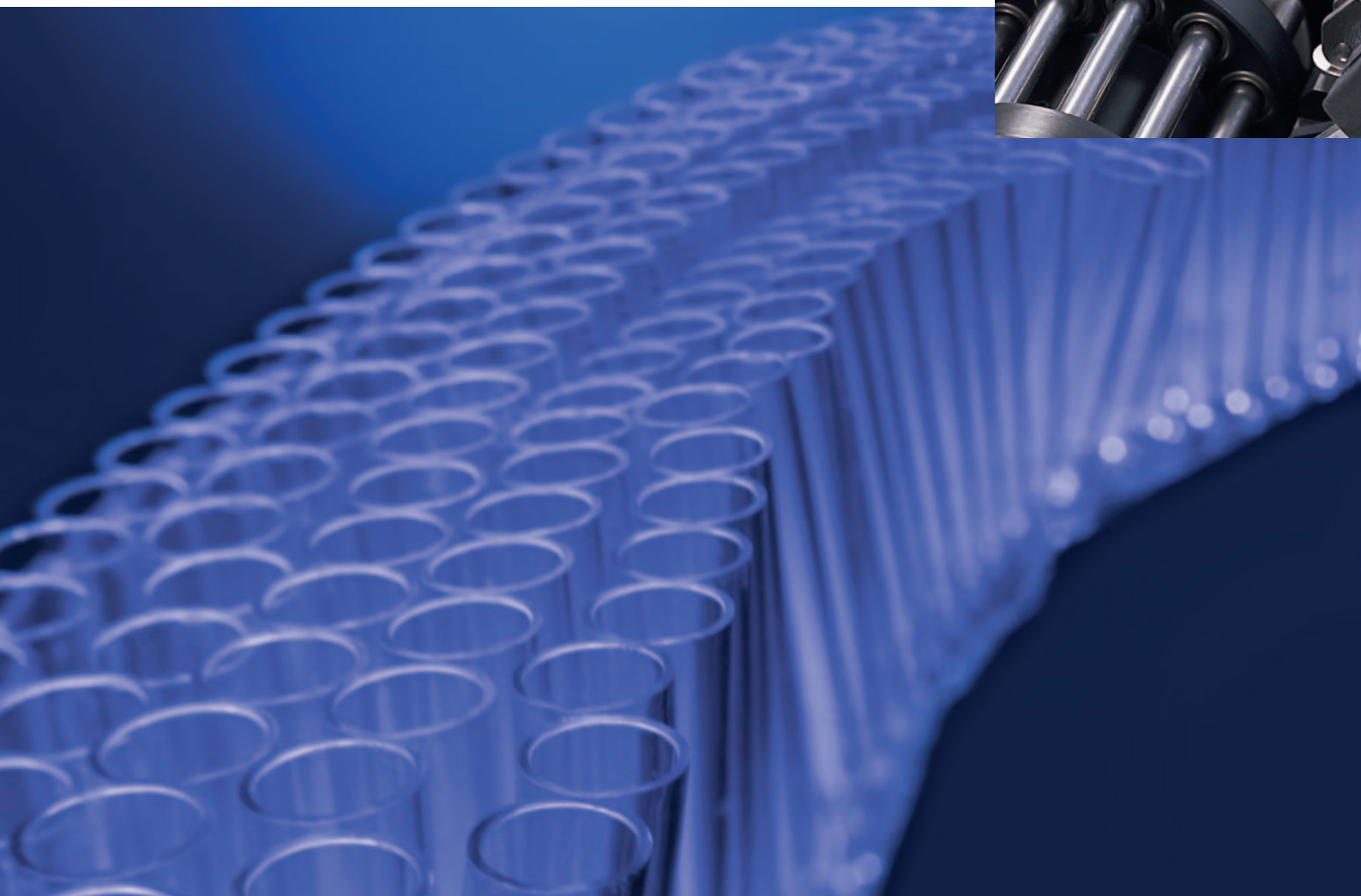


QUAATRO

HIGH PERFORMANCE
AUTOMATIC OPERATION



QUAATRO

THE LATEST IN A HISTORY OF INNOVATION

HISTORY OF THE AUTOANALYZER

THE BIRTH AND GROWTH OF CFA

In the early 1950s Leonard Skeggs, a researcher in a clinical laboratory, had the innovative idea of adding air bubbles to a flowing reaction stream so that one sample after another could be introduced without interacting. From this idea the Technicon AutoAnalyzer was born in 1957.

