
Continuous-Flow Analyzers

Rapid Control of Fertilizer Quality with the AutoAnalyzer

Legislation and quality requirements have led to the need for close control of fermentation and finished products and accurate and speedy analysis. Many routine tests, even those requiring lengthy and complicated manual procedures, can be automated with the AutoAnalyzer to give faster, more accurate results and higher productivity in the laboratory.

A dissolved sample can be analysed for N, P and K within 8 minutes. Finished products and raw materials can be analysed on the same system.

The Advantages of Automation

Accurate results in a short time.

- Lets you take quick decisions on production quality.
- Results are calculated and printed out automatically.

Low manpower requirement.

- After the system has been started, it can run for hours without attention, analysing many samples for several parameters at the same time.
- Maintenance is simple and does not need any special skills.

Low reagent costs.

- Typical reagent consumption per test is between 50 μ L and 2mL.

Methods

Boron
Calcium
Nitrate
Nitrogen:
 ammonia
 nitrate
 urea
 total in manual digests
 ammonia + nitrate fully automatic
Phosphorus:
 water-soluble
 citrate-soluble
 direct available
 total inorganic
 total in manual digests
Potassium
Sulphate

The analysis rate is 30 to 60 samples per hour, depending on the parameter and the system. Several parameters can be analysed in parallel from the same sample.

SEAL Segmented Flow Analyzers

Thousands of AutoAnalyzers are in daily use world-wide for the analysis of samples such as soil, water, beer, wine, chemicals and tobacco. Their success is due to their design:

Flexible

The AutoAnalyzer is a modular system. A single-parameter analyzer can be expanded later to analyse multiple parameters simultaneously, or different samples and parameters can be added to the system as your analysis requirements change.

Simple

The only moving parts are the sample changer and a peristaltic pump. The system is easy to understand and operate.

Continuously developed and improved

Our policy is continual product improvement. We are constantly developing new and improved methods to give faster and more accurate results. AACE software makes the system even easier to use and to interface with central computers.

All these improvements can be incorporated into old systems. When you buy an AutoAnalyzer you can be sure that you are making a sound investment for the future.

Principle

The AutoAnalyzer is a segmented flow analyser. Reagents and samples are pumped continuously through an analytical manifold by calibrated pump tubes. The samples are interspersed with a precise volume of wash solution, to make sure that each sample remains separate.

The flowing stream is segmented with air bubbles: these prevent each sample diffusing into the following one, and make the liquid flow easy to see in the glass coils. This is a great advantage in checking for correct operation. Sample preparation, treatment and reaction take place in the manifold tubing. The reaction stream then flows into the colorimeter.

Standards are measured in every run under the same conditions as the samples, and the sample results are calculated from the calibration curve.

Sample Preparation

For most methods, a weighed amount of ground sample is dissolved in distilled water and filtered if necessary. Methods needing special sample preparation, such as citrate-soluble phosphorus, can also be adapted to the AutoAnalyzer.

Results

The AutoAnalyzer is highly reproducible. Typical results are:

Parameter	Content	Standard Deviation of 10 replicates
N (as NH ₃)	8.5%	0.02% - 0.04%
P (free available)	7.5%	0.02% - 0.04%
K	8.9%	0.03% - 0.05% depending on flame photometer type

AutoAnalyzer Applications

Typical System Configurations

Flexible analyzer for medium workloads

2-channel AutoAnalyzer with multitest cartridges and flame photometer

Parameters	NH ₄ , NO ₃ , P ₂ O ₅ , K
Sampling rate	50 /h
Typical workload	Up to 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 - or other method combinations.

3-channel AutoAnalyzer with flame photometer

Parameters	Total N, NO ₃ , NH ₄ , P ₂ O ₅ , K, Urea
Sampling rate	30 /h for Total N, 50 /h for others
Typical workload	Up to 60 samples per day: analyse for Ammonia, Total N and NO ₃ in the morning and the other parameters in the afternoon - or other method combinations.

Economical analyzer for small laboratories

1-channel AutoAnalyzer with multitest cartridge

Parameters	NO ₃ , NH ₄ , P ₂ O ₅ , Ca
Sampling rate	50 /h
Typical workload	Up to 70 samples per day for two parameters or 50 samples per day for three parameters, changing reagents as necessary. Add a flame photometer to measure K (automatically or off-line) and other cartridges as required.

