



On-Line Water Analyser

UV400



TETHYS Instruments



UV 400 On-Line Water Analyser



Parameters

- Ammonia
- H₂S
- COD (UV 254)
- Nitrate
- Hydrocarbons
- Phosphate
- Chlorophyll A
- Colour
- pH / ORP
- Dissolved Oxygen
- Conductivity
- Turbidity

The UV 400 is the new generation of on-line water analyser from Tethys Instruments.

Based on UV spectroscopy for the main parameters (ammonia, H₂S, COD, hydrocarbons and nitrate), it offers an unparalleled reliability and stability with an extremely low operating cost.

Phosphate is measured by standard colorimetric methods, while pH, conductivity and dissolved oxygen is measured by standard external probes.

Applications

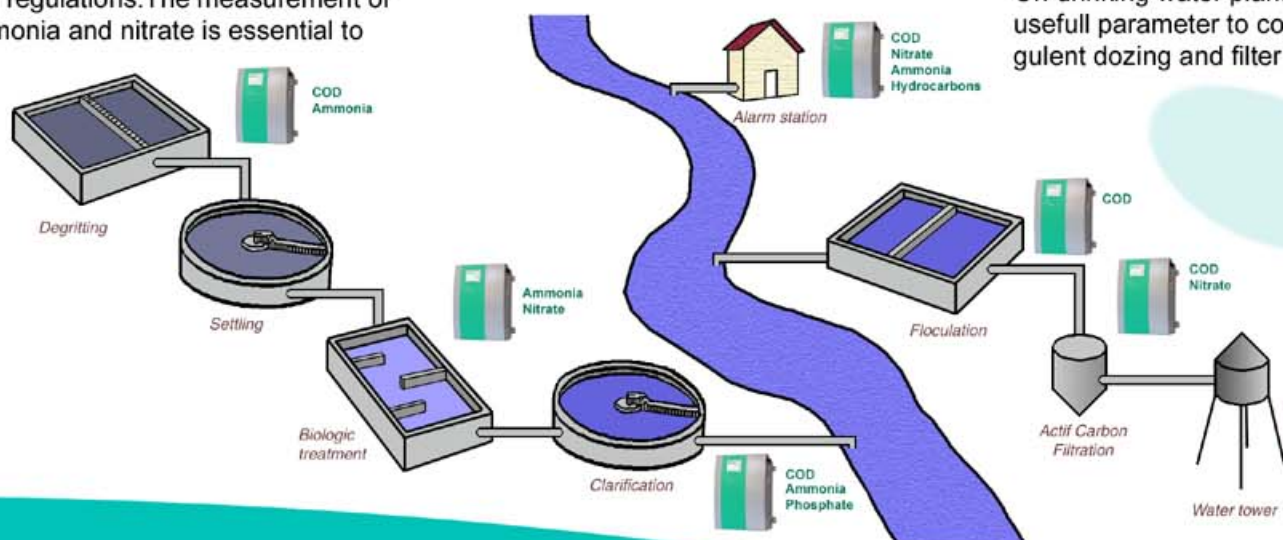
Typical applications covers drinking treatment plants, waste water treatment plants and river monitoring. Nutrients as nitrate and phosphate must stay below limits in accordance with regulations. The measurement of ammonia and nitrate is essential to

control the activated sludge process in waste water treatment plants. Excess of ammonia and nitrate in the final effluent is dangerous for the ecosystem. An excess of H₂S can damage concrete

structure and is a primary cause of odour problems.

For river monitoring, hydrocarbons and COD are key parameters to detect accidental pollutions.

On drinking water plants, COD is a useful parameter to control coagulant dosing and filter efficiency.





Features

- Based on UV spectroscopy for high stability and very low maintenance (main parameters)
- Modular concept from 1 to 12 parameters
- USB port for measurements and diagnostic data download on standard USB key
- User friendly touch screen interface
- Accept very high level of suspended solid (activated sludge) without filtering
- 10-years typical lamp life time
- Built-in automatic cleaning system
- Measuring time within 10 seconds for most parameters
- Mono-board concept for easy maintenance

Up to 12 parameters can be monitored simultaneously in one instrument. The new design gives an easy access to the flow cell and to any part of the analyser.

Thanks to large bore tubing and optical compensations, the measurements can be done directly on wastewater without filtering (even with activated sludge).

A new flow cell design enables very high values of suspended solid (like paper mill wastewater) without risk of clogging.

An USB port enables the download of the measurements and parameters with any USB key.

The user-friendly colour touch screen interface enables fast and reliable checking and calibration for each parameter.

The UV xenon lamp is specified for 10⁹ flashes that give more than 10 years of lifetime with a measurements every minute.

One time per day, a low cost cleaning solution is automatically injected on the flow cell to clean it. An auto-zero is performed at the same time.

The response time of the measurement is within 10 seconds for NO₃, COD, hydrocarbons and 3 minutes for NH₄, H₂S and phosphate.

