

## TECHNICAL MANUAL

### Ammonium ions in water

#### *Ammonium ions analyser AM200*



*AM200 analyser*

## Summary

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# 1 Technical description of the proposal

## 1.1 Detailed description of the monitoring instrument

### 1.1.1 Technology

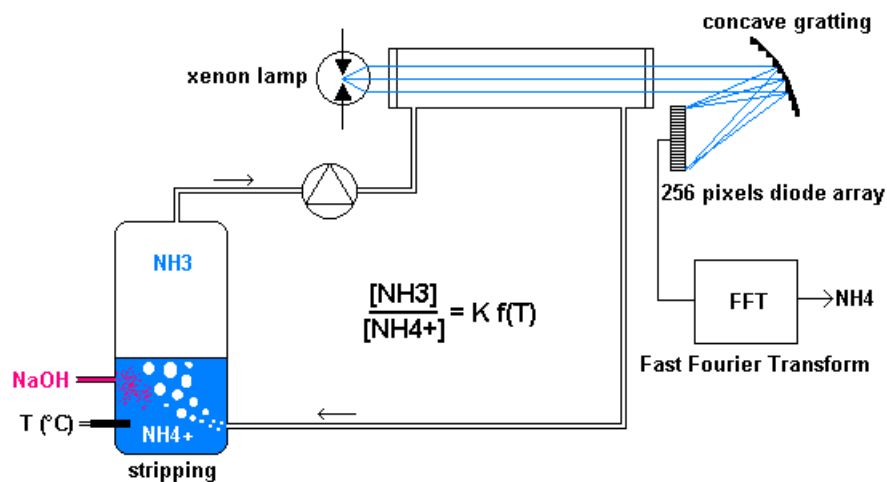
The AM200 analyser has been developed to match with most of applications where a continuous analysis of  $\text{NH}_4^+$  in water is necessary.

The AM200 uses a UV spectrophotometric measurement method. This very reliable method gives the AM200 the advantage of a very long term stability of the measurements and makes the analyser insensitive to probe damage due to aggressive water.

A very low amount of NaOH (1 mL of diluted NaOH solution) is first injected in sampled water in order to perform the measurement. The chemical equilibrium between  $\text{NH}_4^+$  and  $\text{NH}_3$  in water is displaced in favour of  $\text{NH}_3$  because of the pH. This displacement of equilibrium is pretty total if  $\text{pH} > 12$  and causes  $\text{NH}_3$  to give off from the solution. A certain amount of  $\text{NH}_3$  depending on temperature passes in gas phase and UV spectrometric measurement is then performed on the gas.

HENRY's law related to liquid/gas equilibrium is then applied and allows the precise determination of the amount of ammonium present in water by the analysis of outgassed  $\text{NH}_3$

#### Measurement principle



The AM200 is a multi-channel spectrometer which analyses the whole spectrum of  $\text{NH}_3$ . A diode array detector coupled with a high resolution mono-chromator gives the analyser the required accuracy.

The identification of the ammonia spectrum is realized thanks to a mathematical processing called Fast Fourier Transform (FFT) which allows extracting from the crude spectrum of analysed atmosphere the only components typical of ammonia.

The UV source of the analyser is a xenon lamp which is ensured a very low energy consumption and a long life time (about ten years if a measurement is made every 5 minutes) thanks to a specially designed powering mode. Many successive flashes are started for each analysis and the mean of all the results is calculated by the analyser in order to ensure the perfect reproducibility of the measurements.

The lamp parameters are controlled all along the measurement cycle. This gives the analyser a very good reliability.

A LCD panel displays the measured concentration of  $\text{NH}_4^+$  ions and an historical recording of the previous measurements.

The measurement results can be remotely transmitted using a 4 - 20 mA output. The variation range of this output can be set by the user.

During a measurement cycle, a synoptic drawing shows all steps of the cycle on the screen. If any fault occurs during the cycle (lamp signal fault, etc...) faulty component is indicated and the nature of the fault is described.