AutoAnalyzer Applications

Method No. G-247-00 Rev. 0

Ammonia in Water, Waste Water, Fertilizer Extracts, Tobacco Extracts and other aqueous samples

Ranges: 0 – 0.5 to 0 – 5 mg/L as N
and 0 – 5 to 0 – 50 mg/L as N (see operating note 3)

Description

In this automated procedure¹ ammonium present in the sample reacts in alkaline solution with free chlorine, which has previously been liberated from dichloroisocyanurate. The chloramine formed reacts under catalysis of nitroprusside with salicylate at a temperature of 37 °C to form a blue-green indophenol dye which is measured colorimetrically at 640 to 660 nm.

Hardware: 24" Dialyzer, 37°C heating bath (7.7 mL) **Pump tubes:** 7 plus 2 air plus sampler wash (AAII: +1)

Typical performance data using aqueous standards and AA3 colorimeter

(See operating note 5 for performance with AAII colorimeter)

Test conditions: AA3 colorimeter with 10 mm flowcell

Test range	Sample A 0 – 10 mg/L	Sample B 0 – 1 mg/L
Sample pump tubing	orn/wht	blk/blk
sample rate	50/h	50/h
Sample:Wash ratio	5:1	5:1
Sensitivity: absorbance at 10 and 1 mg/L	0.18 - 0.22	0.18 - 0.22
Reagent absorbance	0.01	0.01
Coefficient of variation (10 replicates at 50%)	0.2%	0.2%
Pooled Standard deviation (50 randomised at 5 levels)	0.16 mg/L	0.031 mg/L
Correlation coefficient (linear, 5 points)	1.0000	0.9999
Detection limit (determined according to EPA procedure Pt. 136, app. B)	0.05 mg/L	0.003 mg/L

Note: the above performance specifications were developed with the exclusive use of genuine Seal Analytical parts and consumables.

Reference

1. ISO/DIS method 11732

AutoAnalyzer Applications

Method No. Kemira 1 Rev. 2

Nitrate and Nitrite in Fertilizer

and other aqueous samples

Range: 0 – 90 to 0 – 730 mg/L as NO₃-N

Description

Nitrate is reduced to nitrite by hydrazine in alkaline solution, with a copper catalyst, after which it is, following the DIN and ISO standard methods (1,2), reacted with sulfanilamide and NEDD to form a pink compound measured at 520nm. Phosphoric acid is added at the final stage to reduce the pH, thus avoiding precipitation of calcium and magnesium hydroxide. A dialyzer eliminates interference from coloured samples and suspended solids.

Hardware: 6" dialyzer, 37°C heating bath (7.7mL)

Pump tubes: 6 + 2 air + 1 sampler wash
(with dilution: 10 + 3 air + 1 sampler wash)

Typical performance using aqueous standards

See operating note 6 for performance with AA3 colorimeter.

Test conditions: Range: 0 – 600 mg/L, AAI colorimeter with 15mm flowcell

Sampling rate	60/hour
Sample: Wash ratio	4:1
Sensitivity: Extinction at 600 mg/L as NO ₃ -N	0.59 – 0.67
Reagent absorbance	0.01 – 0.02
Coefficient of variation: (10 replicates at 50 %)	0.36%
Pooled standard deviation (25 randomised at 5 levels)	1.08 mg/L
Correlation coefficient (linear, 5 points)	0.9996
Detection limit (determined according to EPA procedure pt. 136, app. B)	0.34 mg/L
Detection limit in the lowest range (0 – 90 mg/L)	0.18 mg/L

Note: the above performance specifications were developed with the exclusive use of genuine Seal Analytical parts and consumables.

Reference

1. DIN 38405
2. ISO/DIS 13359

AutoAnalyzer Applications

Method no. GB-229-79 Rev. 1

Urea in Fertilizer

Range: 0 - 100 mg/L to 0 - 700 mg/L as N

Description

Urea reacts with dimethylaminobenzaldehyde giving a yellow coloured addition product measured at 440 nm.

Hardware: only glass

Pump tubes: 2 + 1 air + 1 sampler wash (AAll: +1)

Typical performance data using aqueous standards and AAll colorimeter

Test conditions: range: 0 - 500 mg/L. AAll colorimeter with 15 mm flowcell.

