ThermoFisher SCIENTIFIC

DIA and IC in Drinking water and Waste water

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DIA Product Specialist
Analytical Instruments Group, CMD
US – South East, Rocky Mountains & West
Canada -British Columbia
Gallery, Gallery Plus and Beermaster Plus

Key product launches over 35 years

In 70's	In 80's	In 90's	In 2000's
 Olli CD (1977)	 Specific Proteins (1987)	 Konelab/Aquakem & Arena family (1998)	 Gallery / Indiko (2010)
 System Olli 3000 (1972)	 Progress Family (1983)	 System Reagents (1994)	 Konelab /Arena PRIME 60/30
	 Ion Selective Electrodes (1980)		 Arena (2005)
			 TCAutomation (2001)

Product offering

Discrete Systems - Markets

- Water/Environmental market
  - Drinking water companies
  - Waste water plants
  - Government institutes (e.g. EPA)
  - Commercial global companies (e.g. Eurofins)
- Food/Beverage market
  - Fruit juice producers
  - Wineries
  - Breweries
  - Dairy companies
- Industrial bioprocess
  - Detergent manufacturers (e.g. Unilever, P&G)
  - Food additive producers (e.g. DSM)
  - Enzymes manufacturers (e.g. Novozymes)

Gallery and Gallery Plus Water and Soil Applications

- Alkalinity
- Aluminium
- Ammonia
- Boron
- Bromide
- Calcium
- Chloride
- Hexavalent Chromium
- Conductivity (1
- Copper
- Total Cyanide
- Fluoride
- Total Hardness
- Ferrous Iron
- Total Iron
- Magnesium
- Manganese
- Molybdenum
- Nitrite
- Nitrate / TON
- Total Phenols
- pH (1
- Phosphate (Reactive P)
- Silica
- Sulphate
- Sulphide
- Thiocyanate
- TKN
- TKP or TP
- Urea
- Zinc

Gallery and Gallery Plus Applications for food and beverage analysis

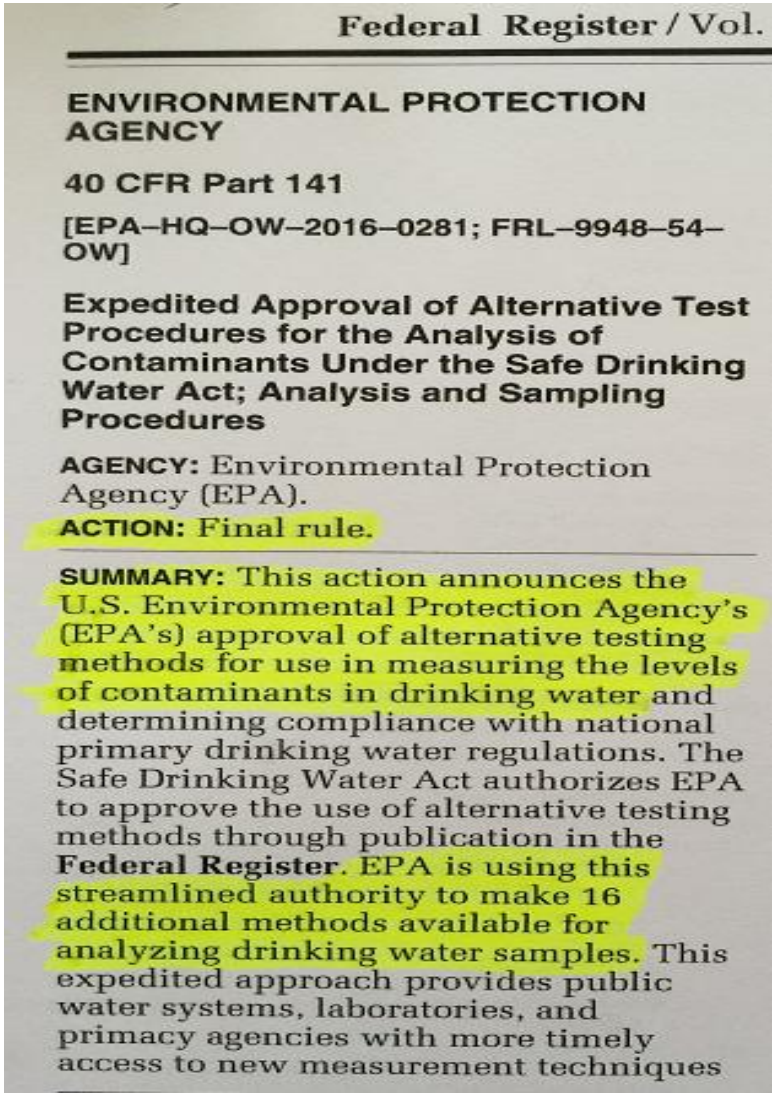
- Acetaldehyde
- Acetic acid
- Alpha-Amino Nitrogen (NOPA)
- Alpha-Amylase
- Ammonia
- Calcium
- Citric acid
- Cholesterol
- Ethanol
- D-Fructose
- Beta-Glucan
- D-Gluconic acid
- D-Glucose
- D-Glucose + D-Fructose
- D-Glucose + D-Fructose + Sucrose
- Glycerol
- ß-Hydroxybutyric acid
- Total Iron
- D-Isocitric acid
- D-Lactic acid
- L-Lactic acid
- Lactose (Glucose)
- Magnesium
- L-Malic acid
- Oxalic acid
- pH
- Potassium
- Total Polyphenol
- Total Protein
- SO2 Free
- SO2 Total
- Sucrose (Total Glucose)
- Urea (Ammonia)

