

# Organic Elemental Analysis

2400 Series II CHNS/O Elemental Analyzer



proven performance

reliable results

# 2400 Series II CHNS/O Elemental Analyzer

## raising the standard

### QUICK GLANCE

- One analyzer with three modes of operation: CHN, CHNS and Oxygen
- Advanced combustion design for handling virtually any type of sample
- Frontal Chromatography for simple, reliable and accurate measurements
- NEW EA 2400 Data Manager software for easy data handling

The PerkinElmer 2400 Series II CHNS/O Elemental Analyzer (2400 Series II) is a powerful instrument for the rapid determination of the carbon, hydrogen, nitrogen, sulfur or oxygen content in organic and other types of materials. It has the capability of handling a wide variety of sample types in the field of pharmaceuticals, polymers, chemicals, environmental and energy, including solids, liquids, volatile and viscous samples.

Based on the classical Pregl-Dumas method, samples are combusted in a pure oxygen environment, with the resultant combustion gases measured in an automated fashion. The design has been field-proven in thousands of laboratories around the world. High-speed microprocessor control, solid-state components and built-in diagnostics provide confidence in performance and reliability.



The new EA 2400 Data Manager simplifies data handling and allows convenient storage and reporting capabilities. In addition, PerkinElmer offers the best quality reagents to provide the highest measurement of accuracy and precision.

Unlike other elemental analyzer designs, the 2400 Series II has easy access to all components for routine care and maintenance.

### Multiple modes of operation

The 2400 Series II offers multiple analysis options: CHN, CHNS or Oxygen mode. As a user, you may choose one or more options to meet your laboratories needs. Changeover to different modes of operation only requires a few simple steps. The optional Column Switching Accessory (CSA) makes switching to the Oxygen mode very convenient.

The **CHN mode** is the most widely used of the analysis modes. A range of reagents and the ability to optimize the combustion parameters offer flexibility for analyzing virtually any sample types. Interfering elements such as halogens and sulfur are removed before detection.

The **CHNS mode** is specifically designed to simultaneously determine carbon, hydrogen, nitrogen and sulfur in organic materials.

The **Oxygen mode** is optimized for the automatic determination of oxygen in organic materials by pyrolyzing the sample.

### Upgradeability

The 2400 Series II can be upgraded at any time to add additional mode capability to suit the needs of your laboratory.

### Automated weight entry

Accurate weighing of samples is a prerequisite for organic elemental analysis since results are presented on a weight percent basis.

To avoid transcription errors, the 2400 Series II provides automatic weight entry from the cost-effective PerkinElmer AD-6 Autobalance as well as other ultra microbalances. Using proven PerkinElmer balance technology, the AD-6 ultra microbalance provides exceptional resolution and accuracy for the best results.