Sampling rate	80/hour
Sample: Wash ratio	3:1
Sensitivity at 500 mg/L as N	0.70
Reagent absorbance	0.04
Coefficient of variation (10 replicates at 50%)	0.2 %
Pooled standard deviation (5 levels)	0.6 mg/L
Correlation coefficient (5 points, linear fit)	0.9999
Detection limit (determined according to EPA procedure pt. 136, app. B)	1.2 mg/L

Note: the above performance specifications were developed with the exclusive use of genuine Seal Analytical parts and consumables.



AutoAnalyzer Applications

Method No. G-129-94

Total Nitrogen in Fertilizer and other aqueous samples

Range: 0 - 25 to 0 - 160 mg/L as N

Description

The total nitrogen measured in this method is nitrate and ammoniacal nitrogen only. No other forms of nitrogen are measured. Nitrate is reduced to ammonia with a hypovanadous reagent. The resulting ammonia plus the ammonia originally present in the sample then reacts with alkaline phenol solution and free chlorine to produce a blue complex measured at 630 nm.

Performance data using aqueous standards

Test range: 0 - 160 mg/L as N

Sampling rate	50/hr
Sample: wash ratio	3:1
Sensitivity at 160 mg/L N	0.70
Reagent Absorbance	0.13
Coefficient of Variation:	
10 replicates at 50 %	0.75 %
Pooled Standard Deviation	
25 at 5 levels	0.94 mg/L
Correlation coefficient	
(linear, 5 points)	0.9997

Note: the above performance specifications were developed with the exclusive use of genuine Seal Analytical parts and consumables.



AutoAnalyzer Applications

Method No. US-722-83 Rev. 1

Potassium in Fertilizer and Soil Extracts

Range: 0 - 400 mg/L as K₂O

Description

The automated procedure follows the modified AOAC method (1) for potassium using a flame photometer (768 nm K-filter) without internal reference as proposed by Newlon (2). Lanthanum oxide is used to eliminate the phosphate effect.

Hardware: flame photometer

Pump tubes : 3 + 1 air + 1 sampler wash

Typical performance data using aqueous standards and flame photometer

Test conditions: range: 0 - 200 mg/L. Flame photometer with 768 nm K-filter.

Sampling rate	60/hour
Sample: wash ratio	3:1
Coefficient of variation (10 replicates at 50%)	<0.7%
Pooled standard deviation (5 levels)	0.8 mg/L
Correlation coefficient (quadratic, 5 points)	0.999
Detection limit (determined according to EPA procedure pt. 136, app. B)	0.36 mg/L

Note: the above performance specifications were developed with the exclusive use of genuine Seal Analytical parts and consumables.

References

1. AOAC Official Methods of Analysis, 15th edition, section 983.02 (1990)
2. Newlon, N. Journal of AOAC International, Vol. 76, No. 6, page 1182 (1993).

AutoAnalyzer Applications

Method No. G-233-99 Rev. 1

Potassium in Fertilizer

Range: 0 – 750 mg/L

Description

This automated procedure for the determination of potassium in fertilizer uses a dual-beam flame photometer with lithium reference. Lanthanum oxide is added to the analysis reagents in order to reduce errors due to the ionisation of phosphate.

Hardware: 12" dialyzer

Pump tubes: 5 + 2 air + 1 sampler wash

Typical performance data using aqueous standards and AA3 system

Test conditions: range: 0 – 750 mg/L. AA3 system with Sherwood Model 420 flame photometer.

Sampling rate	60/hour
Sample : Wash ratio	4:1
Coefficient of variation (10 replicates at 50%)	< 0.3%
Pooled standard deviation (50 randomised at 5 levels)	< 3.5 mg/L
Correlation coefficient (5 points, quadratic fit)	0.9999
Detection limit (determined according to EPA procedure pt. 136. app. B)	0.3 mg/L

Note: The above performance specifications were obtained with the exclusive use of genuine Seal Analytical parts and consumables.



