hydrogen %	Nitrogen %	Oxygen %
Blown film PHA resin	59.6130	6.6984	0.1162	31.7713
	59.6434	6.6748	0.1055	31.5342
	59.495	6.6710	0.1087	31.8177
Average %	59.5838	6.6814	0.1101	31.7077
SD %	0.0784	0.0148	0.0055	0.1521

Conclusion

EMA502 CHNS-O Elemental Analyzer detects and measures the Nitrogen, Carbon, Hydrogen, Sulfur and Oxygen content of different organic samples. The results obtained demonstrate a good reproducibility and no memory effect was observed when changing the sample, indicating the **complete detection of the elements**.

The results obtained are reliable and repeatable, demonstrating the high performance of the instrument. Samples were analyzed by weighing the same amount of sample for all compounds (2-3mg) in the tin foils and introduced into the combustion furnace thanks to the electronic autosampler.

EMA502 CHNS-O Elemental Analyzer is controlled and operated by EMASoft™ software coming with a user-friendly interface that displays all the relevant information at a glance: results, methods, database, and instrument working conditions.

The EMA502 software can be connected to the exclusive VELP Ermes Cloud Platform to improve your laboratory experience.

Key facts of the EMA 502 CHNS-O Elemental Analyzers:

- Start-up of the analysis in a few clicks
- Easy calibration curve creation for all the elements allows for the testing of any sample matrix with no memory effect
- Change of the configuration (CHNS ↔ O) in a few steps with the animated gif tutorial
- Real-time graph displaying gases detected by the TCD
- A dedicated maintenance menu sends alerts when the reactor is almost exhausted
- The result table shows the average, SD, and RSD of the analysis with direct selection on the graph