Within a decade it had become a dominant instrument type in automated analysis. In the late 1960s the AutoAnalyzer II was introduced, having air injection phased, smaller manifold components and a linear output. New techniques such as solvent extraction, automated digestion and continuous distillation were developed.

By 1975 almost 8000 papers on CFA – more accurately termed SFA or segmented-flow analysis to distinguish it from flow-injection analysis FIA – had been published.

MICROPROCESSORS AND HYDRAULICS

After the complex definition of dispersion in segmented-flow streams had been derived by Technicon's Lloyd Snyder, micro-flow systems with higher segmentation frequency and sampling rates over 100/h appeared.

At the same time, computers were built into the instruments, so that in a decade data calculation moved almost completely from ruler and calculator to dedicated computer or PC.

TECHNICON, BRAN+LUEBBE AND SEAL

By 1980 there was a clear division in system design between instruments intended for clinical and industrial use. In 1987 Technicon divided into separate industrial and clinical divisions, and the industrial division was bought by Bran+Luebbe. At the end of 2006 SEAL Analytical bought the continuous-flow business, so ensuring continuation of the AutoAnalyzer lineage.

The CFA analyzers are designed and manufactured in SEAL's Technical Centre in Hamburg, Germany. Here the tradition of research and innovation is combined with German design skill and high quality manufacture to produce analyzers with exceptionally high performance and long working life.

QUAATRO is the latest result of this fusion, and is the world's most highly automated CFA analyzer.

DESIGN

QUAATRO's design objectives were to reduce the detection limit, and to reduce the need for operator training by making the system monitor its own operation.

Our engineers and chemists in Germany and Japan worked together with experts at the Netherlands Institute for Oceanographic Research, Royal NIOZ. Skilled users from the University of Hamburg helped to define and automate the tasks which are routinely performed by an expert user.

The result is a closed, thermostatted system which checks its own performance and has a very low detection limit.

QUAATRO AT A GLANCE

QUAATRO COMBINES IMPROVED PERFORMANCE WITH A HIGHER LEVEL OF AUTOMATION

QUAATRO is an integrated system where only the sampler, PC and reagent bottles are external. Up to four methods can run at the same time on one console, and there is a special 5-channel version for nutrients in seawater. Two consoles can be combined to give an 8-channel system. The modular architecture allows easy expansion and adaptation.

QUAATRO uses microflow hydraulics, which enables higher sampling rates with lower reagent consumption. It is ideal for laboratories with large numbers of relatively clean samples. QUAATRO's high speed and multi-channel design mean that 1000 results per day can be generated with ease on a typical system.

SYSTEM FEATURES:

- High speed – sampling rate typically 1.5 - 2 times higher than a macroflow system.
- Low reagent consumption – per sample, typically one half to one quarter of a macroflow system.
- High reproducibility – about 0.4% RSD for most methods.
- Low detection limit – 0.1 µg/L P in seawater.

COMPACT AND FLEXIBLE



A RANGE OF SAMPLERS

XY-2 SAMPLER (ILLUSTRATED)

- Up to 180 sample cups or tubes in 2 racks.
- Separate rack for standards.
- Any size or shape of sample rack which fits into the sampler can be used.
- Dual-row option.

XY-3 SAMPLER

- Similar to the XY-2, but with 3 sample racks.

INTEGRATED, ENCLOSED ANALYTICAL SYSTEM

The manifold and detector sections are designed as a whole and share the same temperature control system.

