On-line, automatic monitoring of Total Nitrogen (TN) and Total Phosphorus (TP) in water

**Advanced features**
- On-line, automatic spectrophotometric measurements conform standard methods 4500-NO3 (B) and 4500-P
- Low temperature wet-chemical oxidation
- Compact, cost-effective mainframe with small footprint, short liquid pathways and simple maintenance
- **New:** remote access and data communication through secure virtual private network (VPN)
- Complete separation between electronics and wet part
- Multiplexing up to eight (8) sampling points possible
- Incorporated industrial PC with AppliTek controller software
- Extended data communication and exchange features

**Application fields**
- Industrial waste water
- Municipal waste water
- Surface water

**High analytical performance**
- Full oxidation of all nitrogen and phosphorus species
- Smart features: automatic calibration, automatic validation, automatic cleaning and automatic dilution
- Factory configured, tested and calibrated
Introduction

Traditionally, compliance of waste water effluent with local discharge regulations is assessed by a number of well-known nutrient parameters, such as nitrate ($NO_3^-$) and soluble phosphate ($PO_4^{3-}$) concentrations. However, the dynamic nature of nitrogen speciation and phosphorus fractions in treated waste waters and natural waters cannot be underestimated as it may contribute significantly to the total nutrient load of the water body.

In water, nitrogen exists as inorganic and organic species. Inorganic nitrogen is present in the oxidized form (nitrite and nitrate) and reduced form (ammonia/ammonium and dinitrogen gas). Organic nitrogen is available in a variety of complex forms such as amino acids, proteins, humic acids and urea. Total Nitrogen is the sum of all the components of the nitrogen cycle and should not be confused with Total Kjeldahl Nitrogen. Phosphorus is often synonymous with “phosphate” but can be present in different forms: orthophosphate (O-phosphate), condensed phosphate (polyphosphate) or organically bonded. O-phosphate is often the only form that is measured with traditional test kits or even in laboratory, yet the organic form of phosphate can be an important constituent of industrial discharges.

Rapid, convenient analysis of regulatory sum parameters in effluent, river water and ground water is facilitated by the newly developed NIPHO® On-line Total Nitrogen+Phosphorus Analyzer. This unique water analyzer shares similar wet-chemical technology with the TONI® and TOPHO® nutrient analyzers, yet in a compact and cost-effective analyzer mainframe.

Analytical mainframe

At first glance the NIPHO® On-line Total Nitrogen+Phosphorus Analyzer shares the typical look familiar of the range of water analyzers of AppliTek’s On-line Analyzer Suite. Underneath that appearance, the analyzer harnesses a mainframe especially developed for the simultaneous, automatic measurement of Total N and P in water. Key to this measurement is the use of AppliTek’s proprietary oxidation technique converting all N and P species into nitrate and orthophosphate. Contrary to the traditional design of AppliTek’s colorimeters, however, the NIPHO® employs a very compact spectrometer for the measurement of the absorbance of phosphate and nitrate at 630 nm and 220 nm respectively. The new spectrometer combines high thermal stability with low drift, and excellent signal-to-noise ratio.

In summary, key features of the analytical mainframe include:

- New compact, high-performance spectrometer
- Proprietary sample oxidation techniques
- Short liquid pathways: reagents, cooling, drain
- High-quality peristaltic pumps and micropumps
- External pinch valves for handling of sample and reagents
- Water-cooled reflux condenser for increased stability
- Standard smart automatic functions
- Ergonomic outlay of the wet part (hinged ABS door)
- Transparent door allows instant 180° visual inspection

Inside the wet part of the NIPHO®: close-up of the spectrophotometer located between the left and right micropump trains. Also visible: glass body of the reflux condenser sitting on top of the oxidation oven.
Analysis principle

The NIPHO® On-line Total Nitrogen+Phosphorus Analyzer runs two different analysis cycles for the simultaneous measurement of TN and TP. Proprietary sample oxidation techniques convert all N and P species into NO₃ and PO₄, yet completely automated and without risks imposed on operators. The industrial panel PC controls all steps of the analysis procedure, including sampling, sample transfer, addition of reagents and data exchange.

Step 1: oxidation
The sample is mixed with SuperOxi oxidation reagents and heated in a compact, built-in oven during a fixed time of 60 minutes. The oxidation/digestion process causes organic and inorganic nitrogen compounds to oxidize and convert to nitrate (30 minutes), while all organic and inorganic phosphorus is oxidized and converted to phosphate (30 minutes).

Step 2: detection (nitrate)
After the oxidation/digestion process, two different analysis cycles take place. Part of the sample is transferred to a second vessel allowing cooldown and further processing. The analysis of NO₃ involves a direct measurement of the absorption at 220 nm by means of the spectrometer, which is proportional to the concentration of total nitrogen in the sample.