AutoAnalyzer Applications

Method No. G-130-94 Rev. 1

Phosphorus in Fertilizer, Soil Extracts and Food Products

Range: 0 - 9 to 0 - 90 mg/L as P (0 - 20 to 0 - 200 mg/L as P₂O₅)

Description

This automated procedure for the determination of phosphorus is based on the colorimetric method in which a yellow colour is formed by the reaction of phosphate with molybdovanadate in an acidic medium. The phospho-molybdovanadate complex is read at 420 nm.

Hardware: only glass

Pump tubes: 2 plus 1 air plus sampler wash (AAII: +1)

Performance data using aqueous standards and AAII colorimeter

See Notes for performance with AA3 colorimeter

Test Range: 0 - 115 mg/L as P₂O₅

Sampling Rate	60 / hr
Sample: wash ratio	3:1
Sensitivity at 115 mg/L as P ₂ O ₅	0.60
Reagent Absorbance	0.04
Coefficient of Variation	
10 replicates at 58 mg/L as P ₂ O ₅	0.1 %
Pooled Standard Deviation	
(5 Levels)	0.05 mg/L
Correlation Coefficient	
(5 points, linear)	0.9996
Detection Limit (determined according	
to EPA procedure pt. 136, app. B)	0.02 mg/L
Detection Limit in lowest range	
(0 - 20 mg/L as P ₂ O ₅)	0.02 mg/L

Note: the above performance specifications were developed with the exclusive use of genuine Seal Analytical parts and consumables.



AutoAnalyzer Applications

Method No. G-224-99 Rev. 1

Total Phosphorus in Fertilizer

AOAC - approved

Range: 0 - 500 to 0 - 2000 mg/L as P₂O₅

(0 - 873 mg/L as P)

Description

Samples are extracted manually using the AOAC procedure for total phosphorus. The sample extract is diluted with hydrochloric acid, resampled, then mixed with vanadate and molybdate reagents to form a yellow complex measured at 420 nm. (1).

Hardware: only glass

Pump tubes: 6 + 2 air + 1 sampler wash (AAll: +1)

Typical performance data using aqueous standards

Test conditions: range: 0 - 700 mg/L as P₂O₅ using AA3 colorimeter with 10 mm flowcell.

Sampling rate	40/hour
Sample : Wash ratio	4:1
Sensitivity at 700 mg/L	0.12 - 0.16
Reagent absorbance	< 0.03
Coefficient of variation (30 replicates at 50%)	0.2%
Pooled standard deviation (50 randomised at 5 levels)	1 mg/L
Correlation coefficient (5 points, quadratic fit)	0.9999
Detection limit (determined according to EPA procedure pt. 136, app.)	0.5 mg/L

Note: the above performance specifications were developed with the exclusive use of genuine Seal Analytical parts and consumables.

Reference

1. AOAC proposed analytical method, Laboratory of the Indiana State Chemist, May 1999



AutoAnalyzer Applications

Method No. US-484-77 Rev. 1

Direct Available Phosphorus in Fertilizer

AOAC - approved

Range: 0 - 80 to 0 - 700 mg/L as P₂O₅

(0 - 306 mg/L as P)

Description

Samples are extracted manually using official AOAC procedures for direct available phosphorus. The sample extract is mixed with 4N perchloric acid and passed through two 95°C heating baths where hydrolysis to ortho-phosphate occurs. A portion of the hydrolysed sample is mixed with molybdovanadate reagent and the absorbance of the yellow complex formed is measured at 420 nm. The same manifold can also be used to measure total phosphorus extracted with HCl or HNO₃, in which case the heating baths can be by-passed and the perchloric acid reagent replaced by water plus surfactant (1).

Typical Performance Data

using aqueous standards and AA3 colorimeter with 10 mm flowcell

Sampling rate	40/hr
Sample: wash ratio	4:1
Sensitivity at 700 mg/L as P ₂ O ₅	0.8 - 0.9
Reagent absorbance	<0.03
Coefficient of variation:	
10 mid-scale replicates	0.2%
Pooled Std. Dev. (5 levels)	1.3 mg/L as P ₂ O ₅
Quadratic correlation coefficient (R ²)	0.9999
Detection limit (determined according to EPA procedure pt. 136, app. B)	0.04 mg/L as P ₂ O ₅

Note: the above performance specifications were developed with the exclusive use of genuine Seal Analytical parts and consumables.