The entire hydraulic network is equipped with large diameter tubes which allow AM200 to perform measurements on filtered and unfiltered water.

### 1.1.2 Range and accuracy

The AM200 analyser can be set for several measurement ranges:

- 0.1 - 20 mg/L  $\text{NH}_4^+$
- 0.2 - 1000 mg/L  $\text{NH}_4^+$

The typical measurement repeatability is +/-0.15 mg/L at 0.5 mg/L and +/-0.5 mg/L at 10 mg/L.

The detection limit is 0.15 mg/L. The initial calibration accuracy is within 4%

### 1.1.3 Measurements and recording

The AM200 can make an analysis every 3 minutes. The time interval between measurements can be set minute by minute up to 12 hours.

The measurements performed in the automatic mode are automatically stored in an internal memory. In the manual mode, a special key on the front panel allows the operator to store the value in the memory if desired. So, the AM200 analyser has the advantages of a digital datalogger. Each stored event contains:

- Date and time of the measurement,
- Measurement result expressed in mg/L  $\text{NH}_4^+$  or in mg/L (N)  $\text{NH}_4^+$

### 1.1.4 Transmission of stored results

Stored measurements may be transferred using three methods:

- Directly using the RS232 link by connecting the analyser to a PC computer equipped with WINDOWS,
- via an analogical 4 - 20 mA output connected to the transmission system.

### 1.1.5 Energy

The AM200 is operated using mains 110 – 240 VAC, 50 – 60 Hz.

In the standard version a 12 VDC built-in battery supplies the power in the case of mains failure (optional in the ECO version).

### 1.1.6 Alarm Relays

AM200 analysers are equipped with three alarm relays NO/ NC. A high threshold one and a low threshold one which can be programmed by the user using the keyboard of the analyser, the third one is a default relay.

### **1.1.7 Technical reliability**

The measurement realized by AM200 analysers is not based on a chemical or on a physicochemical reaction but on a physical principle. The only reagent that is required is the NaOH solution that increases the pH of water. No contact between the water which is analysed and the measurement probe is required and therefore the measurement probe cannot be damaged by aggressive water. The only parts in contact with water are the feeding tubes (large diameter) and the glass stripping chamber used to realize the liquid / gas equilibrium.

As the measurement is performed on the gas phase there is no influence of the turbidity of water.

As the pH of water is kept high, some parasitic depositions of carbonates may occur on the walls of the Vigreux tube. They do not influence the measurements but could be a source of problems over long periods of time if they become thick. An automatic cleaning system maintains the system's measurement capacity over long periods of time.

The automatic zeroing is performed before each measurement.

This concept allows our analysers to work in isolated sites with very high reliability and reproducibility. The AM200 do not need compressed air, distilled water or standard solution for its current operation. No daily re-calibration is necessary.

Any unreliable measurement due to a failure of the measurement cycle produces an error message on the measurement frame and activates the default relay of the analyser.

A journal of events which can be read on a PC records the date and the time of all events (excepting measurements) occurring on the analyser: cleaning cycle, error measurements, potential communications or messages of the operator using the RS232 link.

Measurements, which are realised in automatic mode or manual mode, can be recorded in a static internal memory thus giving to the AM200 the advantages of a system of data acquisition

### **1.1.8 Hydraulic connections**

The hydraulic connections use double ring fittings. The fittings material is SS316L, but could be replaced by PP for applications in sea water (on demand).

If the optional peristaltic sampling pump is used, the input fitting is a PE nut for smooth tube.

