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Beyond Wastewater Analysis Using Discrete Analyzers

The world leader in serving science

Key Product Launches Over 35 Years

In 70's

Olli CD (1977)

System Olli 3000 (1972)

In 80's

Specific Proteins (1987)

Clinical Chemistry Reagents (1984)

Progress Family (1983)

Ion Selective Electrodes (1980)

In 90's

Konelab/ Aquakem & Arena families (1998)

System Reagents (1994)

In 2000's

Gallery/ Indiko Analyzers (2010)

Konelab/Arena PRIME 60/30 Analyzers

Arena (2005)Analyzer

TCAutomation (2001)

Product offering

Industrial and Environmental System Solutions

- Thermo Scientific™ Gallery™ and Gallery Plus Analyzer – new automated, discrete photometric systems for food, beverage, water, waste water, soil/sludge digests, saline, process water, pharmaceutical, agricultural, chemical applications and bioprocess testing and QC

- Thermo Scientific™ Arena™ Analyzer – random access photometric analyzers for product analysis and quality control in industrial processes like food and beverage, pharmaceutical, agricultural, and chemical analyses

- Thermo Scientific™ Aquakem™ Analyzer – discrete, photometric analyzers for water and environmental samples like clean water, waste water, soil/sludge digests, saline, and process water

Thermo Scientific Discrete Analyzer Platforms

Environmental

Aquakem Workcell Analyzer

Aquakem 600 Analyzer

Aquakem 200 Analyzer
Aquakem 250 Analyzer

Gallery Plus Analyzer

Gallery Analyzer

Arena 60 Analyzer

Arena 30 Analyzer

Arena 20XT Analyzer

Arena 20 Analyzer

Industrial

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Range of Discrete Analyzers for Wastewater Analysis

	Gallery/Aquakem 200/ Arena 20 Analyzers	Aquakem 250/ Arena 20 XT Analyzers	Gallery Plus Analyzer	Aquakem 600/ Arena 30/60 Analyzers
	 			
Capacity (tests/hr)	Up to 200	Up to 250	Up to 350	Up to 600
Incubation temperature	25 to 60 ˚C (Gallery Analyzer) 37 ˚C (Aquakem/Arena Analyzers)	37 ˚C	25 to 60 ˚C	37 ˚C
Optional units	pH and Conductivity (Gallery Analyzer) Cadmium reduction(Aquakem Analyzer)	Cadmium reduction	pH and Conductivity	Cadmium reduction and automation

Outline

- Wastewater
  - Sources
  - Reasons for analysis
  - Analytical challenges
- Common anions in wastewater
- Other industrial applications
- Discrete analysis
  - Automated photometric assays
  - Accurate, precise measurement
- Conclusion

Wastewater

- Municipal or household waste
  - Sewage effluent
  - Raw sewage
  - Treated effluent
  - Leachates
  - Surface run-off
- Industrial
  - Production effluents
  - Process and cooling waters
- Agriculture
  - Soils - leached/extracted into solution

Reasons to Perform Wastewater Analysis

- Monitoring discharge
  - Regulatory limits
- Nutrient analysis
  - Excessive plant growth in aqueous environments
- Known samples
  - Historical analysis
    - Examining high chloride levels from a treatment facility with a water inlet near the sea/estuary
- Unknown samples
  - Investigative, pollution incident, farm run-off, milk spill, or industrial discharge due to plant failure

Wastewater Analytical Challenges

- The content of wastewater samples is often unknown
- Accurate, rapid results are needed
- Samples that are out of calibration range will have to be rerun
  - Ability to automatically perform dilutions pre-test or post-test is advantageous
- Samples can contain disparate analyte concentrations
  - May need to run multiple dilutions depending on the analytes of interest

Common Anions in Wastewater

- Inorganic anions
  - Chloride
    - Disrupts nitrification process (treatment)
  - Sulfate
    - Disrupts anaerobic digestion process (treatment)
  - Phosphate, nitrate, nitrite
    - Plant nutrients; phytoplankton blooms
  - Bromide
    - Ozonation, chlorination, e.g., disinfection by products such as brominated trihalomethanes, bromate (carcinogens)
- Organic acids
  - Formic, acetic, propionic acids
    - pH balance