Specifications

COD	Low range: 0 - 100 mg/l COD (river water, drinking water, final effluent) High range: 0 - 20,000 mg/l COD (inlet effluent)
Turbidity	Internal with COD low range: 0 - 150 NTU Internal with COD high range: 0 - 1500 NTU External cylinder with probes: 0 - 100 NTU
Phenol, BTEX	0 - 10 ppm (0 - 100 ppm on request)
Oil with 10% aromatics	0 - 100 ppm (0 - 1000 ppm on request)
Nitrate	0 - 100 mg/l NO ₃ (0 - 1000 mg/l on request)
Ammonia	0 - 100 mg/l (0 - 5000 mg/l on request)
H₂S	Low range: 0-10 mg/l S ₂ ⁻ High range: 0-100 mg/l S ₂ ⁻
Color	Low range: 0-100 Pt-Co unit High range: 0-1000 Pt-Co unit
Chromate	Low range: 0-25 mg/l High range: 0-250 mg/l
Sample flow	0 - 5 l/min, typical 0.5 l/min
Analog output	4-20 mA opto-isolated, 12-bit resolution, 500 Ohm max (option)
Communication	RS232 - No specific software, compatible with Excel® or MODBUS protocol RS485 - MODBUS protocol
Display	320x240 pixel colour LCD with backlight
Power supply	90-264 VAC / 40 VA / 50-60Hz 12 V to 15 V DC, 3 A
Operating limits	0 to 50°C
CE standards	Electromagnetic compatibility EN50081-2, EN50082-2, EN55011
Enclosure	IP65 / Nema 4X, coated steel
Dimensions	520 x 390 x 220 mm (HxWxD)
Weight	14 kg



Multi-Language

The touch screen human interface brings an incomparable facility for setting the parameters, calibrating or testing the instrument in anyone of the available languages that are:

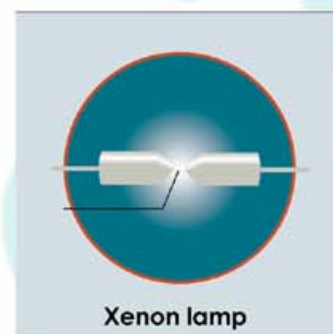
- English,
- Spanish,
- French,
- German,
- Dutch,
- Italian,
- Portuguese,
- Simplified Chinese,
- Traditional Chinese,
- Malay,



10-years lamp lifetime

The UV xenon lamp is specified for 10^9 flashes that give more than 10 years of lifetime with a measurement every minute.

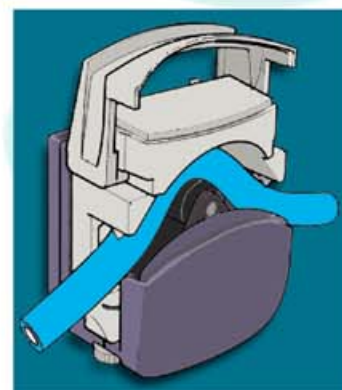
This reduces considerably the maintenance and the risk of wrong measurement due to age lamps or replacement itself.



Sampling peristaltic pump

An optional built-in peristaltic pump can be added to take sample directly on river, reservoir or open pipe with a maximum pumping height of 6 meters. A stainer prevents large suspended

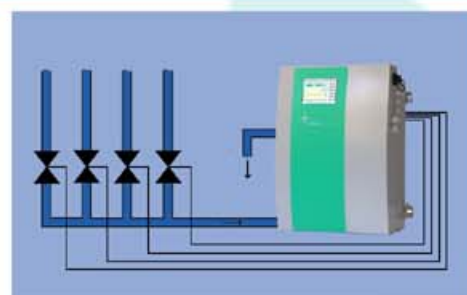
solid to enter into the analyser. A discontinuous pumping is assumed to increase the tubing lifetime. The easy-to-load pump head facilitates the tubing replacement.



Multiplexing configuration

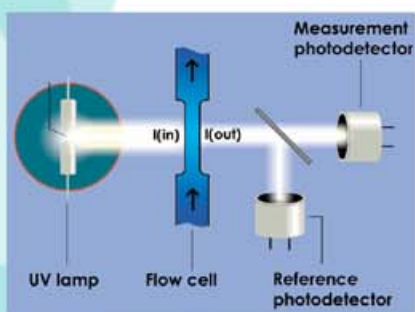
In the multiplexing configuration, the relays can be used to switch up to 6 external electric-valves or pumps (not provided) to measure 2, 3, 4, 5 or 6 water streams, for example inlet and outlet of a treatment plant.

In this case, the high threshold relays used for the multiplexing are no more available and external relays on 4-20mA outputs may be used if necessary.





COD by Correlation Measuring Principle



The measuring principle is based on the UV light absorption by unsaturated organic molecules at 254nm according to the Beer-Lambert law:

$$[C] = k \log (I_{in}/I_{out})$$

With:

[C]: concentration of the sample

k: absorption coefficient (specific to each molecule)

I_{in}: light intensity at the input of the sample

I_{out}: light intensity at the output of the sample

The approximate ratio COD/UV (ppm.abs-1.m) is given below for a few chemicals:

Acrolein	3
Benzene	5
Chlorobenzene	5
Dimethyldisulfide	3.5
Hydrogen peroxide	1.5
Nitro benzene	0.15
Phenol	5
Styrene	0.25
Tetrachloroethylene	0.5
Toluene	5
Triethylamine	1
Xylene	7

Generally, the sample is a mixture of many different molecules giving an average absorption coefficient.