System reagents for water and soil analysis

- Alkalinity
- Ammonia
- Calcium
- Chloride
- Chromium (VI)
- Magnesium
- Silica
- TON (Enzymatic) - Nitrate
- TON (Hydrazine) - Nitrate
- TON (Vanadium) - Nitrate
- Nitrite
- Phosphate
- Sulphate
- Total Hardness
- Urea (Ammonia)

Continuosly expanding selection

Enzymatic Reductase for Nitrate+Nitrite Determination



Federal Register / Vol.

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 141

[EPA–HQ–OW–2016–0281; FRL–9948–54–OW]

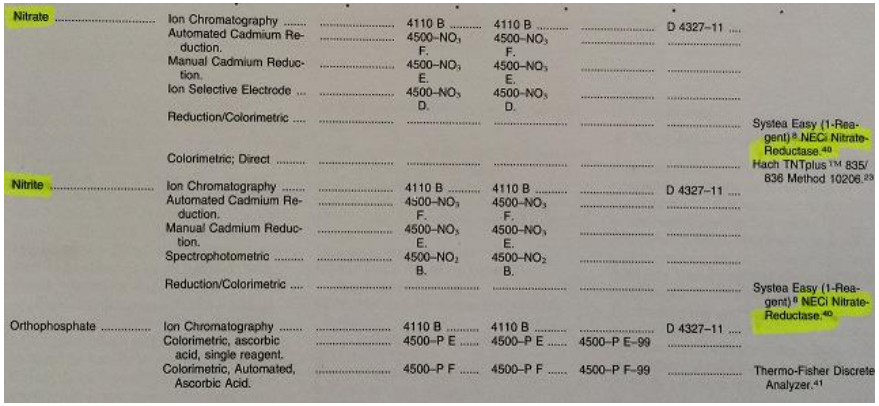
Expedited Approval of Alternative Test Procedures for the Analysis of Contaminants Under the Safe Drinking Water Act; Analysis and Sampling Procedures

AGENCY: Environmental Protection Agency (EPA).

ACTION: Final rule.

SUMMARY: This action announces the U.S. Environmental Protection Agency's (EPA's) approval of alternative testing methods for use in measuring the levels of contaminants in drinking water and determining compliance with national primary drinking water regulations. The Safe Drinking Water Act authorizes EPA to approve the use of alternative testing methods through publication in the **Federal Register**. EPA is using this streamlined authority to make 16 additional methods available for analyzing drinking water samples. This expedited approach provides public water systems, laboratories, and primacy agencies with more timely access to new measurement techniques

Replaces Cadmium Reduction in Drinking and Waste Water



Nitrate	Ion Chromatography		4110 B	4110 B	D 4327–11	
	Automated Cadmium Reduction.		4500–NO_3 F.	4500–NO_3 F.		
	Manual Cadmium Reduction.		4500–NO_3 E.	4500–NO_3 E.		
	Ion Selective Electrode		4500–NO_3 D.	4500–NO_3 D.		
	Reduction/Colorimetric					Systea Easy (1-Reagent)[8] NECi Nitrate-Reductase.[40]
	Colorimetric; Direct					Hach TNTplus™ 835/836 Method 10206.[23]
Nitrite	Ion Chromatography		4110 B	4110 B	D 4327–11	
	Automated Cadmium Reduction.		4500–NO_3 F.	4500–NO_3 F.		
	Manual Cadmium Reduction.		4500–NO_3 E.	4500–NO_3 E.		
	Spectrophotometric		4500–NO_2 B.	4500–NO_2 B.		
	Reduction/Colorimetric					Systea Easy (1-Reagent)[8] NECi Nitrate-Reductase.[40]
Orthophosphate	Ion Chromatography		4110 B	4110 B	D 4327–11	
	Colorimetric, ascorbic acid, single reagent.		4500–P E	4500–P E	4500–P E–99	
	Colorimetric, Automated, Ascorbic Acid.		4500–P F	4500–P F	4500–P F–99	Thermo-Fisher Discrete Analyzer.[41]

- No more column regeneration!
- No reagent waste disposal cost!
- Method developed specifically on Thermo GALLERY Discrete Analyzers!
- Excellent performance in saline and other tough matrices!

