

Soil and Plant Methods List for Automated Ion Analyzers

Flow Injection Analysis



10 June 2019

Introduction

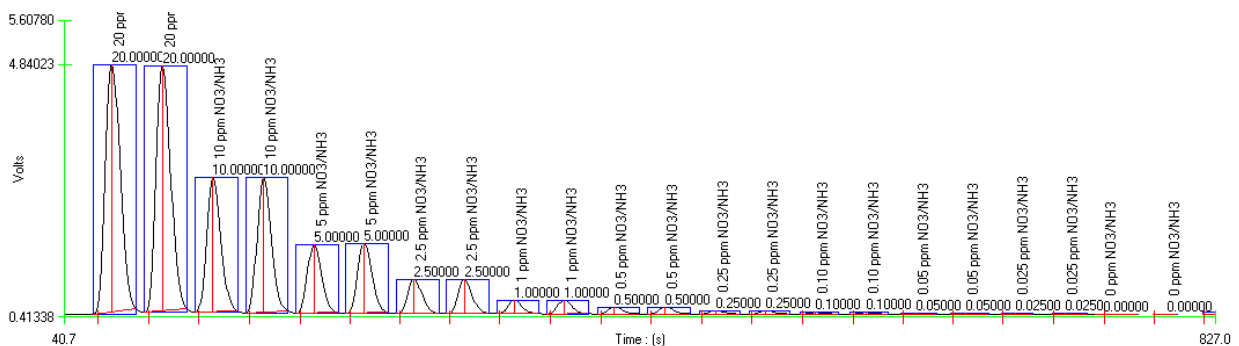
Nutrient levels in soil are critical to agriculture. Collection of samples, as well as their processing and measurement however, pose some unique challenges. Labs that perform soil analyses are exceedingly busy as farmers prepare to fertilize and plant their fields. Soil testing procedures attempt to estimate the amount of nutrients available during the growing season. For this testing to be of use, the cost per test must be as low as possible. This is done using extraction procedures that allow testing of as many analytes as possible from one solution. Soil extractants were developed to extract nutrients in the form they are available to plants. There must be a balance between applied materials, and the effect of nutrient run-off on water quality.

Automation is an absolute requirement in soil labs, as during the busy season, these labs may be analyzing literally thousands of samples per day! Automation benefits include increased throughput, improved precision and accuracy, simplified data management, and increased productivity. All of these lead to cost reductions, improvement in profitability, and major savings in soils labs. A “typical” Flow Injection Analysis (FIA) method allows the analysis of an average of 60 samples and standards per hour per channel, with some of Lachat’s methods attaining throughputs of over 100 samples and standards per hour per channel! In addition, there are no bubble patterns to set, or need for extended baseline stabilization time - so your lab can be up and running quickly!

The biggest challenge is the **required sample throughput**. Thousands of samples per day are analyzed in larger labs during their peak seasons. Lachat has developed a suite of Ultra High Throughput (UHT) methods to assist. These methods allow the analysis of 100 samples per hour or more on each of up to 5 analytical channels.

Automated Solution

Lachat methods are designed to prevent carryover between samples (a common problem for segmented flow systems). Lachat’s FIA methods produce sharp peaks with fast rise and recovery times, and a complete return to baseline (i.e. no carryover) between samples.



Calibration diagram for Nitrate.

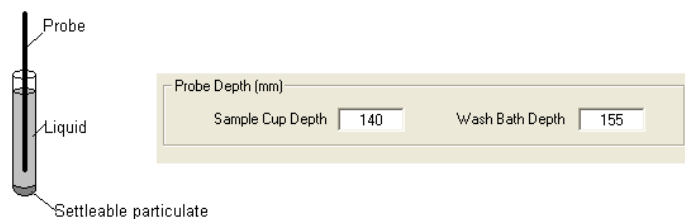
Analysis Requirements

Among other analytes, Ammonia-N, Nitrate-N and Phosphate -P are commonly measured. Where N-content is measured, 2M KCl is very commonly used for the extraction. This means that ammonia, nitrate-nitrite, and even urea can be measured from a single extract. For the analysis of phosphorus however, extraction solutions vary by region and soil type so that samples must be analyzed in separate batches.