That means that the instrument must be calibrated according to a COD laboratory measurement before using.

Also, the ratio of the different molecules must remain approximately constant to assume a good correlation with laboratory COD.

The UV absorption can be considered as an alternative method for COD (Chemical Oxygen Demand) when fast, reliable and inexpensive measurements with very low maintenance are required.

The correlation for industrial wastewater may need an experimentation to be validated while results are guaranteed on river water or urban wastewater.

Turbidity, suspended solid or dirty on the flow cell is automatically compensated by a differential measurement with a second detector at a reference wavelength.

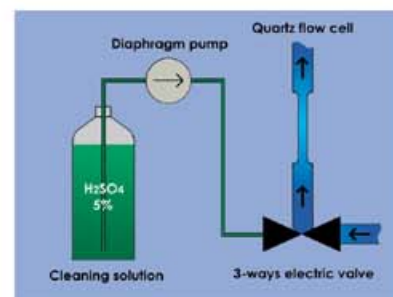
This method is in accordance with DIN38404-C3 standard and can be considered as an alternative method referring to AFNOR XPT90-210 standard.

Automatic Cleaning System

One time a day, a low cost cleaning solution (5% sulphuric acid) is automatically injected on the flow cell to clean it. An auto-zero is performed at the same time.

The autonomy is about 2 weeks with the built-in 2 litres tank.

An alarm is generated when the cleaning solution tank is empty.





Range & Calibration

Two ranges are available on the UV400 according to the flow cell:

- Low range with 10 mm flow cell for drinking or river water:
0 - 100 mg/l COD

- High range with 1 mm flow cell for effluents:
0 - 20,000 mg/l COD (depends of the effluent)

The instrument is pre-calibrated for

river water on the low range and for urban waste water on the high range.

For a specific effluent, the ratio COD/UV can be entered in the instrument according to laboratory COD measurements.

Operating Cost

The operating cost is limited to the refilling of the 2-litres tank of cleaning solution every 2 weeks with 5%

sulphuric acid on distilled water (for effluent measurements, tap water instead of distilled water can be

tolerate after checking). It can be estimated to about US\$ 100 per year including labour.

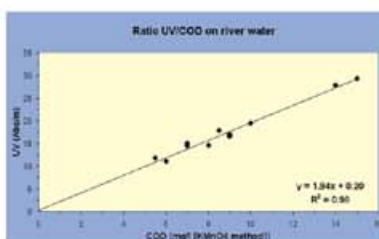
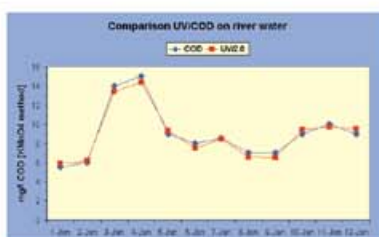
Application on River Water

Many studies have been conducted on river water to demonstrate the relation between UV absorption and COD such as:

American Public Health Association- "Standards methods for the determination of water and Wastewater - UV Absorbing organic constituents, p5-60", 1995.

J.C. ROSTANG, C.MOUVET- "Contribution of UV spectrometry and dissolved organic matter to the studies of the functioning of fresh-water ecosystems". Science de l'Eau, 5(1986) 9-28.

V.LEMAUVIEL- "Utilisation de la spectrometrie U.V. dans l'analyse des eaux naturelles". Rapport DIREN-SEMA Basse Normandie, 1994.



The applications concern mainly river monitoring for environmental studies and drinking water treatment plants. Successful and cost-efficient applications are also reported on automatic coagulant dosing. The graph above shows a typical relation between UV absorption and COD on river water.





Application on Waste Water

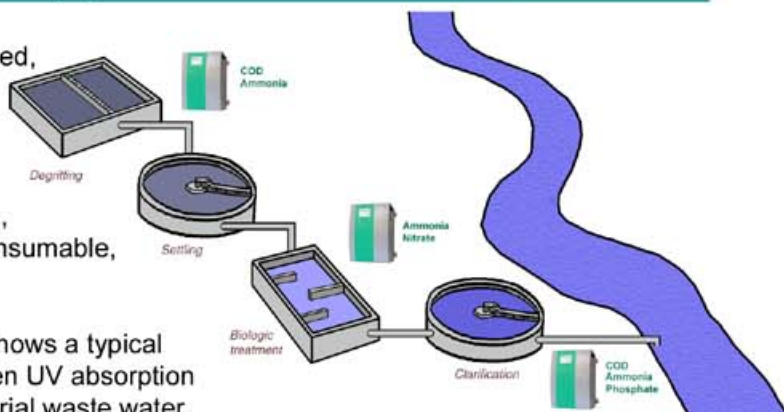


The COD of the final effluent is a critical parameter for environmental requirements on many chemical and food industries.

A fast and reliable on-line measuring system is needed. If the correlation

with COD is assumed, UV absorption appears to be the most adapted and cost-effective method (no filtering, no reagents, no consumable, no dilution).