- Up to four methods in one console plus optional external detectors.
- Thermostatted manifold: 37°C heating baths are not usually needed.
- 1:1 compatibility with existing methods.
- Quick access to service components.

INNOVATIVE VALVE SOLUTIONS

Solenoid valves with opto-electrical timing for air injection replace mechanically activated bubble injectors.

- 8 silent valves for manifold air injection.
- Programmable method-specific bubble frequency.
- 2 valves for independent flowcell segmentation.
- Optional flow valves for automated dilution and stream switching.
- Optional individual valves for each reagent for fully flexible automatic control.

THREE LEVELS OF AUTOMATION

BEFORE...

ELECTRONIC, HYDRAULIC AND CHEMICAL CHECKS

With the automated pre-analysis checks you can be sure that key system parameters are within specification before starting a run.

SYSTEM CHECK

The electrical and optical performance of the photometers is checked by measuring the sample and reference transmission intensity and the lamp power supply parameters. Faults such as an aging lamp or a dirty flowcell can be diagnosed. Heater temperature is checked.

WATER CHECK

The water baseline is monitored for noise and drift. The bubble pattern, a sensitive indicator of correct hydraulic performance, is monitored to detect faults causing incorrect flow.

REAGENT CHECK

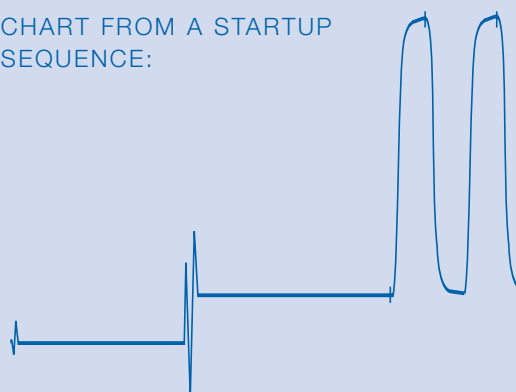
The reagents are connected and the bubble pattern is checked again. At this stage a missing reagent or surfactant can be detected. The reagent absorbance is recorded.

TEST REPORT

The report indicates out-of-spec parameters and can be used for system validation.



CHART FROM A STARTUP SEQUENCE:



Water baseline, reagent baseline and first peaks

DURING...

RUN-TIME-MONITOR

CHEMISTRY PERFORMANCE

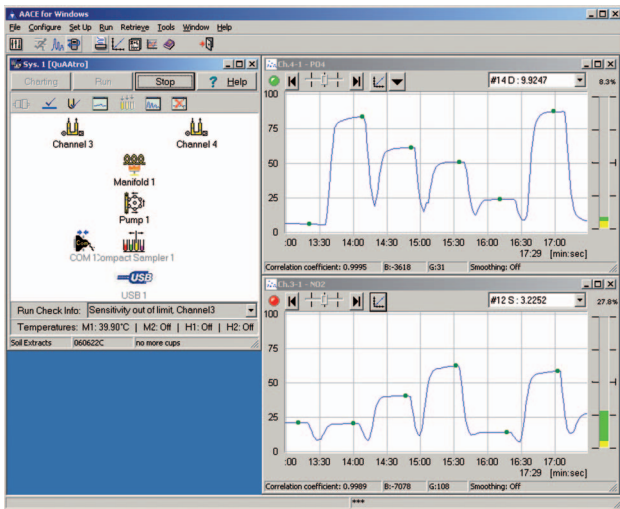
When the first peak appears the method sensitivity is checked to verify the reagents and flow rates. The run can be broken off at this point if the chemistry performance is out of specification. When the standards are through, the linearity and correlation are checked against specification. Again the run can be stopped.

HYDRAULIC PERFORMANCE

The bubble pattern monitor detects problems such as a reagent running out. Sample interaction can be measured to indicate a hydraulic fault causing high dispersion.

STABILITY

As recalibration standards appear during a long run the baseline and sensitivity drift are measured and checked. During the entire analysis the working temperature of the analytical system is continuously monitored.