Wide Selection of Tests Optimized for Anions

- Chloride
- Fluoride
- Nitrate - Hydrazine
- Nitrate - Enzymatic
- Nitrate - Vanadium
- Nitrite
- Ortho-Phosphate
- Sulfate
- T.O.N
- TKN as N
- TP as P

- Additional analytes
  - Alkalinity
  - Ammonia
  - Calcium
  - Chromium (VI)
  - Iron (Ferrous)
  - Magnesium
  - Silica
  - Total hardness
  - Urea
  - pH
  - Conductivity

Industrial Water Refinery Processes: Instruments for Industrial Water and Scrubber Solutions

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 determine the concentrations of byproducts and corrosive analytes such as heat stable salts, acid gases, metals, anions, and cations.

We have the broadest array of analytical instrumentation for water refinery processes.

Hydraulic Fracturing: Instruments for Waters, Sediments, and Brine Analyses

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 determine the concentrations of these analytes in an effort to minimize the environmental impact of groundwaters, improve fracking processes, wastewater 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.

Pharmaceutical, Enzyme Producers, and Other Markets

Pharmaceutical-like Creams, Tablets, Etc.

Arena Photometric Analyzer Applications

- Fructose
- Glucose
- Sucrose
- Lactose
- Starch
- Acetic acid
- Citric acid
- Gluconic acid
- Glutamic acid
- L-Lactic acid
- L- and D-Malic acid
- Ethanol
- Cholesterol
- Glycerol
- Sorbitol

Cosmetics

Arena Photometric Analyzer Applications

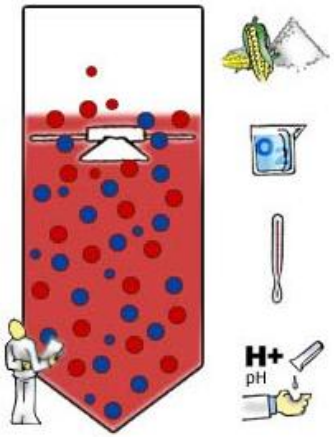
- Glucose
- Fructose
- Lactose
- Starch
- Citric acid
- Gluconic acid
- L-Lactic acid
- L-Malic acid
- Ethanol
- Cholesterol
- Dihydroxyacetone
- Glycerol
- Sorbitol
- Urea

Laundry Detergents

- Enzymes for laundry detergents and machine dish washer products are analyzed with the Arena Analyzer
  - Proteases
  - Lipases
  - Amylases
  - Cellulases

Enzymes

- Products that can be analyzed with the Arena Analyzer
  - R&D phase enzymes
  - Amyloglucosidase
    - An enzyme for high fructose corn syrup makers
  - Papaine
  - Lactase
  - Phosphate
  - Amylase
  - Phosphodiesterase



R&D

- To optimize fermentations for correct substrate: e.g. maize (corn), soy beans, potatoes or sugars
- To optimize the right nutrients for the microorganisms to produce that enzyme
- Optimize the fermentation atmosphere: temperature, oxygen level and pH