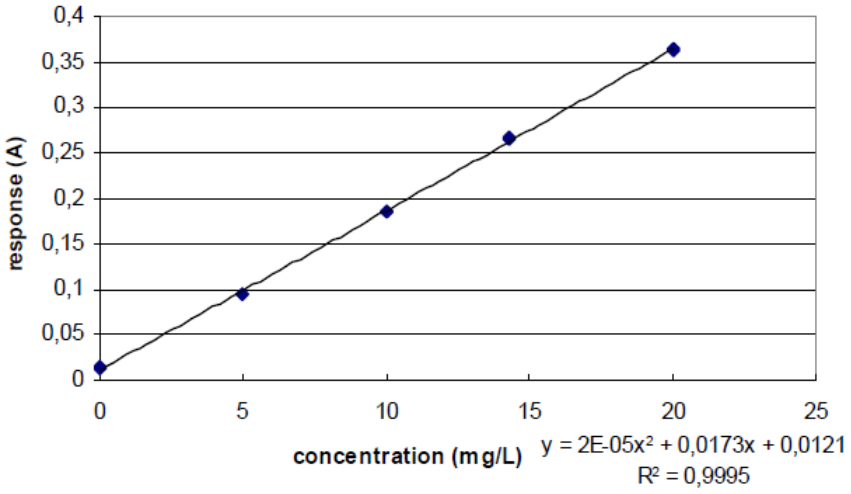
EPA Approved Methodologies

Gallery Tests							
Chemistry	Reagent Kits	SCA Blue Book	EPA Method	Reagents	MDL mg/L	Working Ranges mg/L	
						Typical Low range	Typical High range
Alkalinity		ISBN00117516015 SMWW 2320B	310.2	Methyl orange	2.60	0-300	N/A
Alkalinity	109-1110Alkal 1 109-1120Alkal 2	Adaptation ISBN00117516015 Method C	–	Bromo Phenol Blue	5.00	0-300	N/A
Aluminium		SMWW 3500 Al D	3500 Al D	Phenanthroline/Pyrocatecol Violet/Hexamine	0.01	0-0.3	N/A
Ammonia as N		ISBN 0117516139 SMWW 4500NH3 H	350.1	Phenolate / Hypochlorite / Prusside	0.001	0-0.2	Up to 80.0
Ammonia as N	109-1085 Amm1 109-1090 Amm2	ISBN00117516139	–	Salicylate/DIC/Nitroprusside	0.001	0-0.2	Up to 80.0
Boron		ISBN 0117515833 Part C	–	Azomethine-H	0.01	0-1.0	Up to 10.0
Bromide		ISBN 0117515434 SMWWW 4500 D	320.1	Sodium Acetate/Chloramine T/Sodium Thiosulphate	–	0-20.0	Up to 100
Calcium	981772 (8 x 20ml)	Tietz Fundementals of Clinical Chemistry 4th Edition	215.2	Arsenazo III	1.20	0-0.25	Up to 300
Chloride	109-1010 (4x20ml)	ISBN0117516260 SMWW 4500Cl- E	325.2	Ferricyanide	0.05	0-100	Up to 10,000
Chlorine			330.5	EDTA Phosphate Buffer DPD		0-2.0	
COD		ISBN 0117519154 SMWW 5220 D	410.4	Off line Dichromate Digest	3.00	0-1000	Up to 10,000