# Principle of operations

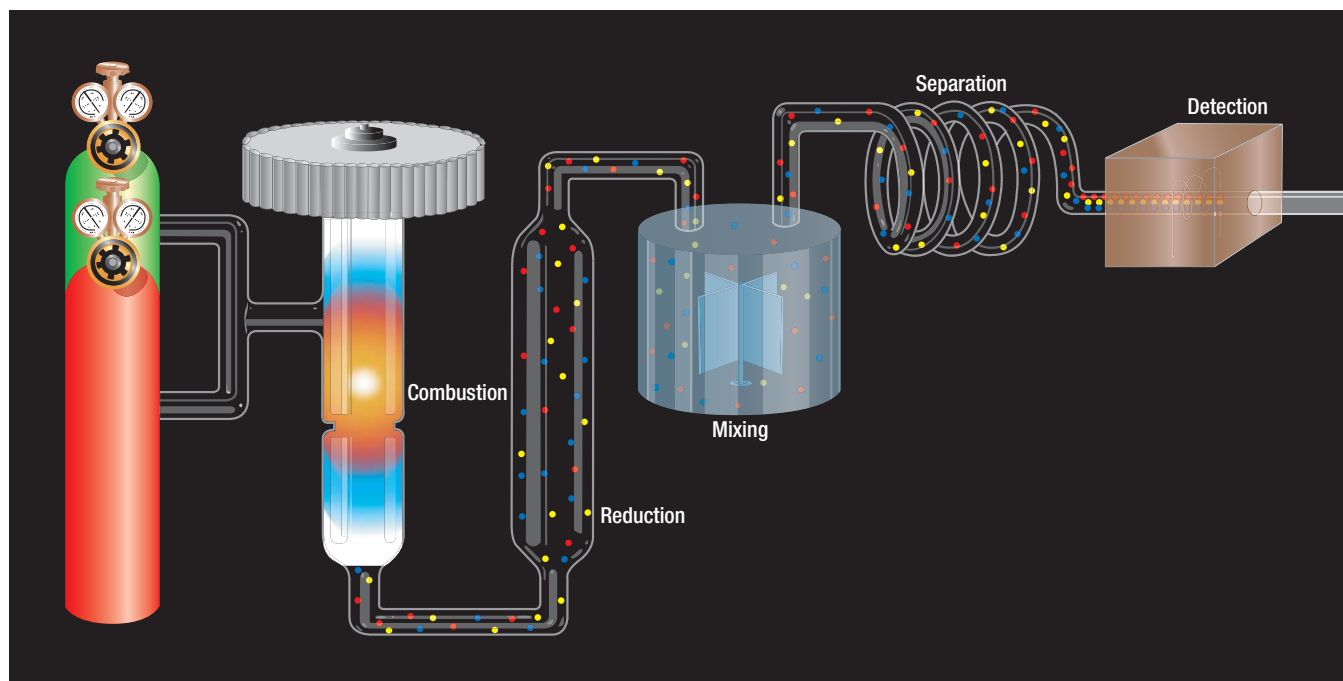


Figure 1. 2400 Series II CHNS/O Schematic

## CHN and CHNS

A schematic diagram of the PerkinElmer 2400 Series II CHNS/O Elemental Analyzer is shown in Figure 1.

The CHN and CHNS methods are based on the classical Pregl-Dumas method where samples are combusted in a pure oxygen environment, with the resultant combustion gases measured in an automated fashion.

The 2400 Series II system is comprised of four major zones:

- Combustion Zone
- Gas Control Zone
- Separation Zone
- Detection Zone

In the **Combustion Zone**, samples encapsulated in tin or aluminum vials are inserted automatically from the integral 60-position autosampler or manually using a single-sample auto injector.

In the presence of excess oxygen and combustion reagents, samples are combusted completely and reduced to the elemental gases  $\text{CO}_2$ ,  $\text{H}_2\text{O}$ ,  $\text{N}_2$  and  $\text{SO}_2$ . Users have the flexibility of optimizing static and dynamic combustion conditions to meet the specific sampling need of their laboratory. The combustion products are then passed to the **Gas Control Zone** of the 2400 Series II.

Gases are captured in the mixing chamber of the Gas Control Zone. Here, gases are rapidly mixed and precisely maintained at controlled conditions of pressure, temperature and volume. The result is the thorough homogenization of product gases.

After homogenization of product gases, the mixing chamber is depressurized through a column in the **Separation Zone** of the instrument. The separation approach used is a technique known as Frontal Chromatography.