The graph above shows a typical comparison between UV absorption and COD on industrial waste water. The UVpcx can drive a sampler using the high alarm relay if a standard method is required.



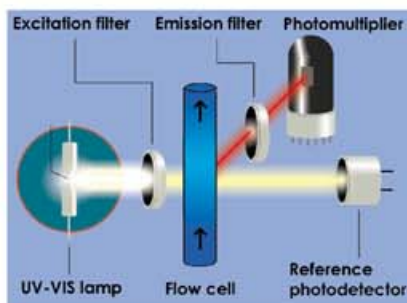
The samples are taken only above a critical value to limit the number of laboratory analysis.

Comparative Table

Method	UV absorption (UV400)	UV absorption (Immersed probe)	Automated lab. COD	COD by ozone or OH electrode	TOC with UV oxidation	TOC high temperature
Measuring time	< 10 seconds	< 10 seconds	2 hours	tens of minutes	tens of minutes	tens of minutes
Auto-zero capability	yes	no	yes	yes	yes	yes
Correlation with COD on river water	very good	very good	very good	very good	very good	very good
Correlation with COD on industrial effluent	variable	variable	very good	good	variable	variable
Detection of unsaturated organic molecules	yes	yes	yes	yes	yes	yes
Detection of alcohol and linear hydrocarbons	no	no	yes	yes	no	yes
Reagents	no	no	yes, pollutant	yes	yes	yes
Consumable, gas cartridge	no	no	no	yes	yes	yes
Distilled water for dilution	no	no	yes	>10 litres/day	no	no
Periodic change of electrode or lamp or parts	no	yes	yes	yes	yes	yes
Maintenance	very low	medium	high	high	high	high + waiting time
Filtering	no need	no need	inevitable	inevitable	inevitable	inevitable
Operating cost	low	low	high	high	high	high
Size	compact	compact	big	big	big	big
Weight	14 kg approx.	>10 kg	> 30 kg	>30 kg	> 30 kg	> 40 kg
Transportable by car or passenger plane	yes	yes	no	no	no	no
Installation time	few minutes	few minutes	hours	hours	hours	hours



Hydrocarbons or Chlorophyll A or Rhodamine Measuring Principle



The measuring principle is based on fluorescence: when lighted at a specific wavelength (excitation), some chemicals re-emit light (emission) at a longer wavelength.

Very few chemicals are fluorescent giving a highly selective measurement.

The table below gives the relative intensity of some aromatic hydrocarbons.

Anthracene	42
Benzene	10
Biphenyl	20
Chlorobenzene	7
Fluorobenzene	10
Naphtalene	35
Phenanthrene	25
Phenol	18
Propybenzene	17
Styrene	10
Toluene	17
Xylene	22

The emission light is detected by a high sensitivity photomultiplier to detect very low concentrations from a few ppb.

The excitation light is controlled by a detector to compensate any variation of the source.

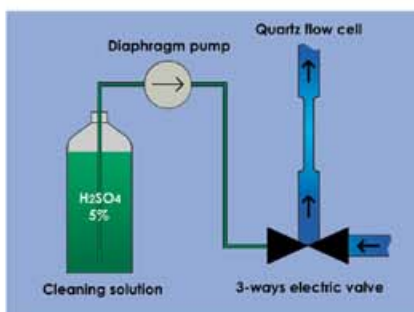
The application (Aromatic Hydrocarbons, Chlorophyll A, Rhodamine or Fluorescein) needs to be specified when ordering the instrument.

It can be modified by the user by changing the optical filters.

A higher sensitivity than falling stream flow cell is obtained due to the absence of parasite light reflections.

The flow and pressure of the sample may vary in a wide range at the opposite of falling stream flow cells that need a complex hydraulic system to control the flow.

Automatic Cleaning System



One time a day, a low cost cleaning solution (5% sulphuric acid) is automatically injected on the flow cell to clean it. An auto-zero is performed at the same time.

The autonomy is about 2 weeks with the built-in 2 litres tank.

An alarm is generated when the cleaning solution tank is empty.



Operating Cost

The operating cost is limited to the refilling of the 2-litres tank of cleaning

solution every 2 weeks with 5% sulphuric acid on distilled water.

It can be estimated to about US\$ 100 per year including labour.

Application on Surface Water

Hydrocarbons are dangerous pollutants that have to be detected very early on reservoir or river for producing drinking water.

Fast and reliable measuring system is necessary and the UV fluorescence is the only method matching these requirements.

Alga growing is becoming a major environmental concern on more and

more lakes and reservoirs due to the excess of nutrients coming from fertilisants or urban wastewater.

Fast and reproducible on-line measurement of **chlorophyll A** can be done by fluorescence for environmental studies.

Rodamine and fluorescein are the major tracers used for environmental studies (for example underground

water contamination or transit time of pollutants in a river).

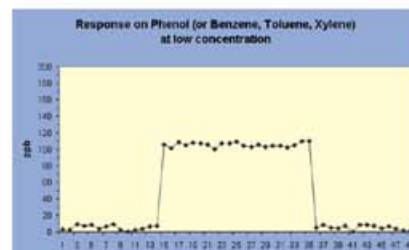
Very low concentrations (below ppb) are to be detected and fluorescence is the only fast and selective method applicable.