Differing extraction matrices are a challenge. Lachat's Omnion software and Shared Peripherals Option allows one auto sampler to be shared between up to 4 "instruments". This means samples can be set up to be analyzed only on the correct channel, and up to 4 matrices can be analyzed at a time. (Throughput is decreased somewhat).



To decrease issues with aspiration of sand and other solid materials missed by filtration, the system allows the user to set the depth that the probe goes into the samples.



Performance Data Specifications

•**Range:** The range quoted in the Lachat methods list is based on the **actual, calibrated range**. The calibrated range is the lowest calibration standard to the highest calibration standard. (A blank is typically included in the calibration but is not included in the method range)

•**MDL:** The MDL (method detection limit) is calculated by the following protocols:
The Student's T number for the number of replicates is multiplied by the standard deviation calculated from those replications.

If **7 replicates** are used: The Student's T value is 3.14.

If **21 replicates** are used: The Student's T value is 2.528.

Example for 21 replicates: $2.528 \times 0.123 = 0.39$ for an MDL

•**Quantitation Limit:** Quantitation limit is typically 3 to 5 times the calculated MDL or 10X the standard deviation of the MDL standard used. Typically, this is the lowest calibration standard in a given method.

•**Precision:** Stated in the methods as %RSD. %RSD is calculated as follows: $\%RSD = (SD / \text{Mean}) \times 100$

Part Numbers Versus Method Numbers

To convert Method Numbers to part numbers, place an **E** in front of the Method Number.

Concentration:

Each range of concentrations for an analyte is given by a single letter. See the methods list for the ranges. Some methods cover more than one range.

Heaters:

Standard heater: Standard heaters have a 175 cm section of 0.032" i.d. (0.8mm) and a 650 cm section of 0.032" i.d. tubing

Non-standard heater: Has a different type and/or length of tubing than that listed above. (Controller and heater block are the same; only the tubing is different).

R^R Designation means the manifold is compliant with RoHS-2. (Verify with your sales person that the method can be sold into the EU).



Flow Injection Analysis

Aluminum

12-113-33-1-B ^R	1.0 – 30	0.1	mg Al/L	Soil extracts	Total reactive (monomeric) Al; pyrocatechol violet; Determination in 1 M KCl extracts. 580nm Inert Probe required	3-Sep-03
----------------------------	----------	-----	---------	---------------	---	----------

Ammonia

See also IC section

12-107-06-1-A ^R	0.01 – 1.0	0.002	mg N/L as NH ₃	Soil extracts	Alkaline phenol-based method; Determination in 2M KCl soil extracts 630 nm. Requires a standard heater.	17-Sep-08
12-107-06-1-B ^R	1.0 – 20.0	0.035	mg N/L as NH ₃	Soil extracts	Alkaline phenol-based method; Determination in 2M KCl soil extracts 630 nm. Requires a standard heater.	15-Sep-08
12-107-06-2-A ^R	0.10 – 20.0	0.035	mg N/L as NH ₃	Soil extracts	Sodium salicylate-based method; Determination in 2M KCl soil extracts 660 nm. Requires a standard heater.	3-Sep-03
12-107-06-2-F ^R	0.1 – 20	0.026	mg N/L as NH ₃	Soil extracts	Sodium salicylate-based method; Determination in 2M KCl soil extracts; <u>Ultra High Throughput method</u> (>120 samples/hr) 660 nm. Requires a standard heater.	15-Aug-07
12-107-06-2-H ^R	1-100	0.06	mg N/L as NH ₃	Air monitoring (above soil) extracts	Sodium Salicylate. 0.029M glycerol/0.18M H₃PO₄ matrix. 660 nm. Requires a standard heater.	18-Mar-13
12-107-06-2-I ^R	0.1-5	0.02	mg N/L as NH ₃	Air monitoring (above soil) extracts	Sodium Salicylate. 4% glycerol/1M H₂SO₄ matrix. 660 nm. Requires a standard heater.	18-Aug-17
12-107-06-3-A ^R	2.0 – 40.0	0.11	mg N/L as NH ₃	Soil extracts	Sodium salicylate-based method; Determination in 0.0125M CaCl₂ soil extracts 660 nm. Requires a standard heater.	3-Sep-03
12-107-06-3-B ^R	0.2 – 4.0	0.01	mg N/L as NH ₃	Soil extracts	Sodium salicylate-based method; 2M KCl soil extracts. 660 nm. Requires a standard heater.	3-Sep-03