References

1. Methods of Analysis of the AOAC, 15th Edition, Association of Official Agricultural Chemists, Washington, D.C., 1990: section 978.01



AutoAnalyzer Applications

Method No. US-288-73 A

Sulfate in presolubilized Fertilizer Samples

Range: 20 - 1000 mg/L as SO₄

Description

In this automated procedure for sulfate, the sample containing sulfate is reacted with barium chloride at a pH of 2.5-3.0 to form barium sulfate. Excess barium reacts with methylthymol blue to form a blue-colored chelate at a pH of 12.5-13.0. The uncomplexed methylthymol blue color is gray; chelated with barium, the color is blue. The amount of uncomplexed methylthymol blue, measured at 460 nm is proportional to the sulfate present. 1

Performance data using aqueous standards

Sampling rate	20/hour
Sample / Wash ratio	3:1
Sensitivity at 1000 mg/L	0.35
Reagent Absorbance	approx. 0.3
Coefficient of Variation	
30 Replicated at 600 mg/L	0.59%
Correlation Coefficient	1.000
(5 points, piecewise)	
Detection Limit	20 mg/L

Note: the above performance specifications were developed with the exclusive use of genuine Seal Analytical parts and consumables.

References

1. Lazarus, A.L.; Hill, K.C.; Lodge, J.P., Jr., "Automation in Analytical Chemistry Technicon Symposia, 1965"; Mediad: White Plains, N.Y. 1966, pp 291-293.

AutoAnalyzer Applications

Method No. G-102-93 Rev. 2 (multitest MT7/MT8)

Ammonia in Water, Waste Water and Soil Extracts

and other aqueous samples

Ranges: 0 - 0.25 to 0 – 5 mg/L as N
and 0 - 2.5 to 0 – 25 / 0 – 80 mg/L as N (only for MT7, see operating note 9)

Description

Following the DIN and ISO standard methods (1,2), the sample is reacted with salicylate and dichloro-isocyanuric acid to produce a blue compound measured at 660 nm. Nitroprusside is used as a catalyst. Alternative reagents are given for reaction with salicylate and phenate. A dialyzer for the high range on MT7 eliminates interference from coloured samples and suspended solids.

This method is a multitest with alkalinity (methyl orange), boron, calcium, chloride, hydrogen sulfide, iron, nitrate, nitrite, TKN, phosphate, TKP, potassium, sodium, silicate.

Hardware: 24" dialyzer, 37°C heating bath (7.7 mL) **Pump tubes** 7 + 2 air + 1 sampler wash (AAII: +1)

Performance data using aqueous standards and AAII colorimeter

See operating note 8 for performance with AA3 colorimeter.

Test ranges:	Salicylate		Phenate	
	2 mg/L	10 mg/L	2 mg/L	10 mg/L
Sampling rate			50 / hr	
Sample: wash ratio			5:1	
Reagent absorbance	0.05	0.03	0.03	0.03
Sensitivity: Extinction at 2 and 10 mg/L	0.42	0.38	0.37	0.42
Coefficient of variation (30 repl. at 50%)	0.3%	0.3%	0.4%	0.3%
Pooled standard deviation (50 levels)	0.007 mg/L	0.015 mg/L	0.005 mg/L	0.016 mg/L
Correlation coefficient (linear, 5 points)	0.999	0.999	0.999	1.000
Detection limit (determined according EPA procedure pt. 136, app. B)	0.01 mg/L	0.01 mg/L	0.003 mg/L	0.01 mg/L
Detection limit in lowest range:	0.01 mg/L	0.003 mg/L	0.01 mg/L	

Note: the above performance specifications were developed with the exclusive use of Genuine Seal Analytical parts and consumables.

Reference

1. DIN 38 406 Part 23, section 2.
2. ISO/DIS 11732

AutoAnalyzer Applications

Method No. G-214-98 Rev. 1 (multitest MT7/MT8)

Boron in Water, Fertilizer, Soil and Plant Extracts and other aqueous samples

Ranges: 0 - 1 to 0 - 10 mg/L

and 0 - 5 to 0 - 50 mg/L (only for MT7)

Description

Boron reacts with Azomethine-H at pH 5.1 forming a yellow compound measured at 420 nm. Interference from copper, iron and aluminium is reduced with EDTA.