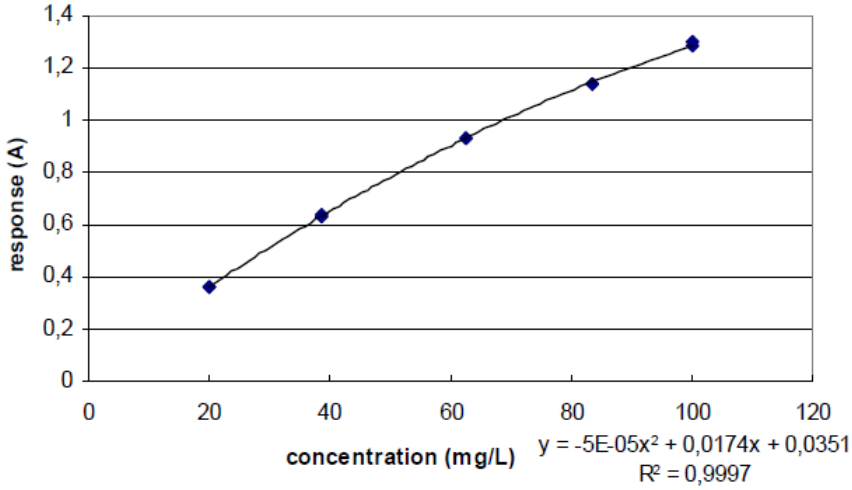
Chloride: Calibration Curves

- Using Thermo Scientific Chloride R1 reagent

Low Chloride (0–20 mg/L)



High Chloride (20–100 mg/L)



Chloride: Precision and Accuracy

Sample	Avg* Result (mg/L)	Std. Dev.	Avg* % Recovery	Std. Dev.	Accuracy
Cl_Low_10	10.01	100.1	100.1	1.52%	1.00
Cl_High_80	83.18	0.56	104.0	0.70%	1.04

*n = 20

Chloride: Method Detection Limit

Sample	Result (mg/L)	% Recovery
Cl_Low_0.5	0.503	101
Cl_Low_0.5	0.514	103
Cl_Low_0.5	0.485	97
Cl_Low_0.5	0.474	95
Cl_Low_0.5	0.482	96
Cl_Low_0.5	0.410	82
Cl_Low_0.5	0.407	81
Avg.	0.468	94
Std. Dev.	0.043	
MDL	**0.14**	

Chloride: Matrix Spiking

Sample	Result (mg/L)	% Recovery	RPD
Wastewater	487.3		
Wastewater_MS50	489.0	101	
Wastewater_MSD50	489.8	103	0.2
Saline water (dil)	154.4		
Saline water (dil)_MS50	187.3	103	
Saline water (dil)_MSD50	186.9	102	0.2

50 mg/L chloride spike; Saline water was diluted 100-fold;
RPD = relative percent difference

IC and DIA

IC

- *Recommended for:* isocratic and gradient IC applications using conductivity detection; complex matrices; detection limits down to ng/L (ppt) levels
- *Excellent Performance:* very low detection limits and RSDs
- *Maximum Convenience:* electrolytic eluent generation and suppression yield great results – “Just Add Water”
- *Automation:* electrolytic sample preparation (ESP) saves labor, reduces errors and improves consistency of results

DIA

- ***Recommended for:*** **fast, automated, low cost colorimetric/enzymatic analysis for water/environment, pharmaceutical, agricultural and chemical and bioprocess testing and QC**
- ***Automation:*** **dispensing, mixing, dilution, incubation, measurement.**
- ***Efficiency:*** **time and costs savings**
- ***Ease -of-use*** **minimal training and skill level**

Thermo Scientific™ Discrete Platforms

Products Sold

Gallery & Gallery Plus

Beermaster

Primary markets served

- Municipal and other drinking water, waste water (sewage, leaches, run off), surface water, sludge, sea water and ground water labs
- Oil and Gas (refiners and natural gas)
- Environmental labs
- Beverage market (Juices, soft drink, wine and beer)
- Snack food
- University's
- Milk and Cheese

Thermo Scientific™ Discrete Platforms

Environmental

Gallery™ Plus

Gallery Plus *Beermaster*

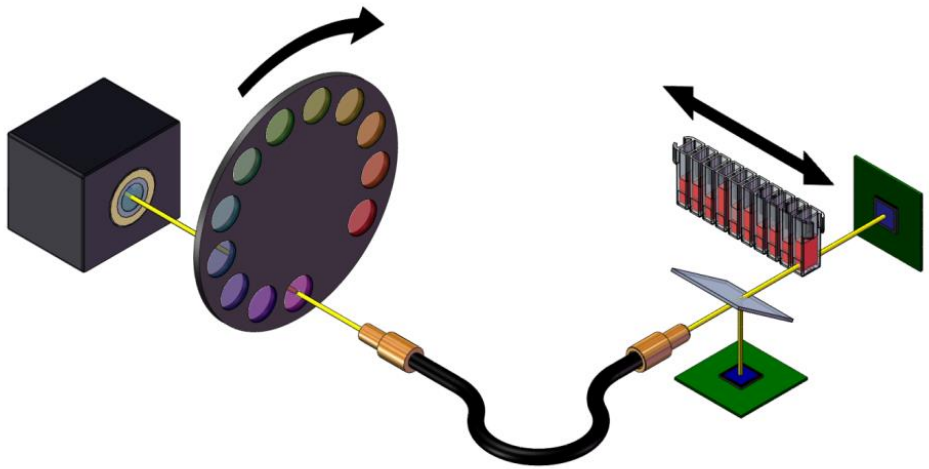
Gallery™

Industrial

ThermoFisher SCIENTIFIC

Basics of Measurement - Spectrophotometry

- Spectral range 275 – 880 nm
  - 12 filter positions
- Fast measurement with a flash lamp
  - Main and side wavelengths measured at the same time
  - Water blank measured in all wavelengths at the same time