Method No	Range	MDL	Units	Matrix	Comments	Rev Date
12-107-06-3-C ^R	0.2 – 4.0	0.03	mg N/L as NH ₃	Soil extracts	Sodium salicylate-based method; Determination in 0.0125M CaCl₂ soil extracts 660 nm. Requires a standard heater.	3-Sep-03
12-107-06-3-D ^R	1.0-75	0.2	mg N/L as NH ₃	Soil extracts	Sodium salicylate-based method; Determination in 1M KCl or water extracts of soils 660 nm. Requires a standard heater.	14-Apr-14
12-107-06-5-A ^R	0.1 – 20.0	0.02	mg N/L as NH ₃	Soil extracts	Gas diffusion method; 2M KCl soil extracts 590 nm.	23-Feb-10

Carbon (Total Dissolved)

12-140-39-5-A ^R	5-400	0.7	mg C/L	Soil Extracts	0.5M K ₂ SO ₄ extracts. Phenol Red Method. 440 nm. Can measure TN from the same digest with method 12-107-04-3-C. Requires an in-line digestion module (One supplies both channels)	19-Dec-11
----------------------------	-------	-----	--------	---------------	---	-----------

Chloride

See also IC section

12-117-07-1-B ^R	0.25-30	0.05	mg Cl ⁻ /L	Soil Extracts	0.01M Ca(NO ₃) ₂ ·4 H ₂ O. Mercuric thiocyanate, 480 nm.	26-Aug-11
12-117-07-1-C ^R	5-800	1	mg Cl ⁻ /L	Soil Extracts	2M HNO ₃ Mercuric thiocyanate, 480 nm.	05-Jun-12
12-117-07-1-D ^R	0.1-30	0.05	mg Cl ⁻ /L	Soil Extracts	0.014M Ca(SO ₄) ₂ . Mercuric thiocyanate, 480 nm.	11-Jun-12
12-117-07-1-E ^R	0.5-30	0.06	mg Cl ⁻ /L	Soil Extracts	0.5g calcium acetate hydrate. Mercuric thiocyanate. 480 nm. 102 samples per hour.	21-Mar-17

Kjeldahl Nitrogen (TKN)

13-107-06-1-A ^R	1.0 – 25.0	0.1	mg N/L	Plant digests	Kjeldahl digests; selenium oxide catalyst Phenate; 630 nm. Requires a standard heater.	15-Sep-03
13-107-06-2-D ^{R*}	10 – 150	0.5	mg N/L	Plant digests	Kjeldahl digests; copper catalyst; low-flow method Salicylate/ nitroprusside; 660 nm. Requires a standard heater.	29-Oct-07

Method No	Range	MDL	Units	Matrix	Comments	Rev Date
13-107-06-2-G ^{R*}	1 – 50	0.12	mg N/L	Plant digests	Kjeldahl digests; selenium oxide catalyst; requires 10% sulfuric acid digest Salicylate/ nitroprusside; 660 nm. Requires a standard heater.	15-Sep-03
14-107-06-2-A ^R	5.0 – 200	0.04	mg N/L	Fertilizers	Kjeldahl digests; selenium oxide catalyst Salicylate/ nitroprusside; 660 nm. Requires a standard heater.	15-Sep-03

Kjeldahl Phosphorus (TKP)

