

# Application Note

## Total Carbon and Nitrogen Determination in Soil

E-CN-001-2019/A2



Driven by curiosity

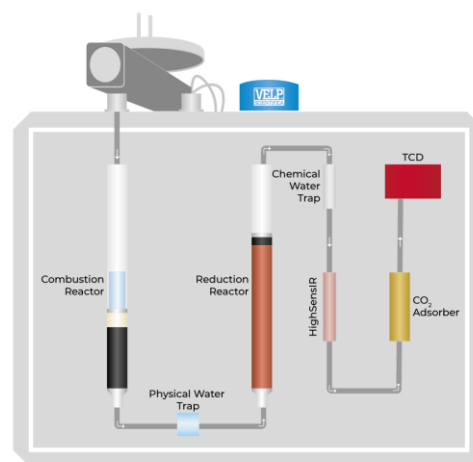


## Introduction

A carbon-to-nitrogen ratio (C:N ratio) is a ratio of the mass of carbon to the mass of nitrogen in a substance. For example, if we have a C:N ratio of 24:1, this means we have 24 units of carbon to 1 unit of nitrogen. The C:N ratio is important because it has a direct impact on residue decomposition and also nitrogen cycling in soils. It can, amongst other things, be used as indicator for nitrogen limitation of plants and other organisms. As a rule of thumb, the higher the ratio, the longer it takes for the material to decompose. Likewise, the smaller the ratio is, the more rapidly the plant material will decompose. This also has a direct relationship with the amount of nitrogen that is tied up in the soil that will be available to the next growing plant. The performance of the CN 802 was evaluated by participating in the Proficiency Testing program organized by WEPAL (Wageningen Evaluating Programs for Analytical Laboratories). Samples of soil were analyzed using the CN 802 and the results obtained (as C % and N %) were compared with the statistical range accepted by WEPAL.

## Dumas method

The elemental analysis starts with a combustion furnace (CF) to burn the sample, obtaining elemental compounds. Water is removed by a first physical trap (WT1 - DriStep™), placed after the combustion, and a second chemical one (WT2). Between the two, the elemental substances pass through a reduction furnace (RF). Velp exclusive Non-Dispersive HighSensIR™ Detector accurately measures the CO<sub>2</sub> concentration that the unit is able to convert in carbon quantity. Then, the auto-regenerative CO<sub>2</sub> absorbers let pass only the elemental nitrogen that is detected by the LoGas™ innovative Thermal Conductivity Detector (TCD) with no requirement for a reference gas. The CN 802 is controlled via PC through the intuitive CNSoft™.



## CN 802 Preliminary Operations (daily)

Follow the operating manual to start the CN 802 and check that the following parameters are set:

- Temperature Combustion reactor (Code A00000158): 1030 °C
- Temperature Reduction reactor (Code A00000226): 650 °C
- Flow rate MFC1 Helium: 190 ml/min
- Flow rate MFC2 Helium: 220 ml/min

Condition the system by testing 2 EDTA standard (Code A00000149) and 3 to 5 empty tin foils (Code A00000153) as Check up. Verify the calibration curves with one or more tests as Standard by testing the same standard used for the curve creation.

## Sample Preparation

4 reference samples:

Sample	Expected Carbon	Expected Nitrogen
Wepal ISE 2018-4 Sediment sample 860	4.524 ± 0.207	0.1628 ± 0.0132
Wepal ISE 2018-4 Clay sample 879	2.911 ± 0.072	0.1688 ± 0.0126
Wepal ISE 2018-4 Sandy soil sample 919	2.586 ± 0.207	0.1487 ± 0.0142
Wepal ISE 2018-4 Sandy soil sample 993	2.624 ± 0.119	0.2361 ± 0.0117

Soils samples have been dried at 105 °C before the analysis.

Using a spatula, put 300 mg of sample into the tin foil. Close the tin foil, obtaining a capsule and load the capsule into the autosampler.

### Analysis procedure

Fill the following fields in the database: Sample name, Weight, Method, Sample type, Calibration number  
Create a new customizable method with the following parameters:

**Protein factor:** none

**O2 flow rate:** 300 ml/min

**O2 factor:** 0.7 ml/mg

Press  to start the analysis.

**Analysis time:** from 3 minutes for one run.

### Typical Results on Soil Samples

Carbon results have been obtained with the calibration curve using the standard  $\text{CaCO}_3$  ( $\text{C}\% = 12$ ), in a range of 0 – 20 mg C. For Nitrogen results, the standard used for the calibration curve has been aspartic acid ( $\text{C}_4\text{H}_7\text{NO}_4$ ), in the range of 0 – 1.5 mg N. The data obtained are included in the tolerance admitted by the certificate of analysis.

All four Wepal reference samples have been analyzed ten times to evaluate the repeatability of the CN 802. The table below shows the total carbon and total nitrogen results on dry matter, obtained simultaneously by the CN 802. The software CNSoft™ automatically calculates the ratio C:N, shown in the table.

Sample name	C % (Average $\pm$ SD%)	%N (Average $\pm$ SD%)	C:N ratio
Wepal Sediment sample 860	4.498 $\pm$ 0.158	0.175 $\pm$ 0.011	25
Wepal Clay sample 879	2.844 $\pm$ 0.006	0.171 $\pm$ 0.013	15
Wepal Sandy soil sample 919	2.531 $\pm$ 0.084	0.160 $\pm$ 0.007	15
Wepal Sandy soil sample 993	2.595 $\pm$ 0.065	0.239 $\pm$ 0.012	11

## Conclusion

CN 802 Carbon/Nitrogen Analyzer is the ideal solution for the determination of carbon and nitrogen and C:N ratio in soil samples.

- The analyzer ensures reliable results in a fast and easy way with automatic calculation made by the software CNSoft™.
- All data obtained show an excellent repeatability and accuracy, meeting the demand of most of the laboratories.
- With high productivity and non-stop performances, CN 802 combustion apparatus is ideal for high throughput, both with Helium and Argon as carrier gas, being fully automated and requiring from 2-5 minutes per analysis.
- Connecting the system to Velp Ermes Cloud Platform makes possible to easily monitor and control the analysis in real time via PC, smartphone or tablet

Reference: **ISO 10694**: Soil quality - Determination of organic and total carbon after dry combustion (Elemental analysis).

**ISO 13878**: Soil quality - Determination of total nitrogen content by dry combustion (Elemental analysis).

**EN13654-2**: Soil improvers and growing media - Determination of nitrogen - Part 2: Dumas method  
Gazzetta ufficiale Official Italian Method 248.1999.

Tested with **Velp Scientifica CN 802 Carbon and Nitrogen Analyzer** (Code F30800090)



### Headquarters

Velp Scientifica Srl  
Via Stazione 16  
20865 Usmate (MB)  
Italy  
T +39 039 628811  
velpitalia@velp.com

### India

velpindia@velp.com

### USA

Velp Scientific Inc  
40, Burt Drive, Unit #1,  
Deer Park  
NY 11729 - U.S.  
T +1 631 573 6002  
velpusa@velp.com

### Latam

velplatam@velp.com

### China

Velp China Co. Ltd.  
Room 828, Building 1, No. 778  
Jinji Road, Pudong New Area,  
Shanghai, China  
T +8621 34500630  
velpchina@velp.com

### SEA & Pacific

velpsea@Velp.com