Optional Electrochemical Unit (ECM)

- Conductivity and pH measurements
- Measuring range for
  - conductivity 20 µS/cm - 112 mS/cm
  - pH 2 – 12
- Sample types
  - Natural water, waste water, drinking water, etc.

Gallery

Small footprint

weight 187 lbs/ 85 kg

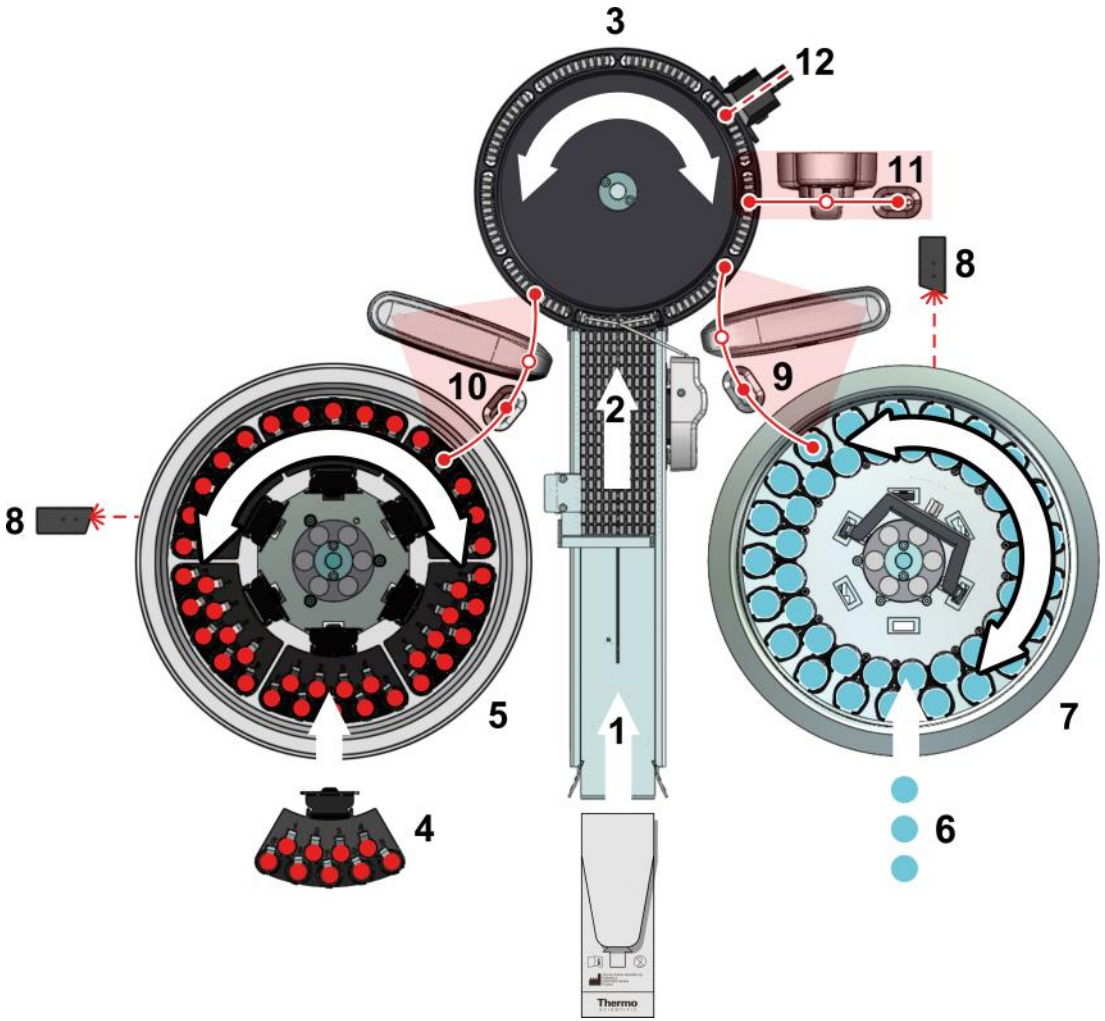
24.4 in/ 62 cm

51 in/ 130 cm
with open cover

- No water supply or drainage requirements
- Power supply 250 W

Gallery Plus System Description

Discrete Analysis Process



1. Cuvette entry point
2. Cuvette loader
3. Incubator
4. Sample racks
5. Sample disk
6. Reagents
7. Reagent disk
8. Barcode reader
9. Reagent dispenser
10. Sample dispenser
11. Mixer
12. Photometer unit

Discrete Analysis Routine Workflow

1.