13-115-01-1-B ^{R*}	1.0 – 50.0	0.08	mg P/L	Plant extracts	Total P; Kjeldahl digests; copper catalyst; molybdate based method; 880 nm Requires a standard heater.	26-Oct-06
-----------------------------	------------	------	--------	----------------	---	-----------

Manganese

12-131-35-1-A ^R	0.5 – 2.0	0.01	mg Mn/L	Soil extracts	Low-flow method; 0.1N HCl . Formaldoxime, 460 nm.	15-Sep-03
----------------------------	-----------	------	---------	---------------	--	-----------

Nitrate + Nitrite

12-107-04-1-A ^R	0.2 – 40.0		mg N/L	Soil extracts	Sulfanilamide/NED Cd reduction method; 520 nm determination in 1mM CaCl₂ soil extracts	15-Sep-03
12-107-04-1-B ^R	0.025 – 20.0	0.005	mg N/L	Soil extracts	Sulfanilamide/NED Cd reduction method; 520 nm determination in 2M KCl soil extracts;	21-Aug-03
12-107-04-1-E ^R	0.05 – 5.0		mg N/L	Soil extracts	Hydrazine reduction. Sulfanilamide/NED 520 nm 1M KCl soil extracts.	15-Sep-03
12-107-04-1-F ^R	0.01 – 2.0	0.0013	mg N/L	Soil extracts	Sulfanilamide/NED Cd reduction method; 520 nm determination in 2M KCl soil extracts	30-Jan-15
12-107-04-1-G ^R	1.0 – 20.0	0.01	mg N/L	Soil extracts	Sulfanilamide/NED Cd reduction method; 520 nm determination in 0.0125M CaCl₂ soil extracts	15-Sep-03
12-107-04-1-J ^R	0.025-20	0.003	Mg N/L	Soil Extracts	Sulfanilamide.NED Cd Reduction Method. 520 nm. <u>Ultra High Throughout method</u> ; 120 samples per hour. 2M KCl extracts of soils.	15-Aug-07
14-107-04-1-B	30 – 300	0.38	mg N/L	Fertilizers	Sulfanilamide/NED Cd reduction method; 520 nm. Dialysis method	15-Sep-03
90-107-04-2-A ^R	0.1-6.0		mg N/L	Water/Soils	Sulfanilamide/NED Hydrazine Reduction. 520 nm. Multiple Matrix Method. Water, 2M KCl, 0.5M K₂SO₄, 0.01M CaCl₂.	27-Jan-11

Method No	Range	MDL	Units	Matrix	Comments	Rev Date
Nitrogen - Total Nitrogen						
12-107-04-3-B	0.2 – 30.0	0.04	mg N/L	Soil extracts	Sulfanilamide/NED Cadmium reduction. 540 nm. Total N; alkaline persulfate digestion; 0.5M K₂SO₄ extracts of soils; inline module required ; samples w/ particulates not suitable.	13-Nov-09
12-107-04-3-C	0.375-30	0.05	mg N/L	Soil extracts	Sulfanilamide/NED Cadmium reduction ,. 540 nm. Total N; 0.5M K₂SO₄ extracts of soils; inline module required ;; persulfate digestion; samples w/ particulates not suitable. <u>Dissolved Organic Carbon may be measured in the same digest using 12-140-39-5-A</u>	
Orthophosphate						
12-115-01-1-A ^R	0.25 – 10.0		mg P/L as PO ₄ ²⁻	Soil extracts	Orthophosphate; molybdate based method; 880 nm. determination in Mehlich III soil extracts. Requires a standard heater.	17-Sep-03
12-115-01-1-B ^R	0.01 – 1.0	0.006	mg P/L as PO ₄ ²⁻	Soil extracts	Orthophosphate; molybdate based method; 880 nm. determination in 0.5 M bicarbonate (Olsens) soil extracts. Requires a standard heater	17-Sep-03
12-115-01-1-E ^R	0.25 – 10.0	0.02	mg P/L as PO ₄ ²⁻	Soil extracts	Orthophosphate; molybdate based method; 880 nm. determination in 0.5 M acetic acid, 0.5 M ammonium acetate soil extracts. Requires a standard heater	17-Sep-03
12-115-01-1-L ^R	0.05 – 6.0	0.01	mg P/L as PO ₄ ²⁻	Soil extracts	Orthophosphate; molybdate based method; .880 nm. determination in Morgans soil extracts. Requires a standard heater	17-Sep-03
12-115-01-1-M ^R	0.25 – 10	0.04	mg P/L as PO ₄ ²⁻	Soil extracts	Orthophosphate; molybdate based method; determination in Mehlich III soil extracts. 880 nm. Requires a standard heater	21-Jun-06

