



A measuring station under a bridge

## ATMS600v3

**SensAqua AS**  
Remote sensing in aquatic systems



**The SensAqua Automatic Trace Metal monitoring System for remote, unattended, automatic and continuous monitoring of heavy metals**

### The ATMS600v3 Technical Specifications

The ATMS600v3 consists of one cabinet, inside is a smaller unit with the main electronics and the water system with pumping stirring and draining and the measuring cell with electrodes. As an option, an additional water system can be connected.

The ATMS600 is run by a microprocessor unit and not by a computer. However, a computer is needed for starting up, input/output and graphical presentations.

#### Electrode system:

Patented Alloys  
Silver/Silver Chloride  
Platinum

**Software:** POS V1.5 (or above) running  
Windows 2000™/XP/Vista/7 (32 or 64 bit)

**Data storage:** Compact Flash Card (CF) or computer

**Dimension:** 40 x 30 x 17 cm  
(ATMS600v3D 60 x 30 x 17 cm)

**Weight:** 8 kg, (ATMS600D 12 kg)

**Power Supply:** 12 V DC (or adapter)

**Polarization:** Voltage range:  $\pm 5$  V

Sweep Types: Differential Pulse/SquareWave/Staircase

Sweep Direction: Anodic/Cathodic

Min. Sweep Step Height: 5/8 mV

Min Sweep Step duration: 10 ms

#### Measurements

Input impedance:  $> 10^9 \Omega$

Current ranges:  $\pm 2 \mu A$ ,  $20 \mu A$ ,  $200 \mu A$

Resolution Current measurement: 16-bit

Resolution Feedback: 16-bit

#### Voltammetry

Linear Scan, CV, Differential Pulse, Square Wave,  
Anodic/Cathodic Stripping

#### Communication

USB/RS232

Communication over Modbus in RTU mode

Mode LAN Data delivery through web services or TCP direct

4 - 20 mA

SMS warning



From an integrated measuring station in Poland



No liquid mercury  
No mercury salts  
No toxic materials

ATMS600v3

**Also available as a dual-cell version, ATMS600v3D, and as a non-automatic version for laboratory use, LTMS600v3**

- ◆ Quantification of several different metals using one or two sensors (Zn, Pb, Cd, Ni, Co, Tl, Hg, As etc.)
- ◆ Environmental friendly non-toxic electrodes and chemicals
- ◆ High sensitivity, down to 1 ppb (1  $\mu g/L$ ), with typical measuring accuracy  $\pm 10\%$  at 10 ppb
- ◆ Automatic updating of software and firmware on Internet
- ◆ Stable over time, typical one month without attendance
- ◆ Simple maintenance, with all electronics on one microprocessor card
- ◆ Short time for each analysis (2-5 minutes)
- ◆ Almost neglectable operating costs and maintenance
- ◆ Compact wall version, but can also be supplied as a complete floor cabinet or as a simplified version for manual use in a laboratory. Integrated automatic systems can also be offered, also to measure pH, TOC, conductivity etc.
- ◆ User friendly calibration
- ◆ Automated sampling pretreatment and analysis
- ◆ Automatic electrochemical cleaning of electrodes
- ◆ Quantification of various metal forms (species)
- ◆ Small sample volume (35 mL)
- ◆ Simple and user friendly software for equipment control and presentation of results
- ◆ Real time/on-line data presentation, if wanted on the Internet

Further information:

[sensaqua@sensaqua.com](mailto:sensaqua@sensaqua.com)

[www.sensaqua.com](http://www.sensaqua.com)

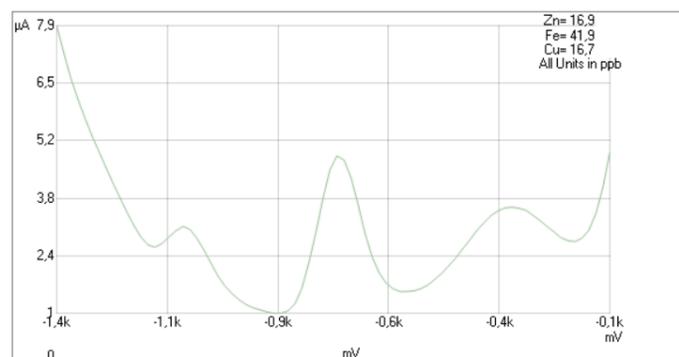
Tel. +47 21 68 79 29

VOLTAMMETRY is an electroanalytical method where metals or other species are determined through their redox and diffusion properties, like. for the reduction of zinc ions or oxidation of solid zinc metal to  $Zn^{2+}$  ions:



This is a very sensitive analysis technique that is very suited for the detection of heavy metals for online and automatic monitoring as no other methods can be used for such purposes. Voltammetry is fast, simple and has low analysis costs. The instruments required are also low cost relative to ICP, ICP-MS and chromatographic methods. The method has good sensitivity and a detection limit for the most important heavy metals in the lower ppb region or lower. As a result, the method is suitable for use in analyses of drinking water, industrial processes etc.