Check/ run calibration

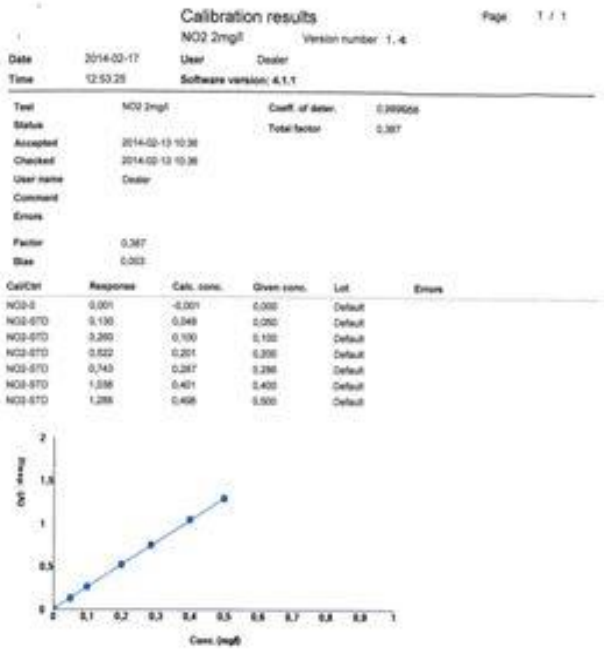
2.

Run samples:

- up to 108 at a time* with Gallery Plus
- up to 90 at a time* with Gallery

* continuous loading

3. Results


Calibration results

NO2 2mg/l

Version number: 1.4

Date	2014-02-17	User	Dealer
Time	12:53:25	Software version: 4.1.1	

Test	NO2 2mg/l	Coeff. of deter.	0.999508
Status		Total factor	0.387
Accepted	2014-02-13 10:36		
Checked	2014-02-13 10:36		
User name	Dealer		
Comment			
Errors			
Factor	0.387		
Bias	0.003		

Cal/Ctrl	Response	Calc. conc.	Given conc.	Lot	Errors
NO2-0	0,001	-0,001	0,000	Default	
NO2-STD	0,130	0,049	0,050	Default	
NO2-STD	0,260	0,100	0,100	Default	
NO2-STD	0,522	0,201	0,200	Default	
NO2-STD	0,743	0,287	0,286	Default	
NO2-STD	1,038	0,401	0,400	Default	
NO2-STD	1,288	0,498	0,500	Default	

