SEAL Analytical

APPLICATION NOTE - CFA

AUTOMATED SOIL AND PLANT ANALYSIS

APPLICATIONS OF CONTINUOUS-FLOW ANALYZERS

In laboratories around the world, the AutoAnalyzer and QuAAtro automate the routine analysis of soil and plant samples for nutrients and minerals. Results are calculated and printed automatically at 40 - 90 samples per hour.

ADVANTAGES

- Officially approved methods
- Fast, accurate and reliable results
- Low manpower and skill requirement
- Low reagent consumption: normally less than 1mL per test
- Several parameters can be measured simultaneously from the same sample

AUTOMATIC SAMPLE PREPARATON

Built-in dialyzers automatically remove interference from colored samples, humic acids, proteins and carbohydrates.

New applications are constantly being developed in our laboratories.

SAMPLE TYPES

- Soil extracts prepared by any method
- Persulfate digests
- Kjeldahl digests of soil or plants
- Fertilizers
- Ashed samples

METHODS

- Aluminium
- Ammonia
- Amino acids
- Boron
- Calcium
- Carbohydrate
- Carbon (dissolved organic)
- Carbon (inorganic)
- Chloride
- Fluoride
- Iodine
- Iron
- Magnesium
- Manganese
- Nitrate
- Nitrite
- Nitrogen, total
- Phosphate
- Phosphorus, total
- Potassium
- Soluble carbo-hydrates
- Potassium
- Silicate
- Sodium
- Sulfate

SAMPLE PREPARATION

SOIL

Samples are normally dried, screened to remove stones and ground before extraction. Many extraction procedures have been developed to provide an estimate of the soil's supply of nutrients available to crops. Some of the most common are dilute acid, calcium chloride, bicarbonate, ammonium acetate and electro-ultrafiltration (see References). Calibration standards are prepared in the sample extraction solution to ensure accurate results. Methods are available for all common sample preparation procedures.

The automated soil methods can easily be adapted for plant and fertiliser analysis.

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PLANTS

ASHING

Applications: P, Ca, Mg, Mn, K, Na, Al, B, Cu, Zn, Fe, I.

Samples are dried, normally at 105 °C, ground, and a representative sample, typically around 1g, is ashed at 500 - 550 °C. The cooled residue is dissolved in dilute acid and diluted to volume.

Alkaline ashing is used prior to iodine determination to prevent loss of I_2.

ACID DIGESTION

Applications: N, P, Ca, S.

Kjeldahl digestion is required for total N: P and Ca can be determined from the same digestate. Sulphur requires digestion with HNO_3, HCl and/or $HClO_4$, or dry ashing with $Mg(NO_3)_2$.

Methods are available for all common sample preparation procedures; several are AOAC approved.

FERTILIZER

For both raw materials and finished products, a sufficient quantity to make up a representative sample is ground, then 1 - 5 g is accurately weighed and dissolved in water, dilute acid or citrate buffer depending on the analysis requirements. Total P can either be measured in pre-digested samples, or an on-line acid hydrolysis can automatically digest the condensed phosphates.

The AutoAnalyzer methods for K, total P and available P_2O_5 in fertilizer are AOAC-approved.

REFERENCES

SAMPLE PREPARATION

- DILUTE ACID
  R H Bray and L T Kurz,
  Soil Science 59:39-45, (1945)

  E Truog and A H Meyer,
  Industr. Eng. Chem. (Anal.) 1: 136, (1929)

- BICARBONATE
  S R Olsen,
  U.S. Dept. Agr. Circ. 939, (1954)

- AMMONIUM ACETATE
  C J Schollenberger and R J Simon,
  Soil Science 59, 13-24 (1945)

- ELECTRO-ULTRAFILTRATION
  K Nemeth,
  Adv. Agron. 31, 155-181 (1979)

METHODS

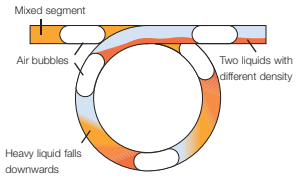
- PHOSPHATE IN BICARBONATE EXTRACTS
  H G Zandstra,
  Can. J. Soil Science 48, 219-220, (1968)

- HIGH-SPEED MULTI-CHANNEL TESTING
  D K Markus et al,
  J. AOAC, 68(4), 794-800 (1985)

TECHNIQUES

MIXING AND INCUBATION

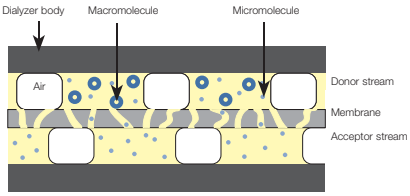
Reaction times up to 20 minutes can be automated, allowing chemical reactions to proceed to completion for maximum sensitivity and freedom from interference.



Mixing is assisted by gravity and the internal flow within each segment

DIALYSIS

Dialyzers with a pore size of 2 nm separate interfering material such as suspended solids, humic acids, proteins and other compounds which could lead to false results.



Principle of dialysis

ON-LINE DIGESTION

UV-assisted persulfate digestion can automate the digestion for total dissolved N, P or C.