This method is a multitest with alkalinity (methyl orange), ammonia (salicylate and phenate), calcium, chloride, hydrogen sulfide, iron, nitrate, nitrite, TKN, phosphate, TKP, potassium, sodium, silicate.

Hardware: 24" Dialyzer, 37°C heating bath (7.7 mL) **Pump tubes:** 7 plus 2 air plus sampler wash (AAll: +1)

Performance data using aqueous standards and AA3 colorimeter

Test conditions: range: 0 - 10 and 0 - 60 mg/L, AA3 colorimeter with 10mm flowcell

	Low range	High range
Sampling rate	60/hour	60/hour
Sample Wash ratio	3:1	3:1
Reagent absorbance	0.09-0.13	0.09-0.13
Sensitivity at 10 / 60 mg/L	0.51-0.63	0.49-0.61
Coefficient of variation (10 replicates at 50%)	< 0.3%	< 0.2%
Pooled standard deviation (25 at 5 levels)	0.017 mg/L	0.15 mg/L
Correlation coefficient (5 points, linear)	1.000	1.000
Detection limit (determined according to EPA procedure pt. 136, app. B)	0.023 mg/L	0.09 mg/L
Detection limit, low range	0.017 mg/L	0.08 mg/L

Note: The above performance specifications were obtained with the exclusive use of genuine Seal Analytical parts and consumables.

Reference

1. W. D. Basson, The Analyst, 94, 1135 (Dec. 1969)
2. R. R. Spencer, Environmental Science and Technology, 13(8), 955 (Aug. 1979)



AutoAnalyzer Applications

Method No. G-209-98 Rev. 1 (multitest MT7)

Calcium in Water, Waste Water and Acid Digests

Ranges: 0 - 12 to 0 - 80 mg/L (only for MT7)

Description

The determination of calcium is based on a colorimetric method in which a red compound is formed by the reaction of calcium and cresolphthalein complexone in an alkaline medium at a pH of about 10.8. The calcium-cresolphthalein complex is read at 570 nm.

This method is a multitest with alkalinity (methyl orange), ammonia (salicylate and phenate), boron, chloride, hydrogen sulfide, iron, nitrate, nitrite, TKN, phosphate, TKP, potassium, sodium, silicate.

Hardware: 24" Dialyzer, 37°C heating bath (7.7 mL) **Pump tubes:** 7 plus 2 air plus sampler wash (AAII: +1)

Performance data using aqueous standards and AAI colorimeter

See Notes for performance with AA3 colorimeter

Matrix:	Water	1% H ₂ SO ₄
Test range:	0 - 60 mg/L	0 - 20 mg/L
Sample pump tube	blk/blk	red/red
Sampling rate	60/hr	60/hr
Sample: wash ratio	5:1	5:1
Sensitivity	0.51	0.29
Reagent Absorbance	0.20	0.19
Coefficient of Variation		
10 replicates at 50%	0.34%	0.37%
Pooled Standard Deviation (5 levels)	0.19 mg/L	0.06 mg/L
Correlation Coefficient (linear)	0.9995	0.9990
Detection limit (determined according EPA procedure pt. 136, app. B)	1.44 mg/L	0.06 mg/L
Detection limit in lowest range (0 - 12 mg/L)	1.44 mg/L	

Acid Digests: HNO ₃ /HCl (0.5 M)	Range	0 - 12 to 0 - 80 mg/L
	Sensitivity at 60 mg/L	0.50
	Reagent Absorbance	0.20
4% H ₂ SO ₄	Range	0 - 20 to 0 - 165 mg/L
	Sensitivity at 60 mg/L	0.28
	Reagent Absorbance	0.22

Note: the above performance specifications were developed with the exclusive use of genuine Seal Analytical parts and consumables.