As the gases elute, as illustrated in Figure 2, they are measured by a thermal conductivity detector in the **Detection Zone** of the analyzer. Since measurements in this design are made as stepwise changes from the carrier gas baseline, the variations associated with the quantification of peak signals in other CHNS/O

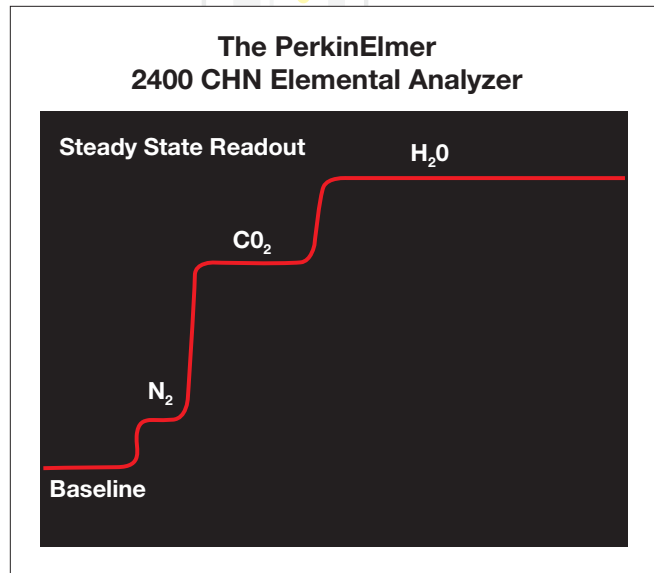


Figure 2. Chromatogram

analyzers is eliminated.

## Oxygen

The oxygen determination method used with the 2400 Series II analyzer is based on the classical Unterzucher method which incorporates the modifications of Oita, Conway and Culmo. The sample is pyrolyzed in a helium/hydrogen (95%:5%) atmosphere at 1,000 °C. The resulting products of reaction containing oxygen are converted to carbon monoxide over the platinumized carbon reagent. The carbon monoxide and other gases pass through a scrubber where interferences are removed. The carbon monoxide is then controlled, separated and determined in the same fashion as above.

# special features

## Operating gases

In the CHN and CHNS modes, operating gases include oxygen, for combustion of sample materials, and a carrier gas – either helium or argon. The use of argon as an optional carrier gas is unique to this design and assures cost-effective use of the Elemental Analyzer in those areas of the world where helium is difficult to obtain due to price or availability.

In the Oxygen mode the operating gas is helium when using silver vials or helium/hydrogen mixture when using tin vials.

## Optimized combustion flexibility for best performance

Combustion is the most critical step to the success of the measurements and ultimately affects the accuracy and precision of the final result: the weight percent of the element or elements being measured. The 2400 Series II provides advanced combustion conditions of temperature, time and available oxygen (or pyrolysis gas in the case of Oxygen mode). The user has the flexibility to increase the sample's combustion time in the oxygen atmosphere as well as the amount of oxygen that is introduced allowing for complete combustion of virtually any type of sample.

## Gas control zone

The thorough mechanical homogenization of product gases under the controlled conditions of pressure, temperature and volume are important in order to achieve the most precise results.

## Frontal Chromatography for highest reliability

In the 2400 Series II, there is selective retention of the gases to produce a steady-state, stepwise signal rather than a peak signal (see Figure 2). This technique allows for a simpler, more reliable and accurate determination of the combustion gases than other CHNS/O systems which use a peak separation method.

## Laboratory efficiency

The 2400 Series II offers fast analysis times, optimizing efficiency and precision. A typical CHN analysis is accomplished in under six minutes, CHNS in eight minutes and oxygen in four minutes.

A unique wake-up routine allows the automatic equilibration and standardization of the 2400 Series II at an operator-selected date and time. This feature allows the system to be ready when you are.

A 60-position autosampler allows unattended operation night or day. The autosampler design has been tested through millions of cycles, both in accelerated quality assurance testing, and most importantly, in labs like yours throughout the world.

Diagnostic routines monitor electronic and pneumatic components for proper operation and alert the operator in the rare event that a failure is encountered. A programmable gas saver valve allows for the automatic reduction of carrier gas flow rate when the analyzer is not in use.

## Consumables

Only the best reagents, tubes and sample vials assure optimum analyzer performance. Every genuine PerkinElmer consumable and reagent is of high quality and designed specifically for your PerkinElmer instrument.

Convenient kits for 2,000, 4,000 or 10,000 experiments simplify ordering and eliminate waste.