The main advantage with this method, compared with other methods, is that this can be used for unmanned remote monitoring



A typical voltammetric curve

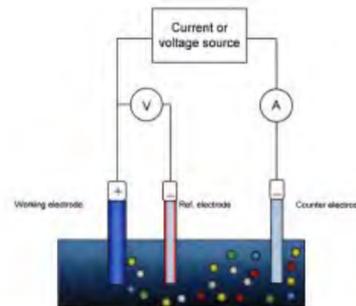
Five requirements are needed for making such automatic voltammetric analyses useful:

1. Sufficient high overvoltage to allow the measurements without interferences from hydrogen gas formation
2. Sufficient long term stability without need of maintenance
3. Sufficient sensitivity to allow monitoring of trace pollutants
4. That non-toxic material is used (very important for off-laboratory methods)
5. Not too expensive material needed

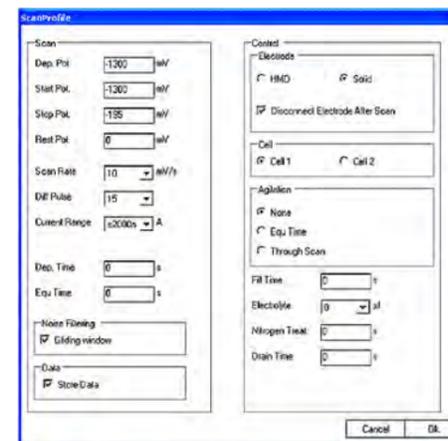
To follow an automatic monitoring station see:  
[www.sensaqua.com/ATMS](http://www.sensaqua.com/ATMS)



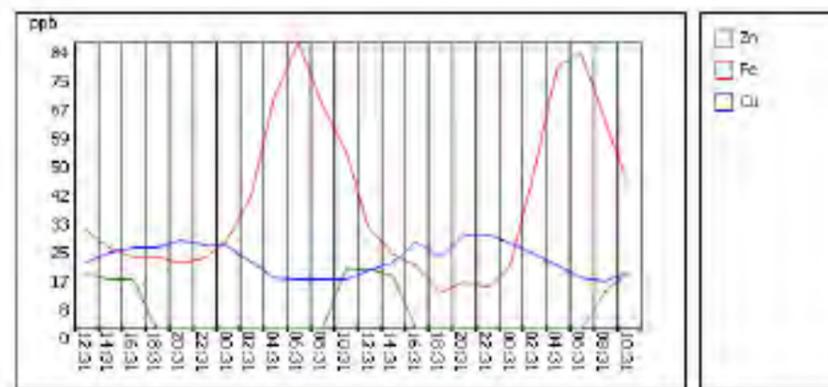
Electrodes



Measuring cell with electrodes



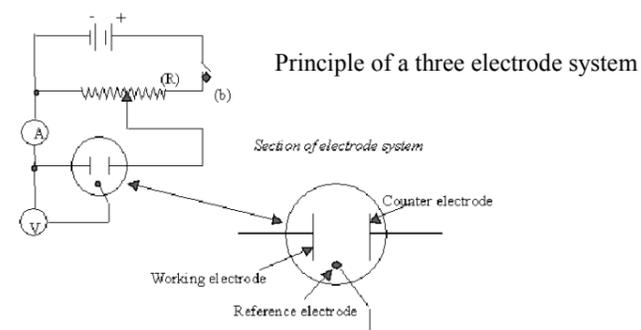
From the programming panel



Typical results of measurements over time in a river close to a mining area in Norway

Actual groups of users

- ◆ Private and public institutions – surveillance of quality of municipal drinking water and effluents
- ◆ Already established automatic monitoring stations, also to include heavy metals
- ◆ Metal and metallurgical industry
- ◆ Terminated industrial areas and mines
- ◆ Construction work
- ◆ Oil and shipping
- ◆ Solid waste and incineration plants
- ◆ Sea farming
- ◆ Fundamental research and laboratory use



A three-electrode system with a working electrode, a reference electrode and a counter electrode is used. The reference electrode is used to control a given potential over time profile vs. the working electrode at zero current. The current flow is measured between the working electrode and the counter electrode, and a voltage is applied there to obtain the mentioned time profile.

There are many different voltammetric techniques, depending upon the given time profile. The most common are Linear Scan Voltammetry, Square Wave Voltammetry and Differential Pulse Voltammetry.