WARNINGS

During an analysis the Run-Time Monitor constantly compares the measured result of each performance parameter with acceptable limits. Most of these limits can be set by the user, who can define what will occur when a limit is exceeded, for example to give a visual or audible warning or to stop a channel or the entire analysis.

...AND AFTER THE RUN

ANALYSIS AND SYSTEM LOGS

DATA STORAGE

At the end of a run three types of data are stored.

METHOD AND SYSTEM DATA

- ▣ The values of all electrical, optical, hydraulic and chemistry parameters.

ANALYTICAL DATA

- ▣ Raw data and calculated results for samples, calibrants and controls
- ▣ Method sensitivity and calibration linearity
- ▣ Operating conditions such as temperature.

RAW DATA

- ▣ The absorbance factor for each individual liquid segment.

DATA OUTPUT

Data can be printed and sent to a file server. The data selection and format for electronic transfer is fully flexible. With the optional AACE GLP software, data on the server is verified and the local data can be deleted.

HYDRAULICS

Depending on the next use of the system, at the end of a run QUAATRO enters one of two states:

- ▣ Standby: pumps are switched to slow or intermittent, reagents remain connected and the temperature is maintained.
- ▣ Wash: reagents are washed out and the manifold is cleaned if necessary. Pumps switch to slow and the temperature is maintained in readiness for the next start or final shutdown.

Conc	Reagent	Sens.	R.A.	Rgr R.A.	Rgr R.A.	Water R.A.	Water R.A.	Energ	Energ	Liquid	Liquid	Disk out.	Disk out.	Lamp	Manifold	Heater1	Heater2
over %	Abs[AU]	Dth %	Dth %	Dth[AU/h]	Noise[AU]	Noise[AU]	Noise[AU]	Ret %	S.F. ratio	Var. %	Var. %	Ret.	Ret.	Value [V]	Temp [C]	Temp [C]	Temp [C]
0.0	-	0.2	0.1	-	-	7.0	0.06	33	0.4	1504	0.6	192384	246949	-	-	-	-
0.0	-	0.0	0.3	-	-	-	-	33	-	1504	1.2 F	-	-	-	15.90	0.0	-
0.0	-	2.2 F	0.1	-	-	-	-	33	-	1224	2.3 F	-	-	-	15.90	0.0	-
0.3	-	0.5	0.1	-	-	-	-	33	-	1576	0.6	-	-	-	15.90	0.0	-
0.3	-	0.2	0.2	-	-	-	-	33	-	1536	0.9	-	-	-	15.90	0.0	-
0.3	-	2.3 F	0.2 F	-	-	-	-	33	-	1544	1.0	-	-	-	15.90	0.0	-
0.2	-	1.1 F	0.2	-	-	-	-	33	-	1568	0.7	-	-	-	15.90	0.0	-
0.1	-	12.6 F	0.3	-	-	-	-	33	-	1536	1.2 F	-	-	-	15.90	0.0	-
0.0	-	19.7 F	0.3	-	-	-	-	33	-	1536	37.5 F	-	-	-	15.90	0.0	-
-	-	0.0 F	-	6.5	0.03	-	-	33	0.4	1512	0.9	-	-	-	-	-	-
-	-	-	-	-	-	1.4	0.02	33	0.4	1536	1.2 F	195487	246745	-	-	-	-
-	-	-	-	-	-	1.6	0.02	33	0.4	1576	0.9	193738	246822	-	-	-	-
0.2	-	7.0 F	0.1	-	-	-	-	33	-	1504	0.7	-	-	-	15.90	0.0	-
0.4	-	0.2	0.1	-	-	-	-	33	-	1520	1.1 F	-	-	-	15.90	0.0	-

System log

QUAATRO

DESIGN FOR HIGH PERFORMANCE

HYDRAULICS

High frequency bubble segmentation is good for achieving high sampling rates on fairly simple methods such as those using only heated coils and dialyzers. However, the high elasticity of a long stream containing hundreds of air bubbles makes it more difficult to apply methods running at high temperature or which use distillation or a long reaction time.