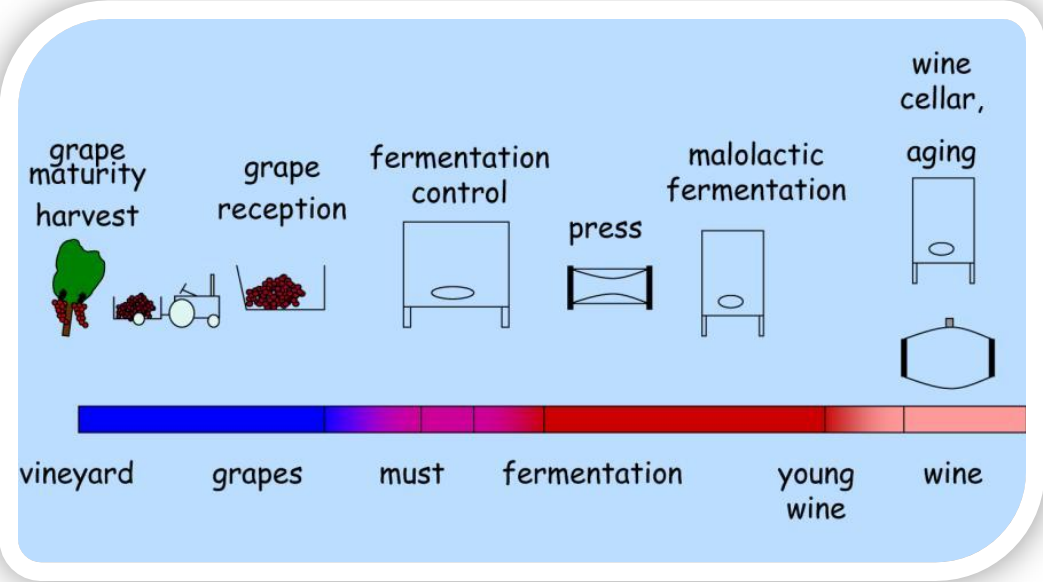
Production QC

- Enzyme activity assays of the products

Reason to choose the Arena Analyzer: incubation at 50 °C, flexibility and low CV

Reasons for Beverage Analysis

- Quality Control of raw material, must (wine) or wort (beer), and final product
- Monitoring of production processes (malolactic fermentation)
- Detection of adulterations and false declaration
- Label claims/legal limits



Sugar and Acid Analysis in Wine

- In wine, fructose is used as a process indicator and as a quality indicator for the final product
  - Yeast enzymes convert sugars (sucrose, glucose, and fructose) to ethanol and carbon dioxide
  - Sucrose is first converted to glucose and fructose, then glucose is consumed followed by fructose
- Acids play a significant role in taste, color, and microbial stability of juice. In wine, acids are present in both grapes and wine.
  - Acids, like D-malic acid are tested to check the fermentation process
- Other tests for wine
  - SO_2 regulated by legislation
  - Glycerol as a taste parameter

Sugar and Acid Analysis in Fruit Juice

- Sugars like sucrose, glucose, fructose, and sorbitol are tested from raw material and the final product
- Ratio of sugars from concentrate used to verify authenticity
  - Glucose – fructose ratio from apple juice
  - Citric acid – iso-citric acid ratio from citrus juices
- Acids and alcohol are measured to check the concentration of natural fermentation – limit is regulated by law

Beer Analysis

- Beer is composed of malt, water, and hops which first form wort; after wort fermentation, beer is formulated
- Typical analytes of wort
  - Beta-Glucans to monitor brewing process
  - NOPA – free nitrogen for yeast
  - Proteins to control haze formation
- Final product
  - pH – flavor indicator
  - Color – to categorize various beers
  - Bitterness – quality parameter for taste, foam, and stability
  - SO_2 – effects flavor

System Reagents for Food and Beverage Analysis

Sugars

- D-Fructose
- D-Glucose
- D-Fructose+D-Glucose
- D-Fructose+D-Glucose+Sucrose
- Lactose (Glucose)
- Sucrose (Total)

Acid analysis

- Acetic acid
- L-Ascorbic acid
- ß-Hydroxybutyric acid
- Citric acid
- D-Gluconic acid
- D-Isocitric Acid
- D-Lactic Acid
- L-Lactic Acid
- L-Malic acid
- Oxalic acid
- Total Acids

Alcohol analysis

- Cholesterol Food
- Ethanol
- Glycerol
- Polyphenols (total)

Others

- Ammonia
- Acetaldehyde
- α-Amylase
- α-Amino Nitrogen (NOPA)
- Bitterness
- Beta-Glucan (High MW)
- Calcium (Ca)
- Copper
- Magnesium
- pH (Colorimetric)
- Potassium
- SO_2 free and total
- Total iron
- Total protein
- Urea (Ammonia)

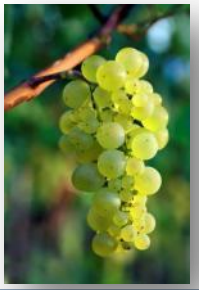
ECM

- pH

Calibrators

- Alcohol std
- Acetaldehyde std
- Acid combination std
- Beta-Glucan Std
- Beta Hydroxybutyrate std
- Cholesterol std
- Copper std
- Glycerol std
- Lactose std
- NOPA std
- Oxalic acid std
- Sugar combination std
- Urea std

- pH standards



Over 50 optimized system products

Applications

- R&D
  - Discovering new products using expensive, high sensitive systems
  - to create rapid, easy-to-use and high quality methods for production QC > Arena analyzers
- Production - QC
  - need quick response
  - need high quality
  - getting less qualified labor
  - budgetary pressures