Stripping Voltammetry is amongst the most sensitive procedures when combined with one of the mentioned techniques. Using this method, the metal is initially reduced to the solid metal that is deposited on the surface of the working electrode and thus enriched, followed by an oxidation of that metal. Higher sensitivity can be achieved by increasing the deposition time. One serious problem in voltammetry is the side reaction:



as this will give an interfering electrical current. This current has traditionally been suppressed by using a measuring electrode of liquid mercury or a mercury film electrode, this in turn being made from a mercury salt. This is because mercury has a very high overpotential relative to hydrogen.

Neither liquid mercury nor a mercury salt can be accepted due to the toxicity, in particular for off-laboratory use. Extensive research has been performed internationally for years to find alternative electrode materials.

The breakthrough came in 2000 when researchers at Norwegian University of Science and Technology - NTNU, Department of Chemistry, Trondheim, Norway found that certain solid alloys had positive properties for suppressing the mentioned hydrogen reaction. This has been further developed and is patented internationally.

The ATMS for remotely and unattended to monitor heavy metals in water and effluents is based on comprehensive documentation, publications and presentations being available on request.



## ATMS600v3

**General detection limit in natural water (drinking water and pure lake water) is in the low ppb area. Some approximate guiding electro labile values using differential pulse anodic stripping voltammetry**

| Metal to detect | Working Electrode  | Supporting electrolyte (high purity chemicals needed)            | $E_p$ (V) <sup>1)</sup> | Det. Limit <sup>2)</sup> | Ligand to add     |
|-----------------|--------------------|--|-------------------------|--------------------------|-------------------|
| Mn(II)          | Solid silver alloy | Ammonium chloride buffer (pH 6.4) (or NH <sub>4</sub> Cl 0.02 M) | -1.45                   | < 5 ppb                  |                   |
| Zn(II)          | Solid silver alloy | Ammonium chloride buffer (pH 6.4) (or NH <sub>4</sub> Cl 0.02 M) | -1.05                   | < 5 ppb                  |                   |
| Cd(II)          | Solid silver alloy | Ammonium chloride buffer (pH 6.4) (or NH <sub>4</sub> Cl 0.02 M) | -0.65                   | < 5 ppb                  |                   |
| Pb(II)          | Solid silver alloy | Ammonium chloride buffer (pH 6.4) (or NH <sub>4</sub> Cl 0.02 M) | -0.50                   | < 2 ppb                  |                   |
| Tl(I)           | Solid silver alloy | Acetate buffer pH 6.4  | -0.75                   | < 5 ppb                  |                   |
| Bi(III)         | Solid silver alloy | Ammonium chloride buffer (pH 3)(or NH <sub>4</sub> Cl 0.02 M)    | -0.35                   | < 10 ppb                 |                   |
| Cu(II)          | Solid gold alloy   | HCl (0.01 M)   | +0.25                   | < 1 ppb                  |                   |
| Ni(II)          | Solid silver alloy | Ammonium chloride buffer (pH 9.6)                                | -0.95                   | < 2 ppb                  | DMG <sup>4)</sup> |
| Co(II)          | Solid silver alloy | Ammonium chloride buffer (pH 9.6)                                | -1.15                   | < 2 ppb                  | DMG <sup>4)</sup> |
| Hg(II)          | Solid gold alloy   | HNO <sub>3</sub> (10 mM) and HCl (10 mM)                         | +0.55                   | < 1 ppb                  |                   |
| Cr(VI)          | Solid gold alloy   | HCl (0.1 M)  | +0.25                   | < 5 ppb                  |                   |
| As(III)         | Solid gold alloy   | HCl (0.2 M)  | +0.15                   | < 1 ppb                  |                   |
| Fe(II)/Fe(III)  | Solid silver alloy | Tri-sodium citrate 5.5 hydrate or NH <sub>4</sub> Cl (0.02 M)    | -0.80                   | < 2 ppb                  |                   |

DMG = Dimethylglyoxime. Deposition time = 360 s<sup>2)</sup>

<sup>1)</sup> Peak potentials ( $E_p$ ) might differ in accordance to used reference electrode (RE), (table values against newly made Ag-AgCl/KCl 3 M RE). (Counter electrode is Platinum).

<sup>2)</sup> For increased sensitivity the deposition time can be expended, but deposition time longer than 1800 seconds is not recommended. Further increase of the sensitivity can also be obtained by using square wave voltammetry.

<sup>3)</sup> By adsorptive differential pulse cathodic stripping voltammetry (deposition potential at – 0.75 V for 60 s).

<sup>4)</sup> If Ni(II) and Co(II) is present simultaneously in the sample; use a mixture of DMG (0.3 mM), oxine (0.02 mM) and nioxime (0.01 mM).

(Maximum number of metals detected simultaneously is five metal, including Mn(II), Zn(II), Cd(II), Pb(II) and Cu(II) (on Solid silver alloy Working Electrode).