The optional built-in peristaltic pump can take water directly on the river or reservoir.

Application for Cooling Water

The concentration of hydrocarbons in cooling water is a critical parameter on refineries.

A fast and reliable on-line measuring system is necessary and the UV fluorescence is the only method matching these requirements.

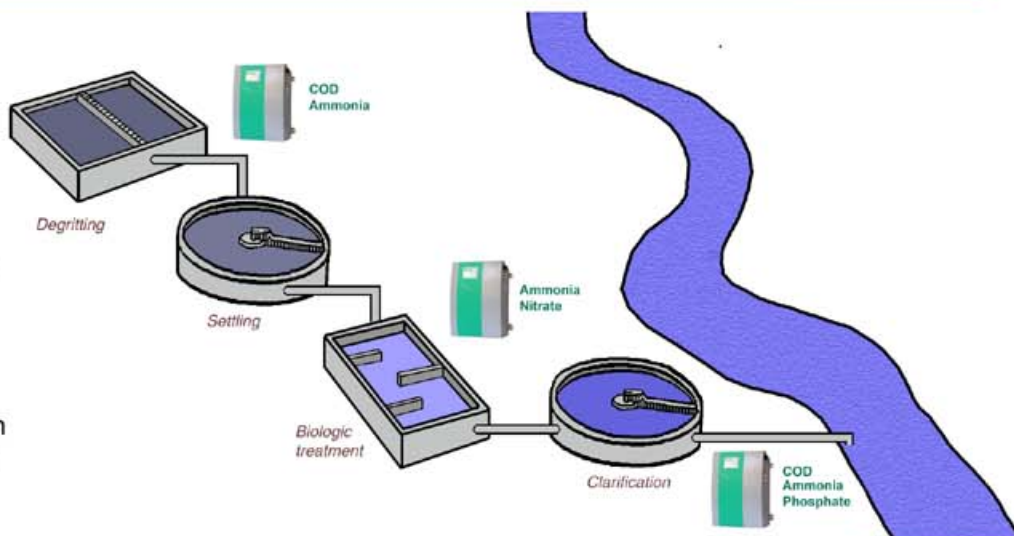


Application on Waste Water

The effluents of refineries and chemical plants have to stay below limits to meet the environmental regulations.

A reliable and low maintenance measuring system is required that only UV fluorescence can achieve.

The automatic cleaning system of UV400 maintains clean the flow cell avoiding any manual operation to clean a calibrated aperture as with open flow cell systems.





Comparative Table

Method	UV fluorescence (UV400)	UV fluorescence (Immersed probe)	UV fluorescence open flow cell mercury lamp	Extraction + IR absorption	Stripping + FID
Measuring time	< 10 seconds	< 10 seconds	<10 seconds	> 5 minutes	> 5 minutes
Auto-zero capability	yes	no	yes	yes	yes
Sensitivity	high	high	medium	high	medium
Use of dangerous solvent (CCL4, freon)	no	no	no	yes	no
Use of flammable gas	no	no	no	no	yes
Air supply	no	no	yes	no	no
Influence of molecular weight	no	no	no	no	yes
Detection of total hydrocarbons	no, aromatics only	no, aromatics only	no, aromatics only	yes	yes
Periodic change of lamp or parts	no	yes	yes	yes	yes
Simple hydraulic system	yes	yes	no, flow control medium	no, extraction	no,stripping
Maintenance	very low	medium	medium	high	high
Filtering	no need	no need	inevitable	inevitable on waste water	inevitable on waste water
Automatic cleaning system	yes	yes	no, impossible*	no, impossible	no,impossible
Operating cost	low	low	medium	high	high
Size	compact	compact	big	big	big
Weight	14 kg approx.	>10 kg	> 30 kg	> 30 kg	>30 kg
Transportable by car or passenger plane	yes	yes	no	no	no
Installation time	few minutes	few minutes	tens of minutes	hours	hours

* require manufacturer's specialist for cleaning the calibrated hole



Nitrate NO₃

Measuring Principle

The measuring principle is based on the strong UV light absorption of the chromophore NO at 210-220nm according to the Beer-Lambert law:

$$[C] = k \log (I_{in}/I_{out})$$

With:

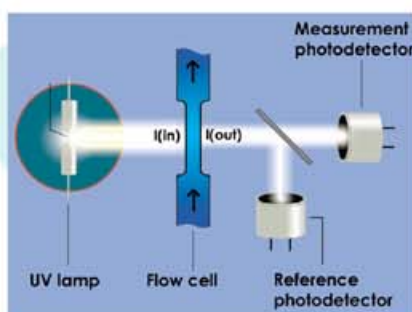
[C]: sample concentration

k: absorption coefficient

I_{in}: light intensity at the sample input

I_{out}: light intensity at the sample output

An automatic internal linearisation compensates the inherent non-linearity



of Beer-Lambert law for high concentrations.

The measurement is the weighted sum of NO₂ and NO₃ concentration, but in

most applications the NO₂ concentration is negligible regarding NO₃ concentration.

