TECHNICAL NOTE

Oxygen consumption in the Thermo Scientific Flash*Smart* Elemental Analyzer

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Key Words
Consumption, Cost per Analysis, Elemental Analysis, Oxygen, OxyTune Function

Goal

To illustrate the oxygen consumption within the Thermo Scientific Flash*Smart* Elemental Analyzer according to the configurations.

Introduction

The Thermo Scientific™ Flash*Smart*™ Elemental Analyzer (Figure 1) operates with the dynamic flash combustion (modified Dumas method) of the sample for nitrogen, carbon, hydrogen and sulfur determination. Samples are weighed in tin containers and introduced into the combustion reactor at high temperature from the Thermo Scientific™ MAS *Plus* Autosampler with the proper amount of oxygen. Due to the exothermic reaction, the temperature in the hottest zone reaches about 1800°C for few seconds assuring the complete combustion of every type of sample matrix. The produced gases are carried by a helium flow over a gas chromatographic column that provides the separation of the gases, before detection by a thermal conductivity detector (TCD).

Figure 1. Thermo Scientific Flash*Smart* Elemental Analyzer.

The Thermo Scientific™ Eager*Smart*™ Data Handling Software controls all analytical parameters of the instrument including the oxygen flow and the timing of oxygen injection. Eager*Smart* Data Handling Software calculates automatically the amount of oxygen, relative to the sample type and sample weight, through the dedicated Thermo Scientific™ OxyTune™ Function ensuring the complete combustion of the sample. This optimization also decreases the cost per analysis by not wasting oxygen or consuming the copper unnecessarily.

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Oxygen parameters

For **CHN**, **CHNS**, and **NCS** configurations, the oxygen flows and the oxygen injection time can be defined according to the sample matrix and sample weight. Figure 2 shows the typical analytical conditions where the oxygen flow is 250 ml/min and the oxygen injection time 5 seconds.

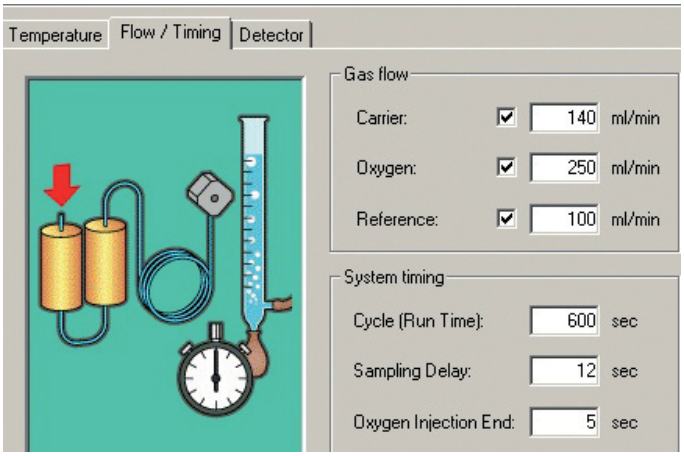

Figure 2. Typical oxygen parameters for CHN, CHNS and NCS configurations.

For **NC** and **N/Protein** configuration, the oxygen flow is 300 ml/min and the OxyTune Function dose the quantity of oxygen by the automated oxygen injection time required for the complete sample combustion, considering the category to which the product belongs (for example: Cheese/*Category A*, Cereals*Category B*, Soil/*Category C*, and so on), and the weight of the sample to be analyzed. Figure 3 shows an example of the OxyTune page of the analysis of 200 mg of milk powder (Category A). The column selection implies the selection of a multiplying factor which, together with the sample weight, determines the number of seconds of oxygen introduction into the carrier circuit, and which corresponds to the injected oxygen quantity.

The seconds of oxygen injection are visualized on top of the table, in the example given corresponding to 52 seconds of oxygen will be injected respectively for complete combustion of the matrices. If the sample nature does not fit one of the four columns **A**, **B**, **C**, or **D**, the sample must be assigned to one of the columns **E**, **F**, **G**, or **H**, entering in the box a multiplying factor to be experimentally found.