Step 3: detection (phosphate)
After the oxidation/digestion process, another part of the sample is transferred to the second vessel allowing cooldown and further processing. The detection of PO₄ requires a color complex to be formed in the vessel prior. Orthophosphate reacts with the color reagent to phosphomolybdic acid. This acid is reduced to an intensely colored molybdenum blue complex. The absorption at 630 nm is measured with the spectrometer and is proportional to the total concentration of phosphorus in the sample.

Smart features
The NIPHO® On-line Total Nitrogen+Phosphorus Analyzer comes factory calibrated in function of the set measuring range and generally requires no recalibration. Smart features are embedded in AppliTek’s controller software and contribute to enhanced analytical performance, minimized down-time and lessened operator intervention.

Automatic cleaning
Sample lines, oxidation oven and/or analysis vessel are cleaned with demineralized water in order to eliminate cross interference.

Automatic calibration and/or validation
Calibration or validation cycles with standard solutions to check analysis and analyzer functionality. These can also be inactivated and carried out manually (with preprogrammed sequences).

Automatic dilution
The controller software closely monitors TN and TP values and adjusts measuring ranges if necessary to compensate for varying incoming levels of nutrients.

Data exchange and supervision
The NIPHO® mainframe uses the same incorporated high performance industrial panel PC running AppliTek’s proprietary controller-database software UPAMATIC® to control all analysis steps, actions and logs. This fully integrated software platform not only acts as the human interface but also features a host of functions specifically designed for industrial monitoring needs. If necessary, the optional AnaComDa® Analyzer Communication and Data Transfer Tool can be installed in order to create a secure VPN (Virtual Private Network) connection between the client (the analyzer) and the host (PC, mobile device).

Solid state data logger recording a history of the last 1,000 analysis results
These can be visualized in a chronological data table and equally be exported as Microsoft Excel files through the sealed USB port outside the analyzer cabinet.

Full integration and communication within industrial production sites and corporate networks
AppliTek on-line analyzers come with industrial standard 4-20 mA outputs. Ethernet communication by means of the TCP/IP protocol enables easy and reliable integration into existing corporate networks. MODBUS interfacing is possible to assure full integration and communication with DCS systems.

Remote access to the panel PC minimizing physical operator intervention (through VPN)
The analyzer screen can remotely be taken over by means of LAN Ethernet software (such as VNC software). Authorized users can carry out all manual operations and settings from a remote PC, such as trouble-shooting before doing any physical intervention.

The AnaComDa® tool allows to create a secure VPN connection to mobile networks (3G, 4G) or Wide Area Networks, giving authorized users the possibility to use e.g. Modbus TCP/IP control through a dedicated webpage or via VNC software. The tool also allows extended data logging in the cloud and visualization (connection of an IP camera). With the VPN created, FTP protocols can be used directly from a PC or a mobile device.
## Technical specifications

### Analytical data

**Analysis methods**  
Standard method 4500-NO₃ (B)  
UV spectrophotometric measurement after persulphate destruction in alkaline medium  
Standard method 4500-P  
Spectrophotometric measurement using ascorbic acid reduction and molybdate color solution after persulphate destruction in acidic medium

**Parameters**  
Total nitrogen, Total phosphorus

**Standard measuring ranges**  
0 - 2 mg/L N  
0 - 50 mg/L N with automatic dilution (threshold = 5 mg/L → dilution)  
0 - 0.5 mg/L P  
0 - 20 mg/L P with automatic dilution (threshold = 2 mg/L → dilution)

**Cycle time**  
80 minutes including oxidation of 60 minutes

**Calibration**  
Factory calibrated

**Cleaning**  
Automatic, free adjustable sequence

**Detection limit**  
Better than 0.2 mg/l (range 0 - 5 mg/L)

**Precision / Repeatability**  
Better than 4% full scale for standard solutions

### Environmental data

**Ambient operating conditions**  
10 °C - 30 °C +/- 4 °C deviation at 5 - 95% relative humidity non-condensing  
(50 °F - 86 °F +/- 7.2 °F deviation)

**Reagent temperature**  
Keep between 10 °C - 30 °C (50 °F - 86°F)

**Sample pressure**  
By external overflow vessel

**Sample flow rate**  
Fast loop sample supply required - minimal flow rate depends on application

**Sample particulates**  
Maximum size 40 µm, < 0.1 g/l

### Reagents

**Reagent containers (included)**  
Outside cabinet: 7 (9 with calibration/validation)  
Containers come with torqueless screw caps.