ION-EXCHANGE

For the measurement of sulphate by methyl thymol blue an on-line ion-exchange column removes interfering cations.

USERS ALL AROUND THE WORLD

- United States Geological Survey
- United States Department of Agriculture
- United States Environmental Protection Agency
- Department of Agriculture, U.K.
- Università di Napoli, Italy
- Universidad de Cordoba, Spain
- Foulum Research Centre, Denmark
- Netherlands Institute for Ecological Research
- Institut National des Recherches Agronomiques, France
- Institute of Agriculture, Germany
- Agrifood Research Centre, Finland
- Teijin Eco Science, Japan
- National Agricultural Science & Technology Institute, Korea
- Department of Land Development, Thailand
- Dept of Agriculture, Indonesia
- Department of Agriculture, Malaysia
- Nanjing Agriculture University, China
- Agricultural Research Institute, Australia

INSTRUMENTS

AUTOANALYZER

With more than 11,000 systems sold, the AutoAnalyzer has a superb record of reliability and long life.

The AutoAnalyzer 3 is fully computer-controlled and is module-for-module compatible with AAII systems to enable users to update to the latest techniques.

QUAATRO

A high-speed analyser with ultra-low reagent consumption, QuAAtro is ideal for laboratories with very high workloads.

Up to 4 parameters can be analyzed at the same time in each console.

ECOANALYZER

An economical 1- or 2-channel analyzer, the EcoAnalyzer brings the advantages of automatic operation, dialysis and high precision to smaller labs.

TYPICAL SYSTEM CONFIGURATIONS

HIGH-CAPACITY NUTRIENT ANALYZERS

2-channel QuAAtro with multitest manifolds and flame photometer

Parameters
NH_4, NO_3, PO_4, K

Sampling rate
90 - 100/h

Typical workload
150 samples per day: analyse for NH_4 and K in the morning, change reagents to analyse NO_2 and NO_3 in the afternoon.

4-channel QuAAtro with flame photometer

Parameters
NH_4, K, NO_3, PO_4

Sampling rate
90 - 100/h

Typical workload
400 or more samples per day: analyse all four parameters in parallel.

With multitest manifolds, the above systems can be expanded to analyse Ca, NO_2, Cl^- or Na at low extra cost with no need to change hardware between tests.

ECONOMICAL ANALYZERS FOR MEDIUM WORKLOADS

2-channel AutoAnalyzer with multitest cartridges and flame photometer

Parameters
NH_4, NO_3, PO_4, K

Sampling rate
40 - 60/h

Typical workload
70 samples per day: analyse for NH_4 and K in the morning, change reagents to analyse NO_2 and NO_3 in the afternoon.

3-channel AutoAnalyzer with flame photometer

Parameters
Total N, NO_3, NH_4, PO_4, K

Sampling rate
30/h for Total N, 50/h for others

Typical workload
60 samples per day: analyse for Total N and NO_3 in the morning and the other parameters in the afternoon.

FLEXIBLE ANALYZER FOR SMALL LABORATORIES

1-channel AutoAnalyzer or EcoAnalyzer with multitest cartridge

Parameters
NO_2, NO_3, NH_4, PO_4, Cl^-, Ca

Sampling rate
40 - 60/h

Typical workload
70 samples per day for two parameters or 50 samples per day for three parameters.

Add a flame photometer to measure K, and other cartridges as required, or a second channel to double the workload.

MULTI-TEST METHODS

Specially developed for soil and plant analysis, these Bran+Luebbe multi-test methods enable you to measure several different parameters with one analytical cartridge or manifold. When changing from one test to another only the reagents and the colorimeter filter need to be changed.

Multitest methods are ideal for laboratories with small to medium workloads, or where some tests are required only occasionally, as there is no need to invest in a separate manifold for each chemistry.

The multitest methods for soil and plant analysis incorporate a dialyser, and can also be used without the dialyser for low-level samples which do not require automatic clean-up.

Parameters and typical ranges for the soil and plant multitest methods. Ranges can be varied by changing sample pump tubes.

PARAMETER	LOW RANGES	HIGH RANGES
Ammonia	0-0.65 to 0-5.5 mg/L	0-7.5 to 0-100 mg/L as N
Boron	0-1 to 10 mg/L	0-5 to 0-50 mg/L
Calcium	-	0-25 to 0-135 mg/L
Chloride	0-9 to 0-110 mg/L	0-60 to 0-650 mg/L as Cl
Nitrate	0-0.3 to 0-2.5 mg/L	0-2.8 to 0-20 mg/L as N
Nitrite	0-0.25 to 0-2.2 mg/L	0-2.2 to 0-20 mg/L as N
Nitrogen, total Kjeldahl	0-1.5 to 0-8 mg/L	0-9 to 0-100 mg/L as N
Phosphate	0-1.5 to 0-6 mg/L	0-26 to 0-100 mg/L as P
Phosphorus, total Kjeldahl	0-2 to 0-7 mg/L	0-30 to 0 -100 mg/L
Potassium	0-10 to 0-100 mg/L	0-70 to 0-700 mg/L as K

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