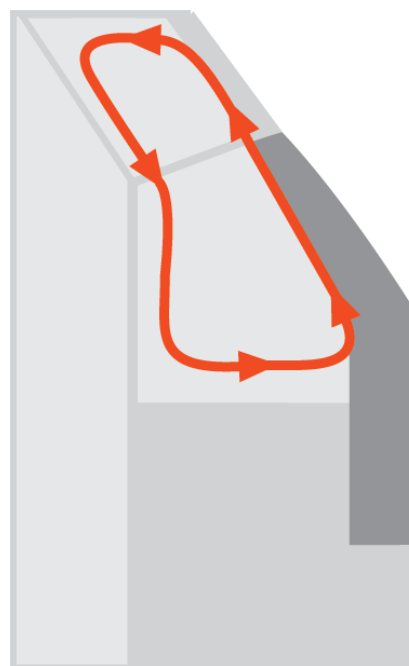
Bubble segmentation on QUAATRO is programmable so that the interval between bubbles can be short for simple methods and longer for more complex ones. Limiting the air volume on these methods greatly improves flow stability.

Another advantage of programmable air injection is that the bubble interval can be selected so as to allow bubble-through operation with flowcells having a variety of lengths and internal diameter.

The optimum bubble frequency for each method is stored in the analysis configuration file and is automatically applied when the method is used.



Quick-connect strips make changing the tubes faster and easier



Warm air circulation

TEMPERATURE

Thermostating the whole analytical system has several advantages. In many cases it is no longer necessary to use the 37°C heating baths traditionally employed to stabilize the temperature of reactions which are slow or sensitive to changes in ambient temperature, because a simple coil can be used. This reduces the cost of purchase and maintenance.

At very high sensitivity the detector responds to changes in the refractive index of the liquid in the flowcell.

QUAATRO's heated manifolds and circulating fans help to reduce the influence of changes in ambient temperature.

The temperature of the analytical system, and of any high-temperature heating baths used for a method, is shown on the PC and can be set with a calibrated thermometer.



Triple pump assembly

PUMP

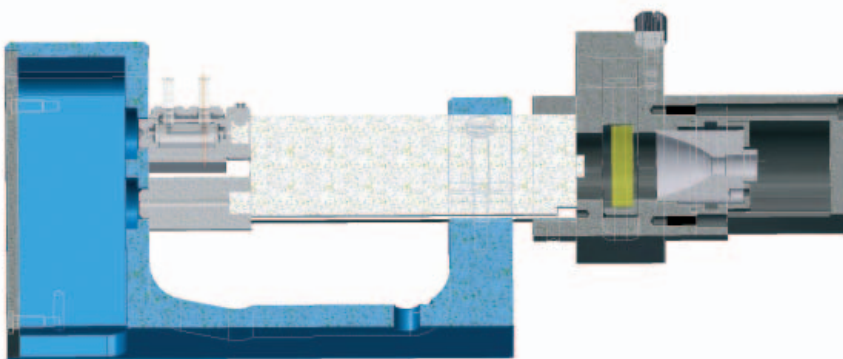
At the heart of the hydraulic system, QUAATRO's high precision micro-peristaltic pumps are manufactured to tolerances down to 8 μm to ensure that each liquid segment in the analytical stream contains the same volume of reagents and sample, an essential requirement for high reproducibility. The pump rollers are made from high grade CrMoV steel which then undergoes a two-stage surface treatment to increase its hardness and chemical resistance. Each roller is mounted on micro-needle bearings for smooth running and long life.

PHOTOMETER

QUAATRO's photometer is similar to the one used in AA3 HR, which is one of the most sensitive CFA detectors available. Every part has been optimized. A new lamp power supply delivers more stable current over a wider range. Detailed research has resulted in optics which increase the light transmission through the flow-cell. The detector output goes directly into an A/D converter whose resolution is increased to 24-bit so as to reliably cope with lower detection limits.