  - Need for flexible and easy-to-use system > Arena analyzers
  - Need for high quality systems & service > Arena analyzers & distributors

Anion Determinations Using Photometric Assays

- Manual wet chemistry assays
  - Labor intensive
  - Waste reagents
  - Error prone
- Continuous flow analyzers
  - Relatively slow
  - Generates a lot of waste
- Discrete analyzers
  - Rapid, automated, efficient

Benefits of Automated Discrete Analysis

- Flexible – various tests can be performed on each sample; there is no limitation to the number of tests
- Fast – ready for immediate analysis; no reagent priming, no method changeover time
- Precise – specific measurements with high reproducibility, achieves low detection levels
- Minimal carry-over – each reaction takes place in its own cuvette

Discrete Analysis Routine Workflow

1.

Check/ run calibration

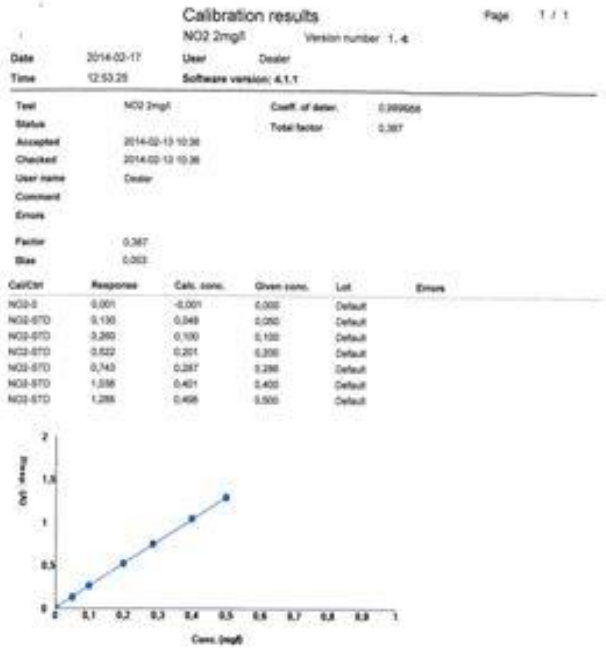
2.

Run samples:

- up to 54 at a time* with Gallery Plus
- up to 45 at a time* with Gallery

* continuous loading

3. Results



Time to first results typically 10 min

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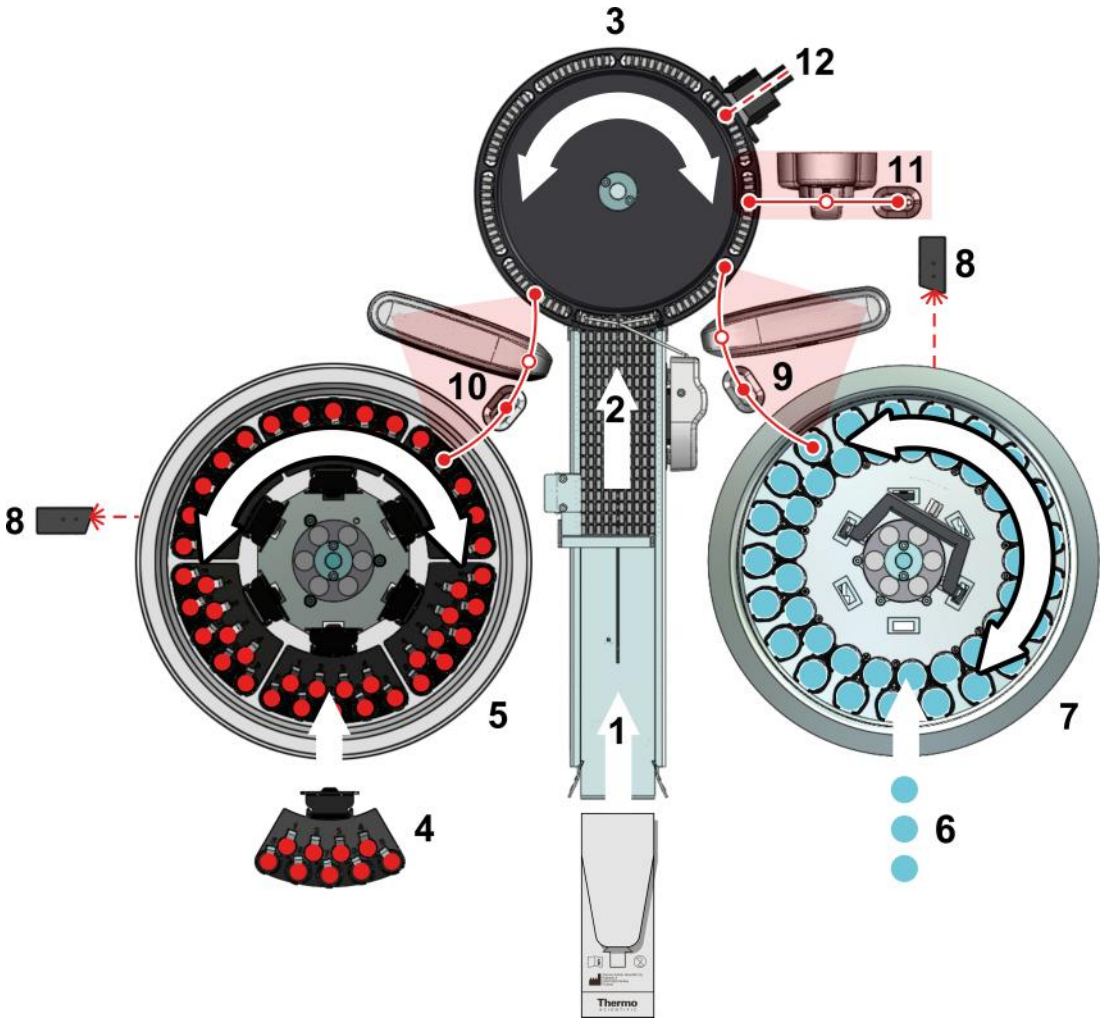
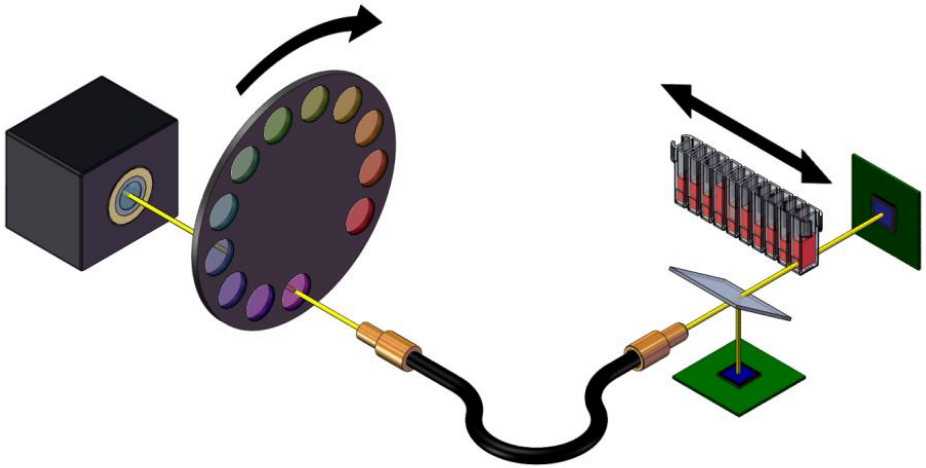
Discrete Analysis Process