Turbidity, organic matter, suspended solid or dirty on the flow cell are automatically compensated by a differential measurement with a second detector at a reference wavelength.

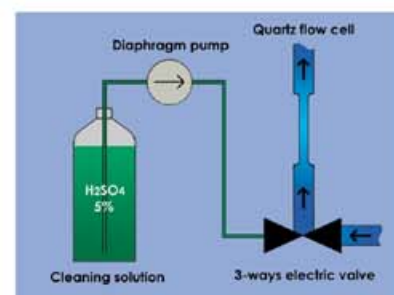
Chlorates and chlorites at high concentration are the only inorganic cause of interference but hopefully they are not encountered on drinking water or urban waste water.

Automatic Cleaning System

One time a day, a low cost cleaning solution (5% sulphuric acid) is automatically injected on the flow cell to clean it. An auto-zero is performed at the same time.

The autonomy is about 2 weeks with the built-in 2 litres tank.

An alarm is generated when the cleaning solution tank is empty.



Operating Cost

The operating cost is limited to the refilling of the 2-litres tank of cleaning

solution every 2 weeks with 5% sulphuric acid on distilled water.

It can be estimated to about US\$ 100 per year including labour.

Application on River Water



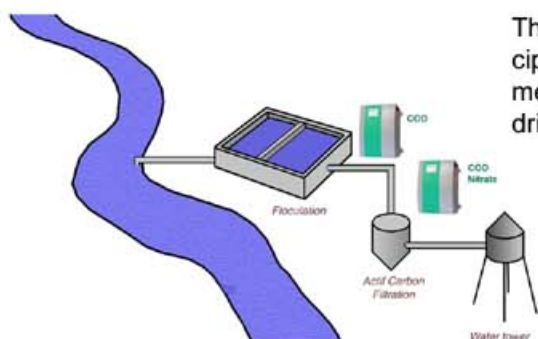
Rivers monitoring for environmental studies and nitrate flow evaluation are the main applications on river. Stability, reliability and low maintenance are the major concern for these remote measu-

rements that only UV spectroscopy method can achieve.

The optional built-in peristaltic pump can take water directly on the river.



Application on Drinking Water



The major water companies and municipalities now largely use the UV method for on-line measurements on drinking water, especially to control

automatically the mixing of several waters or for nitrate removal plants.

Laboratory measurements according to standard methods are still done periodically to follow the local regulations and they show very close results with UV measurements.

Application on Waste Water

Nitrate removal plants need a fast and reliable nitrate measurement to control the process that only UV spectroscopy method can really achieve.

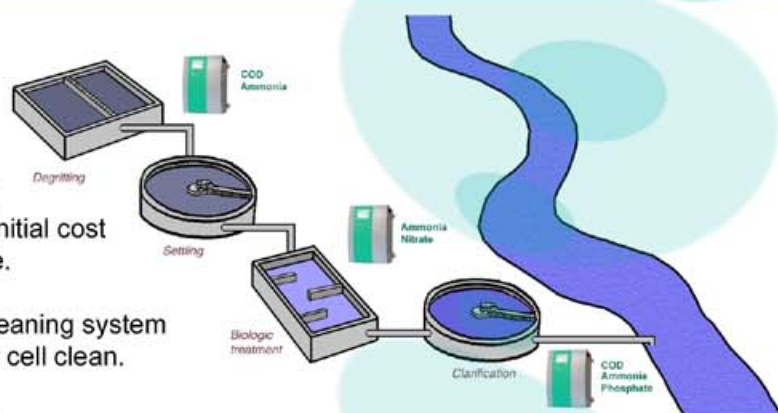
No drift as with electrode-base system are to be feared.

The absence of reagent assumes the lower operating cost.

The turbidity compensation and large bore tubing of UVpccx avoid any filtering

system reducing significantly the initial cost and maintenance.

The automatic cleaning system maintain the flow cell clean.

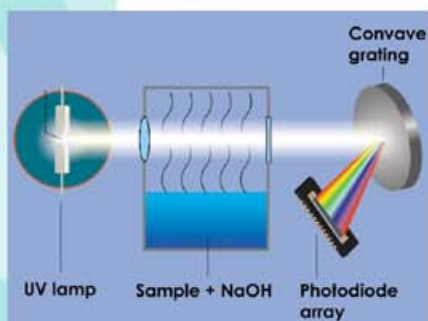


Application on Waste Water

Method	UV absorption (UV400)	UV absorption (Immersed probe)	UV absorption open flow cell deuterium lamp	Specific electrode	Colorimetry	Amperometry
Measuring time	< 10 seconds	< 10 seconds	> 30 seconds	> 5 minutes	> 5 minutes	> 5 minutes
Auto-zero capability	yes	no	yes	yes	yes	yes
Interference with chlorides	no	no	no	yes	yes, high	yes
Reagents or consumable	no	no	no	yes	yes	yes
Periodic change of electrode or lamp or parts	no	yes	yes	yes	yes	yes
Maintenance	very low	medium	medium	high	high	high
Filtering	no need	no need	inevitable to avoid clogging no, impossible require specialist	inevitable on waste water	inevitable on waste water	inevitable on waste water
Automatic cleaning system	yes	yes				
Operating cost	low	low	high	high	high	high
Size	compact	compact	big	big	big	big
Weight	14 kg approx.	>10 kg	> 30 kg	> 30 kg	> 30 kg	> 30 kg
Transportable by car or passenger plane	yes	yes	no	no	no	no
Installation time	few minutes	few minutes	tens of minutes	hours	hours	hours



Ammonia NH₄ Measuring Principle



The measuring principle is based on UV light absorption spectrum of ammoniac gas NH₃ in equilibrium with dissolved ammoniac gas in the water sample.