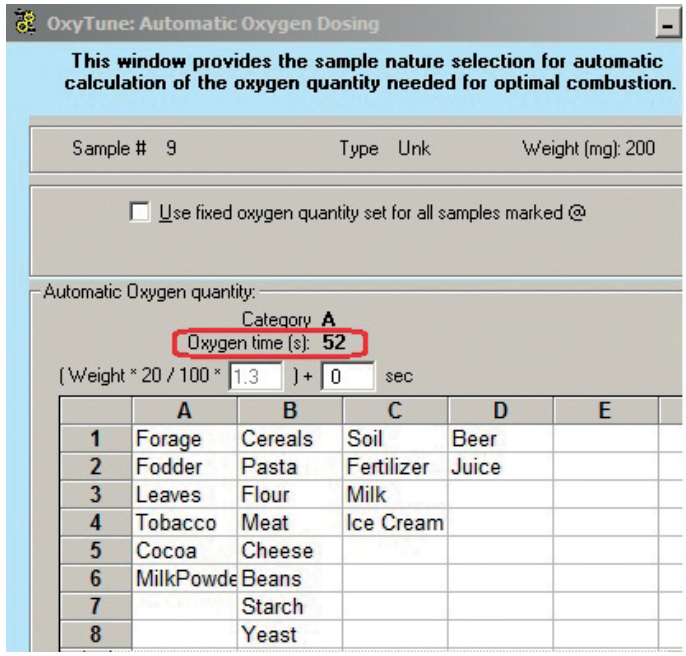

Figure 3 . OxyTune page for NC Soils and N/Protein configurations.

Evaluation of the oxygen consumption

The oxygen consumption was calculated assuming that the Flash*Smart* Elemental Analyzer is used for the analysis of 100 samples by day. In addition to the amount necessary for complete sample combustion, it was also considered the negligible oxygen flow split (10 ml/min) released to maintain the clean gas line. Table 1 and 2 show the oxygen consumption according to the main configurations under typical analytical conditions.

Table 1. Oxygen consumption for CHN / CHNS / NCS and NC soils configurations.

Configuration	CHN / CHNS / NCS	NC Soils
Sample Nature	Organic - Inorganic	Soils
Sample Weight	3 mg – 20 mg	100 mg
Analysis Time	10 min	5 min
Oxygen Flow	250 ml/min	250 ml/min
Oxygen Injection Time	5 sec	10 sec
Oxygen Flow Split / Sample	100 ml	50 ml
Total Oxygen Consumption / Sample	120.83 ml	91.67 ml
Total Oxygen Consumption / 100 Samples per Day	12083 ml	9167 ml

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Table 2. Oxygen consumption for N / Protein configuration.

OxyTune Category	A	B	C	D
Sample Nature	Milk powder, cocoa, forage, leaves, tobacco	Cereals, pasta, flour, meat, cheese, beans, starch, yeast	Soil, fertilizer, milk, ice-cream	Beer, juice
Sample Weight	200 mg	200 mg	200 mg	200 mg
Analysis Time	5 min	5 min	5 min	5 min
Oxygen Flow	300 ml/min	300 ml/min	300 ml/min	300 ml/min
Oxygen Injection Time	52 sec	44 sec	20 sec	8 sec
Oxygen Flow Split / Sample	50 ml	50 ml	50 ml	50 ml
Total Oxygen Consumption / Sample	310 ml	270 ml	150 ml	90 ml
Total Oxygen Consumption / 100 Samples per Day	31000 ml	27000 ml	15000 ml	9000 ml

Oxygen bottle lifetime

To illustrate the potential reduction in cost per analysis, the lifetime of the oxygen bottle (based on a cylinder containing 10,000 liters, 200 bar) was evaluated. Results are showed in Table 3.

Table 3. Oxygen bottle lifetime.

Configuration	CHN / CHNS / NCS	NC Soils	N / Protein			
			Category A	Category B	Category C	Category D
Oxygen Consumption / Day	12.083 Liters	9.167 Liters	31 Liters	27 Liters	15 Liters	9 Liters
Days per Oxygen Bottle	~ 827	~ 1090	~ 322	~ 370	~ 666	~ 1111
Months per Oxygen Bottle	~ 27	~ 36	~ 11	~ 12	~ 22	~ 37

* Month: 30 days

Conclusions

The intelligent optimization of the amount of oxygen needed for proper combustion by the Eager*Smart* Data Handling Software provides that complete combustion of any matrix (solid, liquid, viscous and gas, organic and inorganic) at any sample weight is achieved. The oxygen is introduced only for the time required to provide a sound *FLASH* combustion, which increases the lifetime of the oxygen bottle, increases the lifetime of catalysts, reducing the maintenance of the analyzer and the overall analysis cost.

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