Method No	Range	MDL	Units	Matrix	Comments	Rev Date
12-115-01-1-N ^R	0.4 – 20	0.07	mg P/L as PO ₄ ²⁻	Soil extracts	Orthophosphate; molybdate based method; 880 nm. determination in Bray 1, Bray 2, Mehlich I, Mehlich III soil extracts <u>Ultra High Throughput method</u> (>120 samples/hr) Requires a standard heater	04-Sep-07
12-115-01-1-O ^R	0.1-5.0	0.002	mg P/L as PO ₄ ²⁻	Soil extracts	Orthophosphate; molybdate based method; 880 nm. determination in 0.1N HCl soil extracts. Requires a standard heater	15-Dec-10
12-115-01-1-Q ^R	0.1-10 0.01-1.0	0.004 0.02	mg P/L as PO ₄ ²⁻	Soil Extracts	Orthophosphate; molybdate based method; 880 nm. determination in 0.5 M bicarbonate (Olsen's) soil extracts. Improved throughput - no gas diffusion block needed. Requires a standard heater.	02Feb-15

Phosphorus (Other)

13-115-01-2-A ^R	1.0 – 80	0.095	mg P/L	Plants	Total P in ashed plant material (1M HCl matrix); Vanadate based method 420 nm.	6-Feb-95
13-115-01-2-B ^R	20 – 100	0.2	mg P/L	Plants	Total P in ashed plant material (1M HCl final matrix); Vanadate based method 420 nm	17-Sep-03

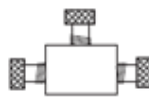
Sulfate

12-116-10-1-D ^R	1 – 20	0.67	mg SO ₄ ²⁻ /L	Soil extracts	Turbidimetric method; 420 nm. determination in 8M monobasic calcium phosphate soil extracts.	16-Sep-03
----------------------------	--------	------	-------------------------------------	---------------	--	-----------

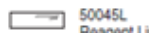
Urea

12-206-00-1-A ^R	0.1-20	0.027	mg N/L as Urea	Soil Extracts	Diacetyl monoxime/thiosemicarbazide. 530 nm. 2M KCl /5 mg PMA extracts of soil. . Requires non-standard heater	15-Mar-13
----------------------------	--------	-------	----------------	---------------	---	-----------

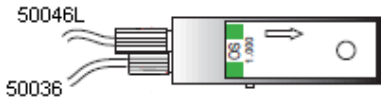
Selected Parts. Please note this is NOT a complete listing




50902 or 50902L
Tee Fitting



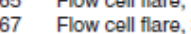
50045L
Reagent Line Weight



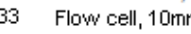
50046L
50036



50065 Flow cell flare, 13 cm




50067 Flow cell flare, 35 cm




31933 Flow cell, 10mm


Nipples




50015 Large




50015A Small




50014L Reducing




50019 Stainless Steel



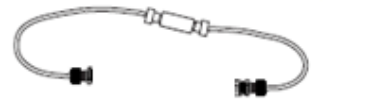
Interference Filters
89### ### indicates the wavelength
400 nm