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

Fast Photometric Measurement

- 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

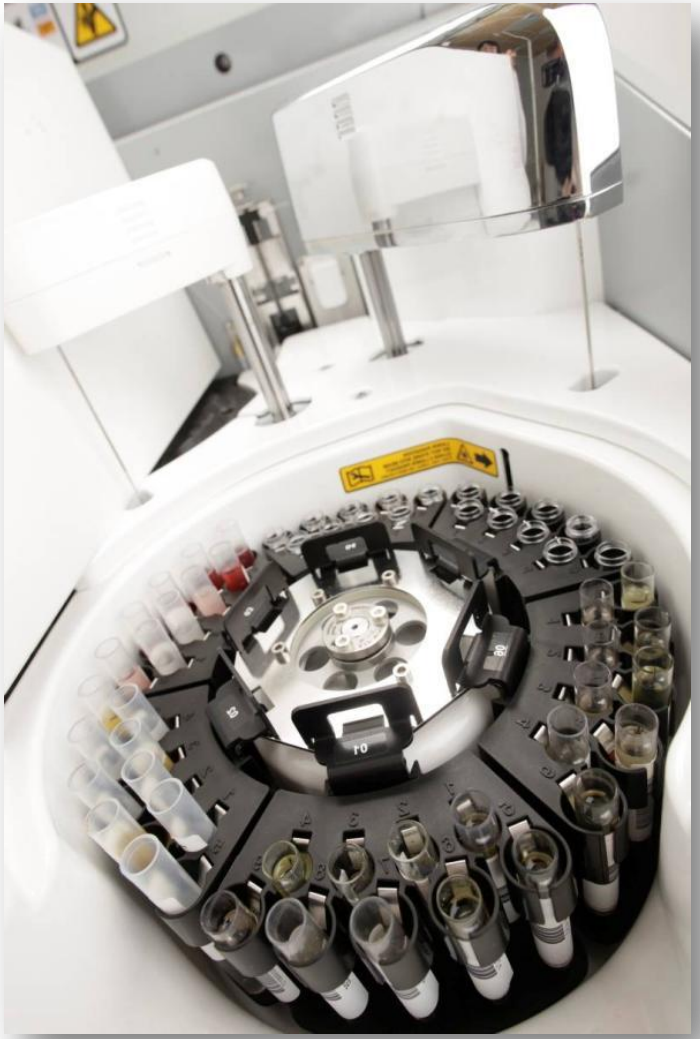
- Conductivity and pH measurements
- Measuring range for
  - conductivity 20 µS/cm – 112 mS/cm
  - pH 2–12
- Sample types
  - Water samples: natural water, waste water, drinking water, sparkling water, and still water

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 25º C and 60º C
  - Default setting at 37º C

Flexible Sample Management

- Sample volumes from 2–120 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



Easy Reagent Handling

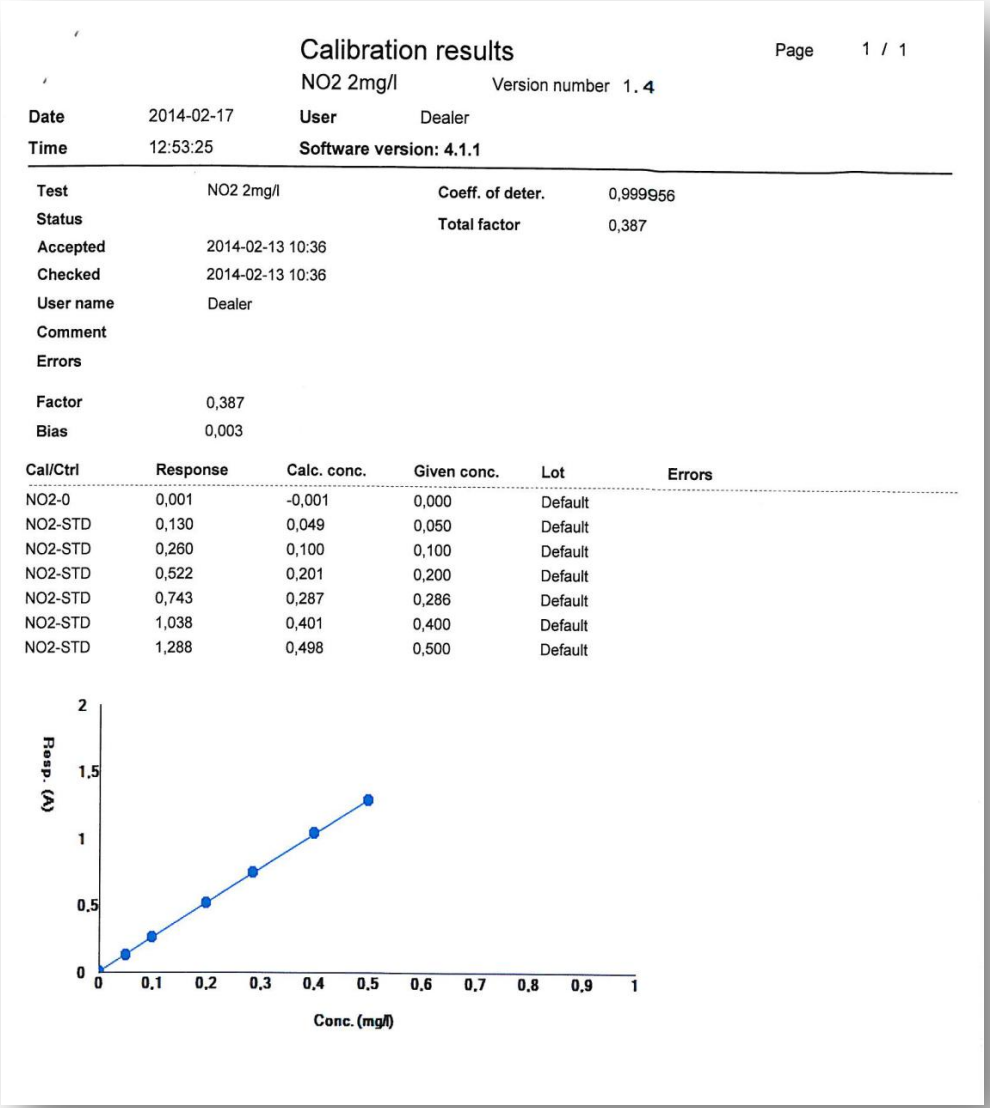
- Reagent volumes from 2–240 µL
- Reagent containers
  - 10 and 20 mL vials
- Barcoded system reagent containers are automatically identified
  - Non-system reagents can be entered without barcodes
- Clearly displayed
  - Real-time reagent volume
  - Remaining test capacity
  - Expired reagents flagged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