**Oxidizing solutions**  
SuperOxi A⁺ ≤ 2.5 L / 30 days *  
SuperOxi B⁻ ≤ 0.5 L / 30 days *  
SuperOxi C⁺ ≤ 0.5 L / 30 days *

**Other solutions**  
Reducing solution ≤ 0.5 L / 30 days *  
Color solution ≤ 0.5 L / 30 days *  
Based on 1 analysis result/80 min

**Cleaning solution (recommended)**  
Demineralized water / specific chemical solution

### Mechanical data

**Protection class**  
Analyzer cabinet: IP55  
Touch screen/Industrial PC: IP65

**Cabinet and materials, hinged part**  
Thermoform ABS / Door: plexiglass

**Cabinet and materials, wall section**  
Galvanized steel, powder coated

**Wetted materials**  
Teflon / PE / PTFE / PP / PFA

**Dimensions (H X W X D)**  
69 cm (27.2”) x 46.5 cm (18.3”) x 33 cm (13”)

**Total weight**  
25 kg (55 lbs.)

### Control and communication

**User interface / controller**  
Industrial PC with 5.7” TFT colour user interface, compact flash memory  
Backlit touchscreen, brightness adjustable

**Data handling, logging and security**  
- Standard Ethernet 10 M (RJ45) NE 2000  
- Communication ports supporting Ethernet connectivity to MODBUS TCP/IP  
- Log files with 1,000 values/results are stored  
- Easy export to spreadsheet files  
- Sealed USB port for data or result graph download and program upload  
- User interface with administrator access and menu keys activated/inactivated  
- Data retention in case of power failure, initialization program for safe status after restart

**Analogue outputs**  
Maximum 8, active 4 – 20 mA  
Max. 500 Ohm load

**Alarms (digital outputs)**  
- Malfunctioning alarm (potential free contact)  
- Result alarm (potential free contact)

**MODBUS TCP/IP, MODBUS-RTU2232 -RS485**  
Optional

### Options / add-on units

**Sample preconditioning I**  
EZ-Size® self-cleaning filtration unit, various pore sizes available, requiring fast loop

**Sample preconditioning II**  
MicroSize® self-cleaning microfiltration unit, various pore sizes available

**Reagent level detection**  
Installed on reagent containers; alarms are generated by controller software

**Multiple streams**  
ModuPlex® 2 or 3 streams (8 on demand)

**Secure VPN connection**  
AnaComDa® remote access and data transfer

### Environmental data

**Carbon footprint**  
69 cm (27.2”) x 46.5 cm (18.3”) x 33 cm (13”)

**Wetted materials**  
Teflon / PE / PTFE / PP / PFA

**Dimensions (H X W X D)**  
69 cm (27.2”) x 46.5 cm (18.3”) x 33 cm (13”)

**Total weight**  
25 kg (55 lbs.)

### Utilities

**Power**  
220 - 240 VAC, 2 A, 50 Hz  
Max. power consumption: 120 VA  
Other voltages available on request

**Instrument air (purging)**  
Dry and oil free according to ISA-S7.0.01-1996 quality standard for instrument air

**Tap water**  
Cooling of the condenser

**Demineralized water**  
Cleaning and/or dilution

**Drain**  
Atmospheric pressure, vented, min. Ø 64 mm

**Earth connection**  
Dry and clean earth pole with low impedance (< 1 ohm) using an earth cable of > 2.5 mm²

**Reagents**  
Reagent containers (included)  
SuperOxi A⁺ ≤ 2.5 L / 30 days *  
SuperOxi B⁻ ≤ 0.5 L / 30 days *  
SuperOxi C⁺ ≤ 0.5 L / 30 days *

**Other solutions**  
Reducing solution ≤ 0.5 L / 30 days *  
Color solution ≤ 0.5 L / 30 days *

**Cleaning solution (recommended)**  
Demineralized water / specific chemical solution

**Protection class**  
Analyzer cabinet: IP55  
Touch screen/Industrial PC: IP65

**Cabinet and materials, hinged part**  
Thermoform ABS / Door: plexiglass

**Cabinet and materials, wall section**  
Galvanized steel, powder coated

**Wetted materials**  
Teflon / PE / PTFE / PP / PFA

**Dimensions (H X W X D)**  
69 cm (27.2”) x 46.5 cm (18.3”) x 33 cm (13”)

**Total weight**  
25 kg (55 lbs.)

### Options / add-on units

**Sample preconditioning I**  
EZ-Size® self-cleaning filtration unit, various pore sizes available, requiring fast loop

**Sample preconditioning II**  
MicroSize® self-cleaning microfiltration unit, various pore sizes available

**Reagent level detection**  
Installed on reagent containers; alarms are generated by controller software

**Multiple streams**  
ModuPlex® 2 or 3 streams (8 on demand)

**Secure VPN connection**  
AnaComDa® remote access and data transfer

### Certification

**CE approval**  
Certified to CE approval

**Factory Acceptance Test (FAT)**  
At AppliTek NV, Belgium