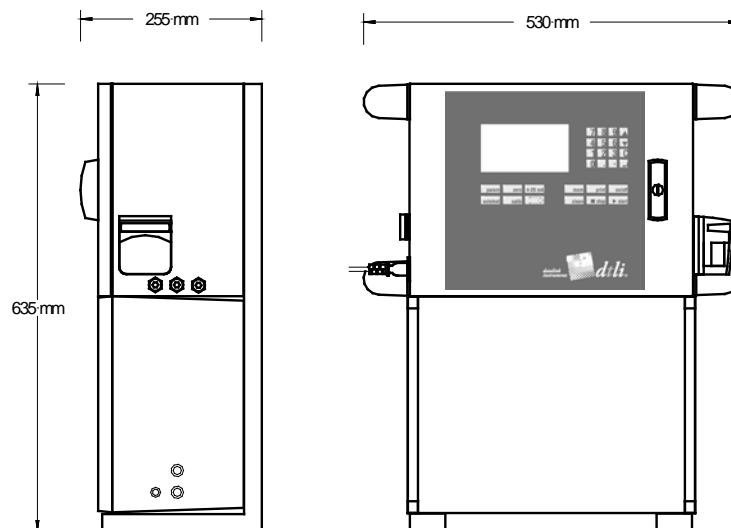
The water outlet connector is a fast connecting fitting for smooth tube.

### **1.1.9 Consumables**

No expensive reagent is required for the measurement. The only product is a solution of NaOH diluted to 10% in water. It is the same for the cleaning solution for the glass stripping chamber (hydrochloric acid or sulphuric acid at 1% in water).

## 1.2 Summarized characteristics

<i>Weight :</i>	20 Kg
<i>Range :</i>	0.1 – 20 mg/L (clean water) 0 – 1000 mg/L (effluent, waste water...)
<i>Energy :</i>	100-240V 50/60 Hz 60 W + internal battery 12 V
<i>Outputs :</i>	4-20 mA isolated, 12 bits resolution High threshold/low threshold relay Alarm default relay
<i>Enclosure :</i>	Watertight IP55 Painted steel box for electronics and spectrophotometer. Polyester IP65 enclosure for hydraulic system.
<i>Communication :</i>	RS232 or RS485 (on demand) for PC, or MODBUS
<i>Water flow rate :</i>	typical 0.6 L/mn
<i>Measurement cell volume :</i>	50 mL
<i>Sample temperature :</i>	> 3 to 40°C (in all the cases the temperature of measured water must be lower than that of the air surrounding the analyser).
<i>Sample pressure :</i>	No pressure if sampling pump 0.1 to 1 bar without sampling pump



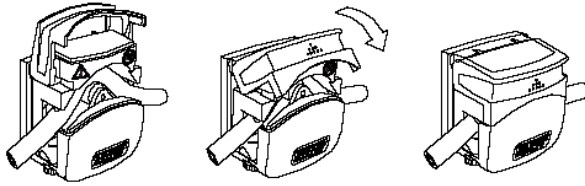
## 2 Possible options

### 2.1 Possible options for both standard and ECO version

#### 2.1.1 Built-in peristaltic sampling pump

It is supplied with power by the battery of the analyser and can be either manually or automatically operated, using the keyboard of the analyser.

The pump is delivered with a five meters silicone tube and a input strainer. The pumping rate is 0.5 L per minute and the pumping is efficient up to five meters high maximum.



### 2.2 Possible option for ECO version only

#### 2.2.1 Built-in battery

Give the analyser a total autonomy that allows mains short breakdown protection or use on the field without external energy power.