Figure 3. CHNS kit (500)

# specifications

## 2400 Series II CHNS/O Elemental Analyzer

### Analysis mode

#### options:

**Option 1, CHN mode** The CHN mode is the most universal of the analysis modes because of the combination of the reagent design and the Optimize Combustion control parameters. Interfering elements (halogens and sulfur) are removed.

**Option 2, CHNS mode** The CHNS mode is designed to handle conventional organics. This mode is specifically designed to include sulfur, which reduces universality. This includes limiting the range of sample types and sample size (1 to 2 mgs recommended). Metal cations are excluded. Special care must be used in calibration and blanks for lower levels of sulfur.

**Option 3, Oxygen mode** The Oxygen mode is designed to handle conventional organics. This mode excludes compounds containing phosphorous, fluorine, silicon and metal cations. Samples containing mineral matter must be demineralized prior to analysis.

**Upgradeability** The user may choose any or all modes. The 2400 Series II may be freely upgraded at any time to add additional mode capability to suit the needs of the laboratory.

**Analysis times** CHN: 6 min, CHNS: 8 min, Oxygen: 4 min

**Sample size** 0 to 500 mgs, depending on sample type. Small samples will generally be limited by weighing errors, but may be used. Large samples are limited by the sample matrix and content (see Analytical Range).

Analytical detector range	Element Range (mgs)
	C 0.001 - 3.6      S 0.001 - 2.0
	H 0.001 - 1.0      O 0.001 - 2.0
	N 0.001 - 6.0

Analytical performance*	Mode	Helium Carrier Gas		Argon Carrier Gas	
		Accuracy[%]	Precision [%]	Accuracy[%]	Precision [%]
Based upon organic standards	CHN	< 0.3	/ < 0.2	< 0.4	/ < 0.3
	CHNS	< 0.3	/ < 0.2	< 0.5	/ < 0.4
	Oxygen	< 0.3	/ < 0.2	< 0.4	/ < 0.3

0.1% = 100 ppm

Best performance requires an ultra microbalance

\*with 95% confidence limits for an organic standard material weighed with a PerkinElmer AD-6 Series ultra microbalance.

# EA 2400 Data Manager ...

This powerful data management software is intuitive and user-friendly, providing a wide range of standard features and capabilities giving you more flexibility. Combined with the proven 2400 CHNS/O Series II Elemental Analyzer, PerkinElmer customer service and support, and the highest quality reagents and supplies, you can be sure you are receiving a complete, robust system for accurate, reliable material characterization.

## Software capabilities

The 2400 Series II data manager is a SQL-based software. It allows the use of a standard PC to collect and store data, perform advanced calculations, recalculate a result, run queries (searches), generate statistics, create reports and archive data. For regulated environments, it is compliant with 21 CFR Part 11.

The software lets you:

- Browse a list of run results that have been collected from the instrument.
- Browse a list of instrument diagnostic messages such as leak test results or instrument status information.
- Browse a list of user-defined queries that enable you to search for a specific set of run results.

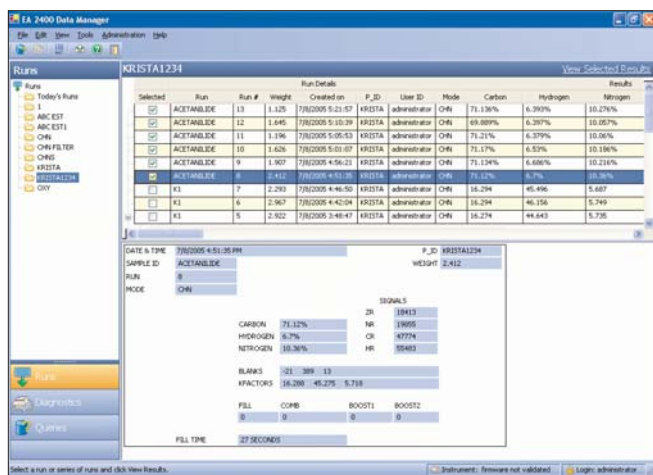


Figure 4. Run Results screen

In addition you can also:

- Filter the browsing to **show specific run results**.
- **Search for run results** by date and time, user ID, Project ID, mode, run type and sample ID.
- **Customize the columns** you wish to display in the results table.
- Select multiple runs to **perform advanced calculations, recalculations or statistical analyses**.