A small quantity of sodium hydroxide (NaOH) is added to the sample to

increase the pH for transforming NH₄⁺ to NH₃.

A Fast Fourier Transform (FFT) is applied on the spectrum to extract the absorption signal typical to ammoniac gas. This method is very selective and no interference is known on river or waste water.

Moreover, turbidity or color of the water has no influence as the measurement is performed in the gaseous phase.

Waste water with suspended solids as activated sludge can be admitted without filtering.

This method is known since 1956* but

requires a strong mathematical signal processing that only powerful-microprocessor-based instruments can handle.

"Quantitative Microdetermination of Gaseous Ammonia by Its Absorption at 204.3 nm" by Gunther, Barkley, Kolbezen, Blinn, Staggs - University of California, Vol 28, no 12, 1956.

The stability of the measurement (at the opposite of the electrodes) avoids the use of costly standard solution. An auto-zero is performed at each measuring cycle.

The detecting system is in a separate enclosure for a good accessibility.

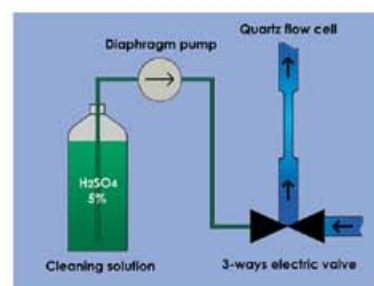
Automatic Cleaning System

One time a day, a low cost cleaning solution (5% sulphuric acid) is automatically injected on the flow cell to clean it.

An auto-zero is performed at the same time.

The autonomy is about 2 weeks with the built-in 2-litres tank.

An alarm is generated when the cleaning solution tank is empty.



Operating Cost

The operating cost is limited to the refilling of the 2-litres tank of cleaning

solution every 2 weeks with 5% sulphuric acid on distilled water.

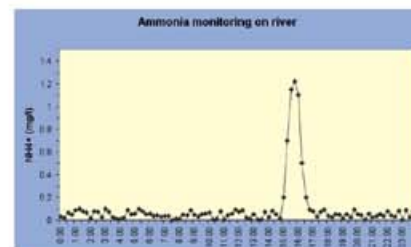
It can be estimated to about US\$ 100 per year including labour.

Application on River Water



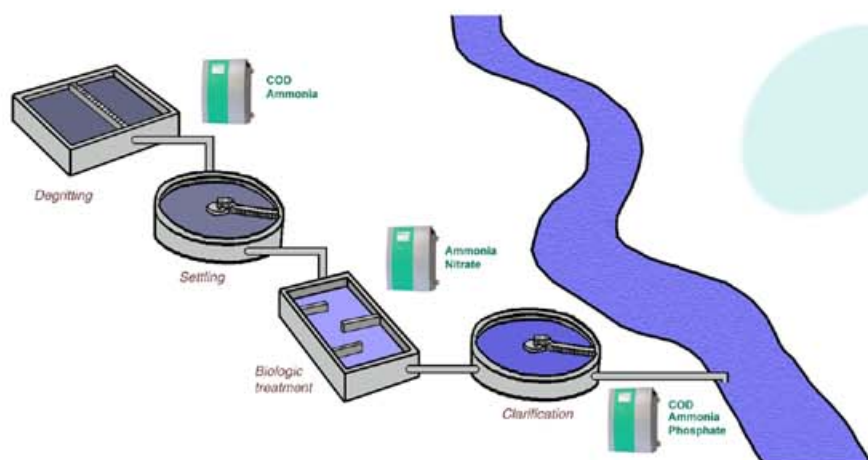
The concentration of ammonia in river water is an important parameter for drinking water treatment plants. Stability, reliability and low maintenance are the major concerns for these applications that only UV spectroscopy method can achieve.

The graph bellow shows typical measurements on river water.





Application on waste water



Waste water treatments plants need a fast and reliable ammonia measurement to control the nitrogen removal process that only UV spectroscopy method can really achieve.

The measurement on the gaseous phase avoids any interference with turbidity or suspended solid and the use of large bore tubing make possible the measurement on activated sludge.

The automatic cleaning system maintains the tubing clean.