### 2.3 Possible option for standard version only

#### 2.3.1 Remote measurement command

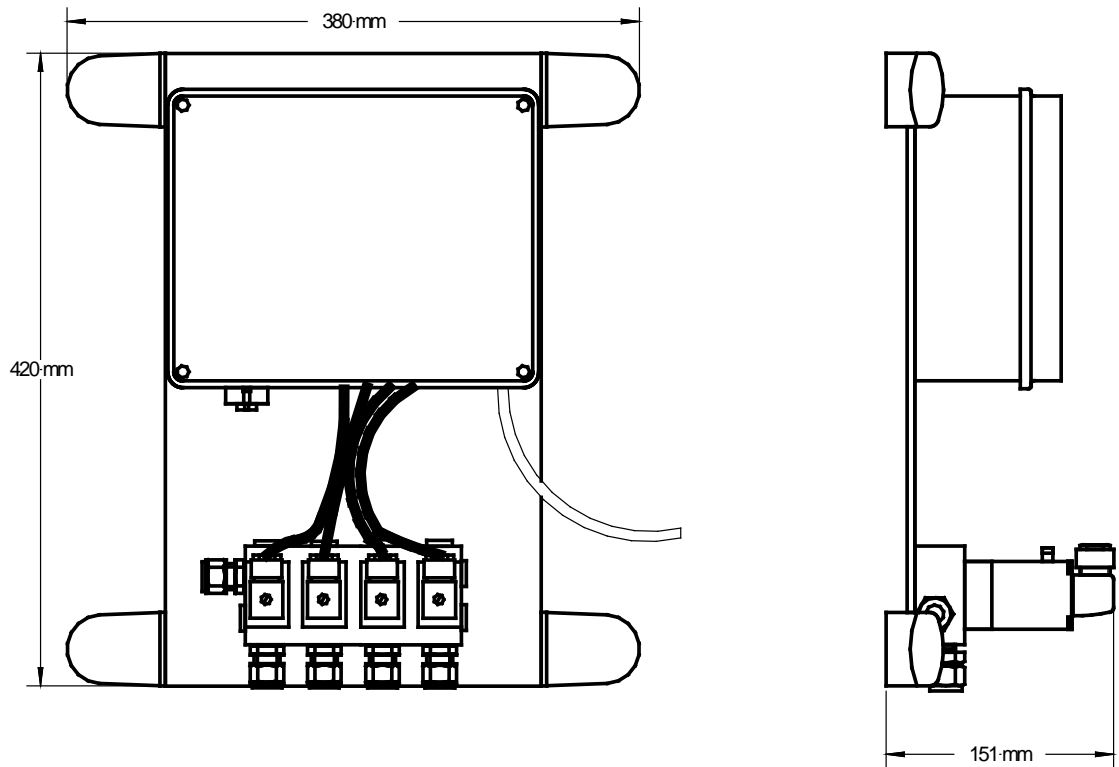
This option allows to start a measurement cycle by activating an analog input with a voltage pulse. This is useful when the analyser is integrated in a system monitored by a PLC.

An output contact is activated when the analyser is ready for a measurement command. If the analyser is not ready (cleaning cycle or previous measurement cycle still in process, keyboard being used) the output contact is disabled

### 2.3.2 Four channel multiplexing system

This option allows to analyse up to four different water networks with the same analyser.


When a measurement cycle is started, all water channels are successively analysed. The water flowing time must be programmed on each channel. As soon as a channel is started on the analyser, the corresponding pump (or electric valve) is activated during the flowing time which has been previously programmed.



















Four 4 – 20 mA outputs are available on the device. Each output is assigned to a water inlet. The four outputs are supplied continuously and maintained at the last measured value for each corresponding channel.



## 2.4 Standard / Classeco (ECO) sum-up and comparison

	Included
	Optional
	Not Available

	STANDARD VERSION	ECO VERSION
<i>Dimensions</i>		
<i>Weight :</i>	20 Kg	20 Kg
<i>Length: (mm)</i>	530	530
<i>Height: (mm)</i>	635	635
<i>Width: (mm)</i>	255	255
<i>Features:</i>		
Watertight IP55 Painted steel box for electronics and spectrophotometer.		
Polyester IP65 enclosure for hydraulic system.		
<i>Automatic chemical Cleaning System</i>		
<i>Datalogger Data compatible with standard worksheets, particularly Excel® to obtain graphs easily.</i>		
<i>Digital and graphic Display</i>		
<i>Feet and Cleaning system Tank Holder</i>		
<i>Peristaltic sampling pump</i>		
<i>Water presence detector</i>		