AutoAnalyzer Applications

Method No. G-109-94 Rev. 3 (Multitest MT7/MT8)

Nitrate and Nitrite in Water, Waste Water and Soil Extracts

and other aqueous samples

Ranges: 0 - 0.25 to 0 - 2 mg/L as N

and 0 - 0.9 to 0 - 10 / 0 - 30 mg/L as N (only for MT7, see operating note 8) *

Description

Nitrate is reduced to nitrite by hydrazine in alkaline solution, with a copper catalyst, after which it is, following the DIN and ISO standard methods (1,2), reacted with sulphanilamide and NEDD to form a pink compound measured at 550 nm. Phosphoric acid is added at the final stage to reduce the pH, thus avoiding precipitation of calcium and magnesium hydroxide. The addition of zinc to the reducing agent suppresses the complexing of copper by organic material. A dialyzer for the high range on MT7 eliminates interference from coloured samples and suspended solids.

This method is a multitest with alkalinity (methyl orange), ammonia (salicylate and phenate), boron, calcium, chloride, hydrogen sulfide, iron, TKN, phosphate, TKP, potassium, sodium, silicate.

Hardware: 24" Dialyzer, 37°C heating bath (7.7 mL) **Pump tubes:** 7 + 2 air + 1 sampler wash (AAII: +1)

Performance data using aqueous standards and AAII colorimeter

See operating note 7 for performance with AA3 colorimeter.

Test ranges:	Nitrate/Nitrite		Nitrite	
	0-2 mg/L	0-5 mg/L	0-1 mg/L	0-5 mg/L
Sampling rate	50 / h	50 / h	50 / h	50 / h
Sample: Wash ratio	5:1	5:1	5:1	5:1
Sample pump tube	orn/wht	blk/blk	orn/wht	blk/blk
Reagent absorbance	0.06	0.01	0.01	0.01
Sensitivity	0.80	0.48	0.50	0.58
Coefficient of variation: (30 replicates at 50%)	0.2%	0.6%	0.7%	0.2%
Pooled standard deviation (50 at 5 levels)	0.012 mg/L	0.015 mg/L	0.003 mg/L	0.01 mg/L
Correlation Coefficient (5 points, linear fit)	0.999	1.000	0.999	0.999
Detection limit (determined according to EPA proc. pt. 136, app. B)	0.003 mg/L	0.017 mg/L	0.001 mg/L	0.002 mg/L
Detection limit in the lowest range		0.007 mg/L	0.005 mg/L	0.004 mg/L

Note: the above performance specifications were developed with the exclusive use of genuine Seal Analytical parts and consumables.

1,2 DIN 38405; ISO/DIS 13359
* 0-20 mg/L N using sample pump tube orn/yel

AutoAnalyzer Applications

Method No. G-188-97 Rev.2 (multitest MT7/MT8)

Total Kjeldahl Nitrogen in Acid Digests

Ranges: 0 - 0.6 to 0 - 6 mg/L as N
and 0 - 2.5 to 0 - 25 mg/L as N (only for MT7)

Description

The sample is reacted with salicylate and sodium hypochlorite solution to produce a blue compound measured at 660 nm. Nitroprusside is used as a catalyst.

This method is a multitest with alkalinity (methyl orange), ammonia (salicylate and phenate), boron, calcium, chloride, hydrogen sulfide, iron, nitrate, nitrite, phosphate, TKP, potassium, sodium, silicate.

Hardware: 24" Dialyzer, 37°C heating bath (7.7 mL) **Pump tubes:** 7 plus 2 air plus sampler wash (AAII: +1)

Performance data using synthetic standards and AAII colorimeter

(see operating note 11 for performance with AA3 colorimeter)

Test conditions : range: 0-2 and 0-10 mg/L as N, AAII colorimeter with 15 mm flowcell

Test range	0-2 mg/L N	0-10 mg/L N
Sampling rate	50/hr	50/hr
Sample: wash ratio	5:1	4:1
Sensitivity at 2 mg/L N and 10 mg/L N	0.32	0.45
Reagent absorbance	0.16	0.16
Coefficient of variation: 10 replicates at 50 %	0.36%	0.63%
Pooled standard deviation 50 at 5 levels	0.007 mg/L	0.035 mg/L
Correlation coefficient (linear, 5 points)	0.9991	0.9998
Detection limit (determined according to EPA procedure pt. 136, app. B)	0.02 mg/L	0.028 mg/L
Detection limit in lowest range (0 - 0.6 / 0 - 2.5 mg/L as N)	0.01 mg/L	0.01 mg/L

Note: the above performance specifications were developed with the exclusive use of genuine Seal Analytical parts and consumables.