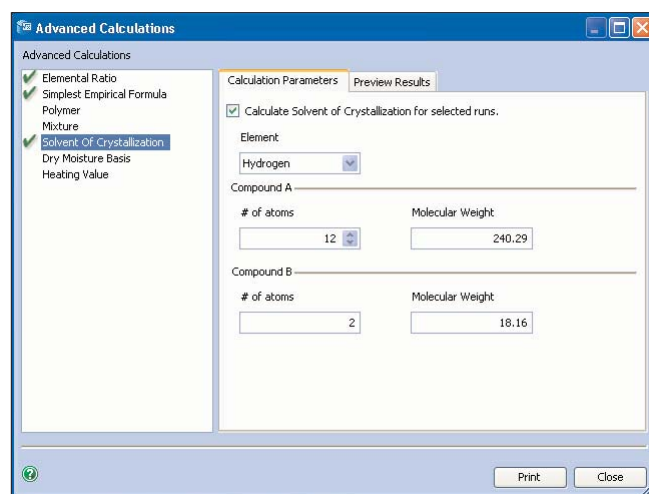


Figure 5. Advanced Calculations screen

## Advanced calculations

Advanced Calculations are standard features in the software allowing users to:

- Perform **Elemental Ratio** calculations of H/C, N/C, S/C or C/N.
- Determine the simplest **Empirical Formula** of a sample to help to confirm an unknown.
- Determine % **Polymer** in a co-polymer formulation or blend using a hetero-element.
- Analyze **Mixtures** when a reasonable element differential exists between two compounds.

# EA 2400 Data Manager

- Study newly synthesized organic compounds for the amount of **Solvent of Crystallization**.
- Correct the result % on all elements to a dry basis when the moisture content is known.
- Determine the **Heating Value** in kJ/g of a material when the CHNS and O percentages are known. This is defined as the theoretical amount of energy released as the material combusts in the oxygen atmosphere.

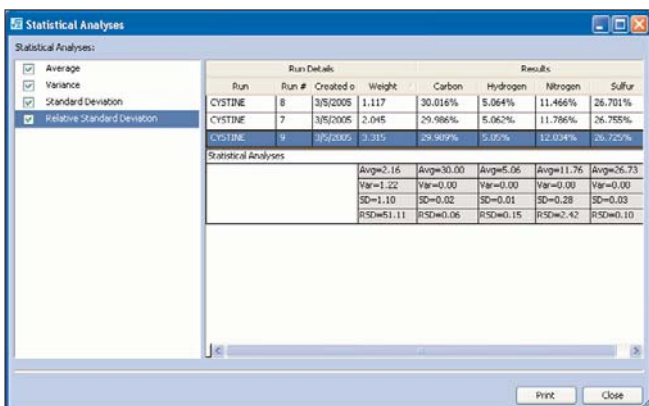


Figure 6. Statistical Analyses screen

## Statistical analyses

Statistics provide a method or basis to better understand your data. The EA 2400 Data Manager offers a choice of Average, Standard Deviation, Variance and Relative Standard Deviation analysis.

## Reporting and exporting

If you wish you can print the table of selected runs or an entire results table, or you can use one of the available predefined report templates. You may choose to either print the hard copy and/or save the report using pdf-, doc- or rtf- file format.

Data can be exported to a csv- or xls- file format.

## Diagnostics

The diagnostic information provided from the instrument is stored providing a permanent record of instrument history and status.