<i>Additional Parameter (up to 4 parameters per analyser)</i>	-	✗
<i>Multiplexing System (Up to 4 channels)</i>	-	✗
<i>Remote measurement command</i>	-	✗
<i>Power:</i>		
100-240V 50/60 Hz 60 W	✓	✓
Internal 12V battery	✓	-
External 12V / 24V Battery Powering mode	✓	✓
DC-DC Converter	-	-
<i>Outputs and Communication:</i>		
4-20 mA isolated output	✓	✓
High / Low Threshold Relay	✓	✓
Default Alarm Relay	✓	✓
RS232 output	✓	-
RS485 output	-	-

## **3 Recommendations for the maintenance and routine checking**

### **3.1 Soft Checking recommendations**

#### **3.1.1 Description**

Any measurement system or automatic on-line analysis must be checked out regularly without a corrective operation is necessarily carried out.

The AM200 analyser is equipped with a system of self-monitoring making it possible to alert a teleprocessing centre by the activation of a default relay. This relay will act if the physical and electronic conditions of realization of a correct measurement are not met.

The automatism discharges the operators from the repetitive operations, but a human control remains however essential.

It breaks up as follows:

- Visual checking of the water pipes state (clogging) and glass stripping chamber
- Possible Replacement of the stripping glass chamber for its cleaning at the laboratory
- Starting a manual cleaning cycle
- Visual checking of the possible presence of traces of condensation in the air pipes.
- Starting a manual measurement to test measurement cycle on the process water.
- Giving-on the level of the tank of cleaning solution and sodium hydroxide
- Replacement of the section of the water pipe which is in the jaws of the peristaltic pump.

#### **3.1.2 Periodicity**

Monthly.

#### **3.1.3 Duration**

Less than 30 mn.

#### **3.1.4 Operator**

Local operator.

### **3.2 Calibration checking**

#### **3.2.1 Description**

This operation is added to the intervention of current control. It consists in taking a manual measurement on a sample of known value or a standard solution of ammonium chloride in water. In the event of variation higher than the accepted limit, it is necessary to correct the calibration of the analyser by using the sample known as standard. This last operation is not very probable concerning the AM200, which by design presents only one very weak drift of sensitivity.

#### **3.2.2 Periodicity**

Every 2 months.

#### **3.2.3 Duration**

Less than 15 mn.

### **3.2.4 Operator**

Local operator.

## **3.3 Yearly preventive maintenance**

### **3.3.1 Description**

This operation is optional but strongly recommended. If controls described above are regularly carried out, the performances of analysis of the instrument will be maintained.

From our experience, we notice that the instruments which are subjected to this annual intervention have a greater reliability as the electronic and optical parameters are then readjusted with their initial values. Moreover breakdowns can be prevented (acid pump default for example).

A detailed attention is given to the pumps and pipes during this intervention.

### **3.3.2 Periodicity (facultative)**

Yearly

### **3.3.3 Duration**

1 day per analyser + travel.

### **3.3.4 Operator**

DTLI qualified technician.

## **4 Limits of use**

### **4.1 Electromagnetic compliance**

The SU200 design was improved and controlled in test bench. The electromagnetic compliance was fully checked in industrial environment. The CE standards are met.

In order to comply with the CE standards, the 4-20 mA and relays wiring should be made using shielded cables. The shield should be connected to the housing of the analyser.

### **4.2 Temperature**

The AM200 analyser is designed to function on water liquidate whose temperature must necessarily be between 3 and 40°C. Apart from this range of temperature, measurements will be less reliable.

Freezing in the piping of evacuation can lead to a water exhaust clogging situation. A risk of water excess in the analyser is to be feared under such conditions. It is important to channel water of evacuation so that it does not remain in piping.

### **4.3 Interference**

The principle of measurement does not show particular interferences in sewage work application.