Flowcells are available in three diameters and three lengths, and can be used in bubble-through or bubble-free mode.

LED light sources are standard for systems used on a ship and can be specified for other high performance applications.



Colorimeter cutaway drawing

Optional GLP software package includes 21CFR Part 11 compliant functions including:

- Individually selectable password-controlled access to every user function
- Password aging
- Administrator-determined relogin
- Analysis log with change control
- Checksum protected encrypted logs for analysis and system parameters
- Data copy to server with optional verify and delete from workstation

QUAATRO SPECIFICATION

ANALYTICAL CONSOLE

Incorporates pumps, fully enclosed and thermostatted analytical manifold and photometers, reagent / wash valves (option on some models) and automatic dilution system (option) for 1 to 4 simultaneous determinations (5 or 6 with detector extension). Two consoles can be combined to create a larger system.

Leak detectors for manifold and photometers, with automatic warning and pump stop.

SAMPLERS

XY-2 SAMPLER

Holds up to 180 cups.

2 sample racks for:
90 x 2 ml cups or 13 mm tubes
60 x 4/5 ml cups or 16 mm tubes
user-programmable sizes.

Extra rack for 11 standards.

Fixed or traveling wash.

Dual-probe option

XY-3 SAMPLER

Holds up to 270 cups.

As for XY-2 but with 3 sample racks.

PUMPS

12-roller peristaltic pump with needle bearings for each roller and fully floating platen.

User programmable 3 step speed: intermittent, normal, high.

Speed consistency better than $\pm 1\%$.

Easy-connect strip for quick pump tube changes.

Emergency pump off switch.

AIR / N₂ SEGMENTATION

User programmable double-acting twin-solenoid air injection valves, each with capacity for 2 tubes.

4 valves for manifold air injection plus two optional for different-frequency flowcell segmentation.

Valve timing controlled by optical disk.

Air injection delay up to 1000 ms individually programmable for each valve.

1, 2, 3, 4 or 6-second air injection frequency, individually programmable for each valve.

Long-life chemically resistant synthetic rubber air tubing with 1 year guaranteed lifetime.

Compressed air / N₂ source via pump tubes or from house supply.

MANIFOLDS

1 mm glass manifold with platinum and sapphire reagent and air inlets.

Compatible with current EPA and ISO standard methods.

Temperature control.

Manifolds and photometers thermostatted with circulating warm air.

Optional heating baths with glass or PEEK coils for temperatures up to 120°C.

1000 Hz proportional controllers for all heaters with PC temperature set and display.

DIGITAL PHOTOMETERS

Dual beam system with same-wavelength correction for high stability.

Microprocessor-controlled digital signal processing.

Light source krypton-filled tungsten lamp or LED.

LED Photometer Wavelength
270, 340, 350, 420, 460, 505, 520, 570,
600, 630, 660, 820 or 880 nm

24-bit A/D converter.

Maximum absorbance resolution 1 in 3×10^6 (equivalent to 0.3 ng/L PO₄-P in a typical low-level method with a 10 mm flowcell).

Baseline noise <1 μ Abs. at 880 nm with water-filled 10 x 1 mm flowcell.

Flowcell pathlength: 10 mm standard.
30, 50 or 500 mm optional.

Bubble-through operation possible for every size of flowcell up to 50 mm.

Maximum sensitivity 0.007 AUFS.

Automatic or manual chart scaling.

REAGENT VALVES

Up to 15 individually controllable 2-way valves with low internal volume.

Reagent contact surfaces PEEK.

OPTIONS

External fluorometer, flame photometer or UV detector.

POWER REQUIREMENT

100-240 V, 50 / 60 Hz, max 260 W.

SIZE AND WEIGHT

567 x 394 x 715 mm W x D x H.

35-40 kg depending on specification.

SEAL ANALYTICAL IS A GLOBAL COMPANY WITH WORLDWIDE OFFICES!

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