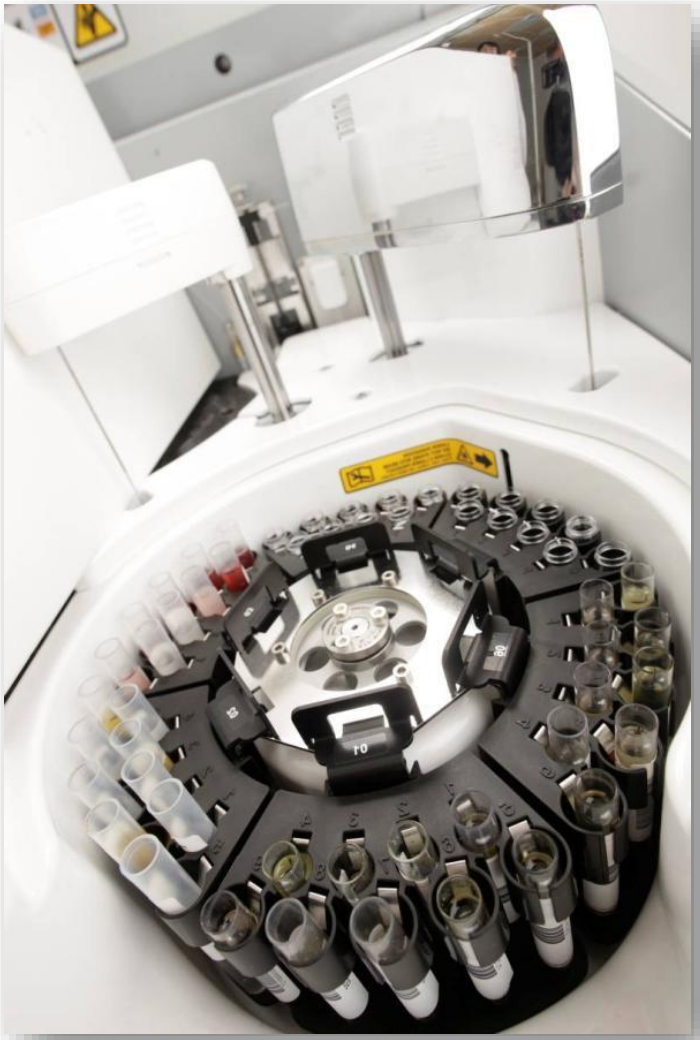
Time to first results typically 10 min

Easy Reagent Handling

- Reagent volumes from 2 to 240 µL
- Reagent containers
  - 10 and 20 mL vials
- Barcoded system reagent containers are automatically identified
  - Non-system reagents can be entered without barcodes
- Clearly displayed
  - Real-time reagent volume
  - Remaining test capacity
  - Expired reagents flagged automatically

Flexible Sample Management

- Sample volumes from 2 to 120 µL
- Any mix of sample containers
  - 0.5, 2.0 and 4.0 mL sample cups
  - 5.0, 7.0 or 10.0 mL sample tubes
- Automatic identification via an internal barcode reader
- Tests can be requested individually or by using a profile

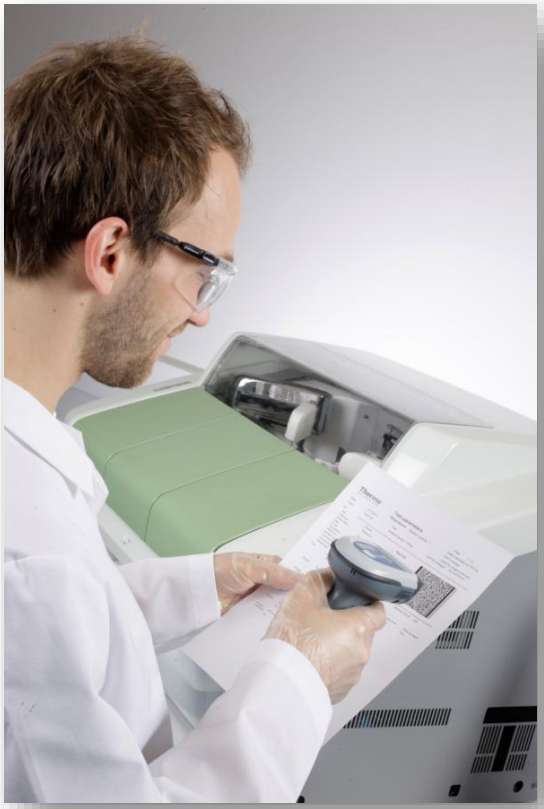


Flexible, Reliable, Temperature-Stabilized Measurement

- Several calibration options
  - Factor, Bias, Linear, Logit-log, Spline, Polynomial, Point-to-point
- Possibility to add up to four reagents per test
  - Automation even for the most complex methods
- Real-time QC program assures reliable performance
- Measurement temperature can be adjusted between 25 ^{o}C and 60 ^{o}C
  - Default setting at 37 ^{o}C

Comprehensive Data Handling

- Application parameter values readable from barcode or electronically from a file
- Results
  - Calculated from both measured and off-line results
  - Automatically flagged in case of
    - Abnormal values
    - Repeats
    - Out-of-limit QC values
- Long term storage of results
  - Associated calibrations
  - Reagent lot data
  - Cumulative QC data



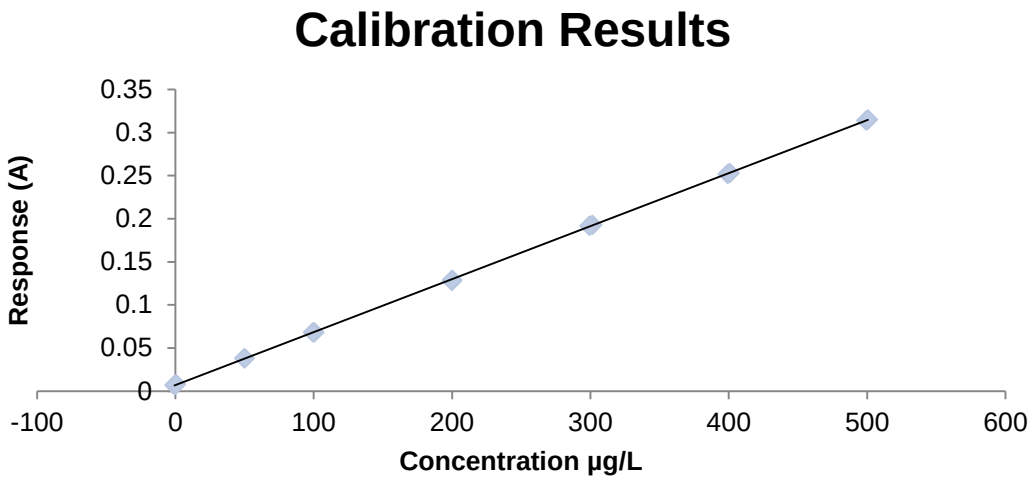
Thermo Scientific™ Discrete Platforms Gallery