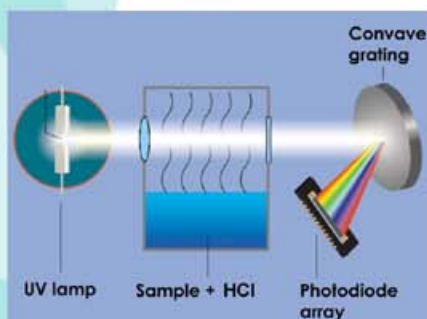
Comparative table

Method	UV absorption (UV400)	Specific electrode	Colorimetry
Measuring time	5 minutes	> 5 minutes	> 5 minutes
Auto-zero capability	yes	yes	yes
Interference with color or turbidity	no	no	yes
Standard solution	no need	inevitable(drift)	yes
Expensive or specific reagents	no	yes	yes
Periodic change of electrode or lamp or parts	no	yes	yes
Maintenance	low	high	high
Filtering	no need	inevitable on waste water	inevitable on waste water
Automatic cleaning system	yes		
Operating cost	low	medium	high
Size	compact	big	big
Weight	16/30 kg approx.	> 30 kg	> 30 kg
Transportable by car or passenger plane	yes	no	no
Installation time	few minutes	hours	hours



H₂S

Measuring Principle



The measuring principle is based on UV light absorption spectrum of H₂S gas in equilibrium with dissolved H₂S gas in the water sample.

A small quantity of hydrochloric acid (HCl) is added to the sample to decrease the pH for transforming H₂S to gas.

A double wavelength absorbance is calculated on the spectrum to obtain the absorption signal typical to H₂S gas. This method is very selective and no interference is known on waste water.

Moreover, turbidity or color of the water has no influence as the measurement is performed in the gaseous phase.

Waste water with suspended solids as activated sludge can be admitted without filtering.

The stability of the measurement (at the opposite of the electrodes) avoids the use of costly standard solution. An auto-zero is performed at each measuring cycle.

The detecting system is in a separate enclosure for a good accessibility.

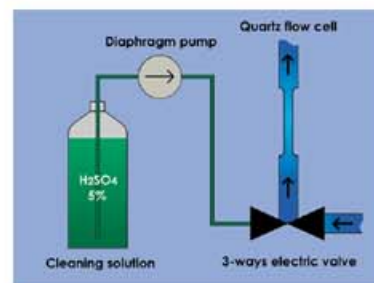
Automatic Cleaning System

One time a day, a low cost cleaning solution (5% sulphuric acid) is automatically injected on the flow cell to clean it.

An auto-zero is performed at the same time.

The autonomy is about 2 weeks with the built-in 2-litres tank.

An alarm is generated when the cleaning solution tank is empty.



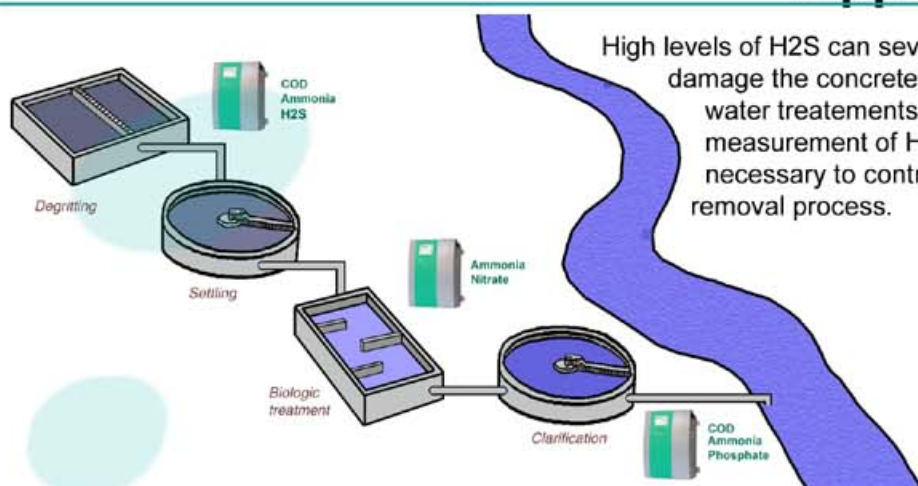
Operating Cost

The operating cost is limited to the refilling of the 2-litres tank of cleaning

solution every 2 weeks with 5% sulphuric acid on distilled water.

It can be estimated to about US\$ 100 per year including labour.

Application on Waste Water



High levels of H₂S can severely damage the concrete of waste water treatments plants. The measurement of H₂S is necessary to control a H₂S removal process.

The measurement on the gaseous phase avoids any interference with turbidity or suspended solid and the use of large bore tubing make possible the measurement on activated sludge.

The automatic cleaning system maintains the tubing clean.



Comparative table

Method	UV absorption (UV400)	Specific electrode	Colorimetry
Measuring time	5 minutes	> 5 minutes	> 5 minutes
Auto-zero capability	yes	yes	yes
Interference with color or turbidity	no	no	yes
Standard solution	no need	inevitable(drift)	yes
Expensive or specific reagents	no	yes	yes
Periodic change of electrode or lamp or parts	no	yes	yes
Maintenance	low	high	high
Filtering	no need	inevitable on waste water	inevitable on waste water
Automatic cleaning system	yes		
Operating cost	low	medium	high
Size	compact	big	big
Weight	16/30 kg approx.	> 30 kg	> 30 kg
Transportable by car or passenger plane	yes	no	no
Installation time	few minutes	hours	hours

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