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 control values
- Long term storage of results
  - Associated calibrations
  - Reagent lot data

Reporting Options

- Reports available
  - Spreadsheet export for further calculations
  - Export to LIMS
  - Printouts
  - PDF files



Calibration results

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NO2 2mg/l Version number 1.4

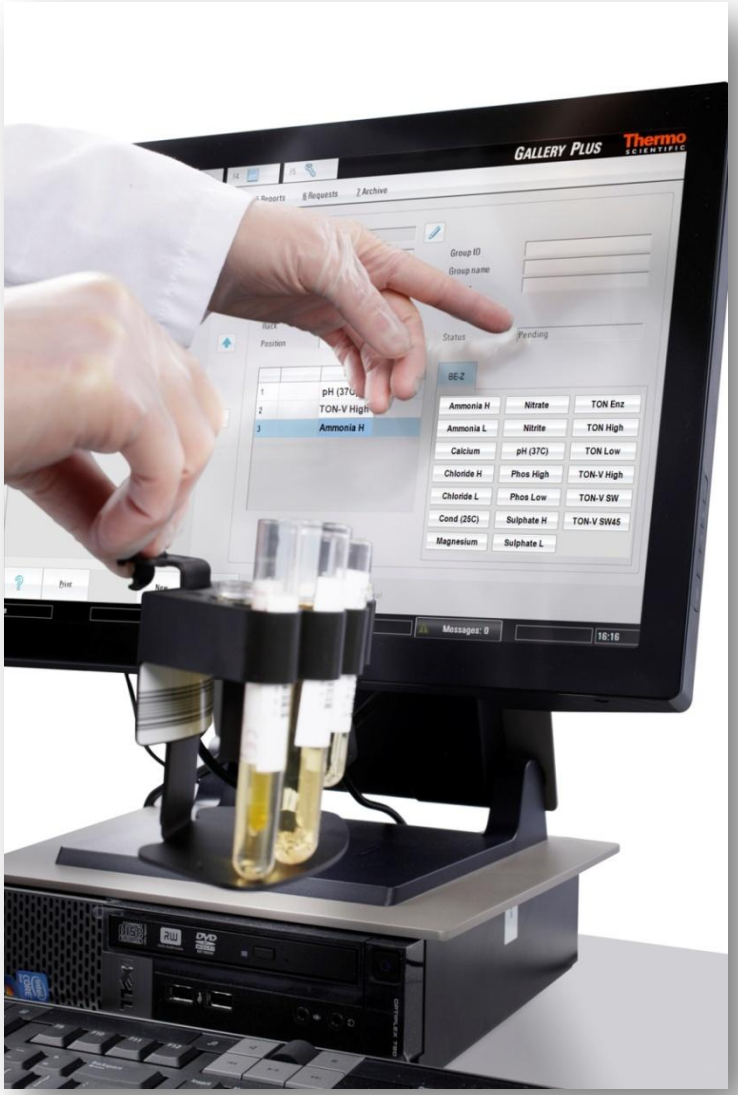
Date	2014-02-17	User	Dealer
Time	12:53:25	Software version: 4.1.1	