24927 Switching Valve
50962 Flare Kit for Nitrate
50963 Flare Kit for Sulfate
24012 Connector, Amber
24015 Washer




50237A Cadmium Column




50254 Cadmium Column Maintenance kit

Union Fitting




50913




50901

Small Pump Tube Adapter




50906




85287 for QC8500

Large Pump Tube Adapter




85293 for QC8500




50907


Pump Tube Adapter




50905




85269 for QC8500



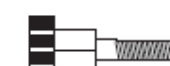
50009
Tube Connector, Amber



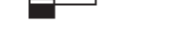
31077 for QC8000 Valve
Valve Connector, White




85245
One-piece fitting
for QC8500 valve



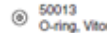
28051L
Rheodyne Nut & Ferrule




28058 Rheodyne Ferrule




28057
Upchurch Nut & Ferrule



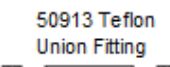
50013
O-ring, Viton




50024L
Large Clip, Gray




50023L
Small Clip, Gray




50913 Teflon
Union Fitting
(ultem nuts)




50007 or 85258 for QC8500
Large Collar, Black




50006 or 85257 for QC8500
Small Collar, White



50060
O-ring Probe



50100L
Degassing Tube



50031
Scalpel



28081
Blades for PEEK
Tubing Cutter



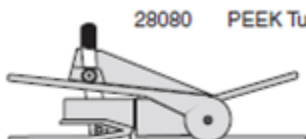
50021
Transmission Tubing, PVC, 0.030" ID



50029
Transmission Tubing, PVC, 0.060" ID



50091 Microloop Tubing, Teflon, 16 cm
50092 Microloop Tubing, Teflon, 12.5 cm

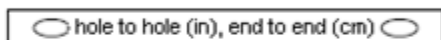


28080 PEEK Tubing Cutter



Teflon Tubing

50927 Manifold, 0.022" ID, Green
50928 Manifold, 0.032" ID
41300L Tefzel Tubing, 0.040" ID x 0.060" OD
30928 Zeus Tubing, 0.032" ID



Coils

Size	Coil Support Only	Wrapped, Teflon 0.022" ID	Wrapped, Teflon 0.032" ID
1" or 4.5 cm	50016L	50981	50916
2" or 7cm	50018L	50982	50918
2.5" or 8 cm	50017	50983	50917
4" or 12cm	50020	50984	50920
8" or 22 cm	50022L	N/A	50922



Alternating Coils 12 cm

Coil Support Only	Wrapped, Teflon 0.022" ID	Wrapped, Teflon 0.032" ID
50039	50985	50921



Pump Tubing

534XX PVC
544XX Duraprene
494XX Silicone
654XX Acidflex

XX is the number that specifies the pump tube color:

05 Orange-Yellow, 0.020" ID	13 Blue-Blue, 0.065" ID
06 Orange-White, 0.025" ID	14 Green-Green, 0.073" ID
07 Black-Black, 0.030" ID	15 Purple-Purple, 0.081" ID
08 Orange-Orange, 0.035" ID	16 Purple-Black, 0.090" ID
09 White-White, 0.040" ID	17 Purple-Orange, 0.100" ID
10 Red-Red, 0.045" ID	18 Purple-White, 0.110" ID
11 Gray-Gray, 0.051" ID	19 Yellow-Blue, 0.060" ID
12 Yellow-Yellow, 0.056" ID	



Bottles

28193L Glass Bottle, 1000 mL
35102 Glass Bottle, 2000 mL
43915 Glass Bottle, 100 mL (includes cap)



50012
O-ring Remover



28101L
End Plug



50062
Drill Bit

Lachat Instruments Brand Loveland, Colorado USA

United States: 800-247-7613 tel | 970-669-3050 tel | 970-461-3915 fax | sales@lachatinstruments.com | techhelp@hach.com
Outside United States: Contact the Lachat office or distributor serving you. | sales@lachatinstruments.com | intltech@hach.com
www.lachatinstruments.com

Printed in U.S.A. ©Hach Company, 2016. All rights reserved.

LACHAT
INSTRUMENTS



Be Right™