AutoAnalyzer Applications

Method No. G-103-93 Rev. 2 (multitest MT7/MT8)

Phosphate in Water, Wastewater and Soil Extracts and other aqueous samples

Ranges: 0 - 1 to 0 - 7.5 mg/L as P

and 0 - 6 to 0 - 50 mg/L as P (only for MT7) *

Description

Ortho-phosphate reacts with molybdate and ascorbic acid to form a blue compound measured at 660 nm. Antimony potassium tartrate is used as a catalyst. A dialyzer for the high range on MT7 eliminates interference from coloured samples and suspended solids.

This method is a multitest with alkalinity (methyl orange), ammonia (salicylate and phenate), boron, calcium, chloride, hardness, hydrogen sulfide, iron, nicotine, nitrate, nitrite, TKN, TKP, potassium, silicate, sodium.

Hardware: 24" Dialyzer, 37°C heating bath

Pump tubes: 7 + 2 air + 1 sampler wash

Typical performance data using aqueous standards

Test conditions: AAI colorimeter with 15 mm flowcell

Matrix	DI water		NaHCO ₃
	2 mg/L	25 mg/L	10 mg/L
Test range	50/hour	50/hour	60/hour
Sampling rate	5:1	5:1	5:1
Sample: Wash ratio	0.01	0.03	0.04
Reagent absorbance	0.18 - 0.22	0.34 - 0.42	0.09 - 0.11
Sensitivity: Extinction at 2 / 25 and 10 mg/L P (sensitivity for CaCl ₂ extracts 10% lower)			
Coefficient of variation: (10 replicates at 50 %)	0.3 %	0.3 %	0.3%
Pooled standard deviation (25 at 5 levels)	0.005 mg/L	0.027 mg/L	0.038 mg/L
Correlation coefficient (linear, 5 points)	1.000	1.000	1.000
Detection limit (water only) (determined according to EPA procedure pt. 136, app. B)	0.002 mg/L	0.069 mg/L	0.049 mg/L
Detection limit in the lowest range (water only) (0-6 mg/L as P)	--	0.023 mg/L	--

Note: the above performance specifications were developed with the exclusive use of genuine Seal Analytical parts and consumables.

* Lower ranges possible with bigger sample pump tube: see operating note 1.



AutoAnalyzer Applications

Method No. G-189-97 Rev.1 (Multitest MT7/MT8)

Total Phosphorus in Acid Digests

Ranges: 0 - 1.7 to 0 - 6 mg/L as P

and 0 - 6 to 0 - 50 mg/L as P (only for MT7)

Description

Organic phosphorus compounds and polyphosphates are converted to ortho-phosphate by an off-line acid Kjeldahl digestion procedure. The determination of ortho-phosphate is then based on the colorimetric method in which a blue color is formed by the reaction of phosphate, molybdate and antimony followed by reduction with ascorbic acid at an acidic pH. The phospho-molybdenum complex is read at 660 nm.

This method is a multitest with alkalinity (methyl orange), ammonia (salicylate and phenate), boron, calcium, chloride, hydrogen sulfide, iron, nitrate, nitrite, TKN, phosphate, potassium, sodium, silicate.

Hardware: 24" Dialyzer, 37°C heating bath (7.7 mL) **Pump tubes:** 7 plus 2 air plus sampler wash (AAll: +1)

Performance data using synthetic standards and AAll colorimeter

See Notes for performance with AA3 colorimeter

Test range	6 mg/L as P	12 mg/L as P
Sampling rate	50/hr	50/hr
Sample: wash ratio	4:1	4:1
Sensitivity at 6 mg/L P and 12 mg/L P	0.38	0.18
Reagent absorbance	0.02	0.02
Coefficient of variation: 10 replicates at 50 %	0.42%	0.81%
Pooled standard deviation 50 at 5 levels	0.009 mg/L	0.032 mg/L
Correlation coefficient (linear, 5 points)	0.9999	0.9991
Detection limit (determined according to EPA procedure pt. 136, app. B)	0.025 mg/L	0.063 mg/L
Detection limit in lowest range (0 - 1.7 / 0 - 6 mg/L as P)	0.014 mg/L	0.063 mg/L

Note: the above performance specifications were developed with the exclusive use of genuine Seal Analytical parts and consumables.