Test	NO2 2mg/l	Coeff. of deter.	0,999956
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	

Intuitive User Interface

- Graphic user-interface
  - Provides fast guidance
  - Includes context-sensitive help
  - Available in different languages
- Secure and traceable data handling
  - Different user groups can have different access rights
- Touch screen option



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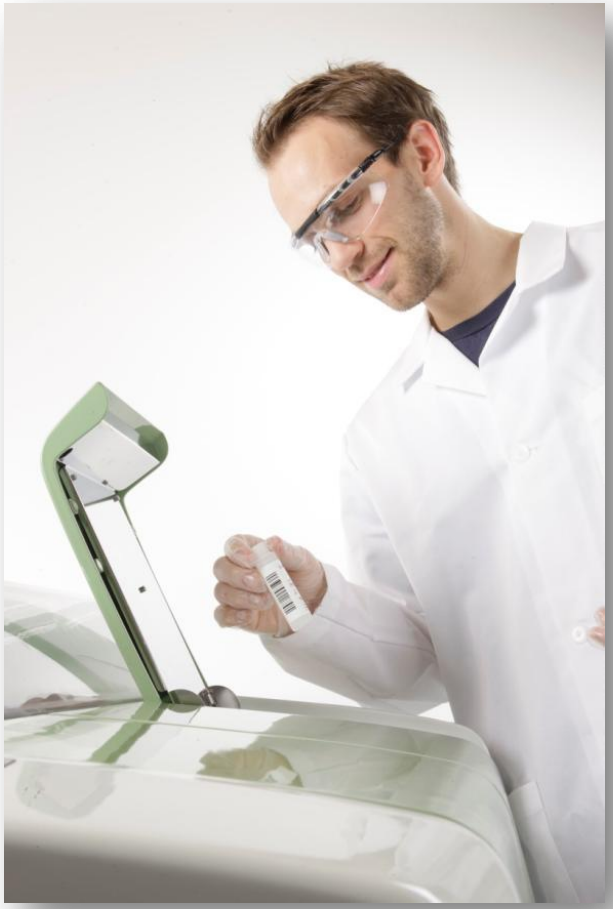
Thermo Scientific System Reagents

- Optimized system solution
  - System applications for water analysis
  - Loadable application data from 2D barcode
  - Optimized kit sizes and on-board stability
  - Wide range of calibrators
- Productivity and efficiency
  - Ready-to-use liquid reagents eliminate reagent preparation
  - Minimal reagent waste
  - Bar-coded reagent vials provide easy and reliable identification
    - lot, expiration date, vial size
    - real-time reagent monitoring



Reasons Automated Industrial Systems Are Used

- 200 open channels, easy-to-use software
- Pick-and-choose application steps, four different reagent additions possible
- Incubator temperature from 30–50 degrees in 1 degree steps
- Filters available from 275 to 880 nm (filter wheel holds 12 filters which can be changed)
- Dilution possibilities for calibration, high range results, pre dilutions
- Secured export function to Excel sheet or with ASTM protocol
- Multi-language software availability
- High quality photometer resolution: 0.0001A, linear abs.: 0-2, 5A, Reproducibility: 0.0005 at 2A
- Disposable, contamination-free cuvettes
- Different user levels available
- Low water consumption, no external water connection required
- Large customer base with long-term experience in creating methods
- Very experienced pre and after sales

Conclusions

- Determination of anions in wastewater is critical to verify its suitability for discharge
- Variety of other applications available
- Discrete analyzers use photometric assays
  - That are specific for individual analytes
  - To provide fast, specific, high-throughput anionic measurements of up to 600 tests/hour
  - To produce accurate, precise data even from challenging matrices such as wastewater
- Electrochemical measurement unit
  - Additional 67 tests/hour

Thank You!

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The world leader in serving science