## Enhanced security for regulated environments

In response to 21 CFR Part 11 and the increasing data security requirements in some industries, PerkinElmer's Enhanced Security™ (ES) feature offers the technical compliance tools needed to meet these mandatory regulations.

## Queries

The Query (search) Setup capability allows you to select criteria to be used to generate a very specific search of the run results in the database. Query definitions can be saved and made available to all users or only the user that created the query.

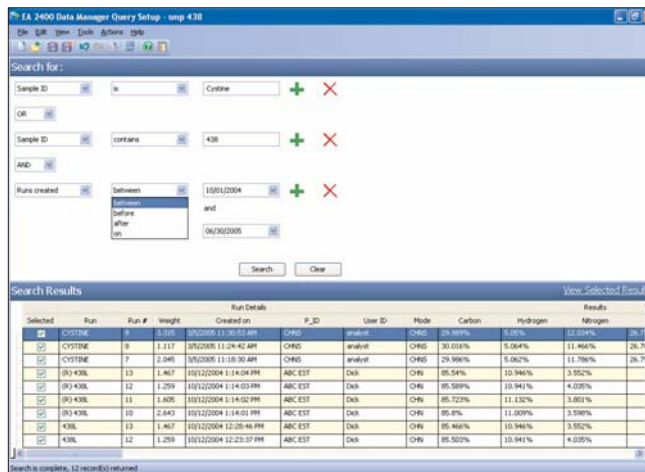


Figure 7. Search screen

# special features

## 2400 Series II CHNS/O Elemental Analyzer

<b>Optimized combustion</b>	Offers advanced combustion conditions for static and dynamic step. Users optimize temperature, time and available oxygen.								
<b>Gas control zone</b>	Controls pressure, temperature and volume of the product gases.								
<b>Diagnostics</b>	Monitors electronic and pneumatic components, continuously, assuring best instrument performance.								
<b>Wake-up</b>	Allows automatic instrument startup, equilibration and calibration at any operator-selected time and date.								
<b>Shutdown</b>	Allows for the automatic reduction of operating temperatures at operator-selected time and date.								
<b>Gas saver</b>	Provides automatic reduction of carrier gas flow rate with a built-in valve at an operator-selected time and date.								
<b>Run counters</b>	Aids in routine maintenance procedures and monitors reagent and expendable components.								
<b>Advanced calculations</b>	Allows calculations on filters and for polymers, element ratios, mixtures, simplest empirical formula, heating valve, calculates solvent of crystallization or results on dry basis.								
<b>Automatic weight transfer</b>	Eliminates transcription errors and simplifies operations through automatic weight transfer using a PerkinElmer cost-effective AD-6 ultra microbalance, Mettler UMX2 or Sartorius SE2.								
<b>Helium or argon carrier gas</b>	Accepts argon as a substitution for the system carrier gas in areas where helium is difficult to obtain or is high in price.								
<b>Copper reagent reduction</b>	Allows for the reduction (with 5-8% H <sub>2</sub> gas mixture) of the copper reagent for reuse at operator-selected time and date.								
<b>Column switching accessory</b>	The Column Switching Accessory (CSA) is available to conveniently switch columns from CHN or CHNS mode to the Oxygen mode.								
<b>Physical details</b>	<table><thead><tr><th><b>Power requirements</b></th><th><b>Bench space</b></th></tr></thead><tbody><tr><td>100 VAC ±10%</td><td>Width 61 cm (24 in)</td></tr><tr><td>120 VAC ±10%</td><td>Depth 55 cm (22 in)</td></tr><tr><td>230 VAC ±10%</td><td>Height 55 cm (22 in)</td></tr></tbody></table> <p>Weight ±45 kg (100 lbs)</p>	<b>Power requirements</b>	<b>Bench space</b>	100 VAC ±10%	Width 61 cm (24 in)	120 VAC ±10%	Depth 55 cm (22 in)	230 VAC ±10%	Height 55 cm (22 in)
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