Ready-to-use Test Kit Analysis

- Kits include all reagents needed for each assay
  - Enzymes
  - Buffers

- Usually kits are ready-to-use and do not need additional preparation – just open the cap and use

TON enzymatic Data



Calibrator	Response (A)	Calculated Concentration µg/L	Concentration
S0	0.007	-0.566	0
S0	0.008	0.497	0
S1	0.038	50.077	50
S1	0.038	49.926	50
S2	0.068	100.43	100
S2	0.068	99.548	100
S3	0.129	200.161	200
S3	0.128	199.822	200
S4	0.193	301.529	300
S4	0.192	299.386	300
S5	0.252	399.241	400
S5	0.253	400.542	400
S6	0.314	499.425	500
S6	0.315	500.628	500

TEA, DIA and IC

ENVIRONMENTAL LABS	Discrete	IC
Anions	YES (selected)	YES
Compliance monitoring with regulated methods	YES	YES
# of samples (>100s/day)	YES	NO
ppm level detection	YES	YES
ppb level detection	YES (limited)	YES
ppt level detection	NO	YES
Complex sample matrices	NO	YES
Integration with MS	NO	YES
Skill level operator +(High) +++(Low)	+++	+
Cation/metal analysis	YES (limited)	YES
Routine analyses	+++	++

Food & Beverage Positioning of DIA and IC

- **Discrete Analyzer**
  - Rapid screening tool for targeted analytes
  - Enzymatic testing for sugars and acids
  - Very competitive price per test ratio, e.g. D-Glucose + D-Fructose cost is US: 50 cent/test, EU: 30 cent/test
  - Best tool for production/product Quality control

- **Ion Chromatography**
  - Rapid screening tool for targeted and non-targeted analytes
  - Broader range of analytes for food safety
  - Research to routine applications
  - Best confirmatory tool utilizing ICP-MS and MS detection

DA for rapid screening, IC for research & confirmation

Customer Examples of IC and DA combined

ALS	• IC for metals and anions • DA for Total Cyanide, Ammonia, Nitrite, TON, Total Phenols, TKN, Alkalinity

SGS	• IC for Sulfate, Chloride, Bromide, Fluoride, Nitrite and Nitrate
	  • Waste, ground, surface waters, destruate/eluate.
	• DA for Ammonium, Sulfate, Nitrate, Nitrite, Chloride, Phosphate, Silicate
	  • Waste, ground, surface waters.
	• Dirty matrix or pH unstable: IC. In general most samples run on DA.

Eurofins	• IC for some metals, Fluoride, Bromate, and low level Chloride • DA for Ammonium, Sulfate, Nitrate, Nitrite, Chloride, Phosphate

The Need for Accurate Industrial Water and Scrubber Solution Analysis

Proper care of amines can do more to improve plant throughput and lower operating costs than preventative maintenance. Alkanolamines (commonly referred to as amines) are used to neutralize hydrogen sulfide (a corrosive) and carbon dioxide (a greenhouse gas). Amines are added to boiler water to control pH. Analysis of “amines” is required for process monitoring to determined the concentrations of byproducts and corrosive analytes such as heat stable salts, acid gases, metals, anions, and cations.

Thermo Fisher Scientific has the broadest array of analytical instrumentation for water refinery processes

Hydraulic Fracturing
Instruments for Waters, Sediments and Brine Analysis

The need for Accurate Water and Sediment Analysis

The process of Hydraulic Fracturing results in addition of chemicals to the subsurface along with mobilization of anions, cations, metals, and radioisotopes in the shale layers that are returned to surface as flowback waters. Analytical instrumentation is required to determined the concentrations of these analytes to minimize environmental impact of groundwaters, improve fracking processes, wastewater prior disposal, drill cuttings, and brines prior to disposal.

We have the broadest array of analytical instrumentation for the analysis of water and soil impacted by Hydraulic Fracturing

Thermo Scientific™ Discrete Platforms Gallery

Thank You!

ThermoFisher
SCIENTIFIC

The world leader in serving science