

μDOES® Micro-Discharge Optical Emission Spectroscopy

ADVANCED MEASUREMENT OF BATTERY METALS IN HYDROMETALLURGICAL PROCESSES



THEY CALL IT A GAME CHANGER

Sensmet's patented breakthrough technology, Micro-Discharge Optical Emission Spectroscopy, μ DOES[®], enables online analysis of dissolved metals in aqueous hydrometallurgical process streams.

The μ DOES[®] represents a rethinking of the principles of the established ICP-OES offline laboratory technique and is designed to meet the robustness requirement for continuous and fully automated industrial process monitoring. Important applications include continuous monitoring of lithium and other battery metals during their hydrometallurgical production and recycling.

μ DOES[®] Analyser benefits:

- Continuous, quantitative real-time data on metal concentrations offers valuable insight into the process efficiency and product quality.
- Introducing a fully automated μ DOES[®] system alleviates the laboratory's workload and reduces the use of typical laboratory consumables such as carrier gas.
- Argon use is a major contributor to the overall operating cost of an ICP-OES. The Sensmet μ DOES[®] enables cost-effective, carrier gas free operation, 24/7.
- High analytical performance.



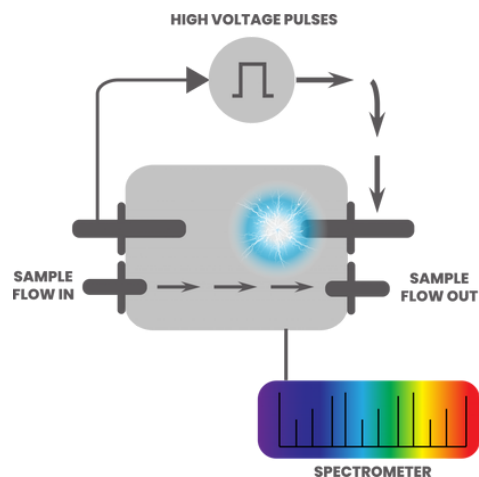
THE μ DOES[®] PRINCIPLE

The patented μ DOES[®] technology is based on atomic emission spectroscopy.

A micro-discharge, i.e., an electric spark, is uniquely created directly inside the aqueous sample. In an instant, a microscopic volume of the fluid surrounding the spark gets flash-heated to a high 10,000 °C temperature.

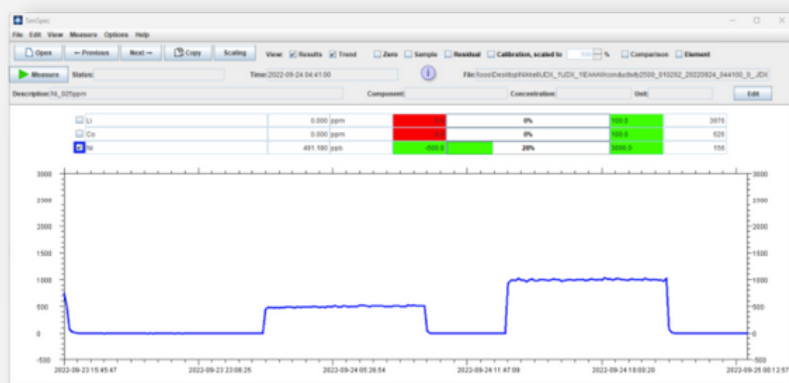
Molecular species in the micro-discharge get dissociated into atoms, followed by excitation of the atoms to their respective higher electronic states. Upon returning to their ground state, atoms release excess energy by emitting light at their characteristic wavelengths.

Measuring the atomic emission spectrum enables quantitative analysis of the metals contained in the sample.



Fully automated system with advanced analytical algorithms

All μ DOES[®] analysers come equipped with the easy-to-use SenSpec[™] software. The advanced algorithms quantify the metal concentrations in the sample, and concentration trends for each metal are presented directly on the local screen. Users have the flexibility to set alarm limits for individual components and monitor system performance effortlessly. The SenSpec[™] software offers comprehensive remote operation capabilities through Modbus TCP/IP.



TIME – THE MOST VALUABLE ASSET

Sensmet μ DOES® is the alternative to expensive and time-consuming laboratory analysis. The other advantages over ICP-OES include:

- Carrier gas free operation
- Internal standards are not necessary
- Torch free operation
- Free from nebuliser issues
- Green Chemistry – no hazardous chemicals
- Optimised for online measurements
- Ease of use



The Sensmet μ DOES® Analyser is a cutting-edge online instrument that precisely quantifies dissolved metal concentrations in aqueous solutions.

When equipped with the Sensmet online dilution unit, the analyser system performs fully automated monitoring, ensuring consistency and reliability in metal concentration measurements 24/7.

The instrument can digitally deliver the analytical results to a distributed control system (DCS) via Modbus.

EXTRACTIVE SAMPLING

The Sensmet μ DOES® operates as an extractive analyser, necessitating the transportation of a small portion of the liquid stream from the industrial process to the analyser system.

Preceding the analysis, the Sensmet system employs an automated dilution unit to dilute the sample liquid with high-quality demineralized water. After dilution, the metal concentrations in the liquid may span from $\mu\text{g/L}$ concentrations up to several tens of mg/L , contingent on the application.

The diluted sample is automatically transported to the Sensmet μ DOES® analyser via PTFE sample line. To reach high accuracy, the μ DOES® fine-tunes the electrical conductivity of the sample liquid before each measurement by introducing a small amount of acid to the diluted sample.

APPLICATIONS

Black Mass Recycling of Li-Ion Batteries

Ensure that the process of Ni, Co, Mn, and Li removal is progressing as it should. The measurement is precise, and measurement ranges are highly dynamic.

In addition, Sensmet μ DOES® measures the impurity concentrations of Cu, Fe, Al, Zn, Ca, Na, K, and Mg.

Lithium Production

Precipitation of lithium carbonate. Real-time measurement of Na and Li concentrations allows for optimal dosing of chemicals.

Battery Metals in Wastewater

Sensmet customer applications have included Nickel, Copper, and Lithium in Wastewater.

Potash Production

In sulphate potash production, knowing the K, Mg and Na trends and concentrations is important to maintain the optimum crystallisation.

TECHNICAL DATA

Principle of μ DOES®	Optical emission spectroscopy. Electrical micro-discharge is generated directly in the sample liquid.
Operating system	Linux
Analysis software	SenSpec™
Interfaces	Ethernet
Bus protocol	Modbus TCP/IP
Sample inlets	Four programmable sample inlets for • Sample 1* • Sample 2* • Sample 3* • MilliQ (high quality demineralized water) *if needed, any sample inlet can alternatively be used for automated • QC sample or • acid cleaning
Sampling	Extractive. For automated dilution, a demineralized water supply needed.
Sample line & cuvette materials	Sample lines: PTFE Peristaltic Pump Tubing: Marperene (optional STA-PURE®) Polymer components: PEEK and PTFE cuvette: Quartz
Required fluids	Sample dilution and rinse: high quality demineralized water (MilliQ®) Conductivity adjustment: 1%-5% acid – HCl, HNO₃ or H₂SO₄ QC standard: recommended Internal standard: supported, typically not needed.
Operation pressure	Ambient pressure
Operation temperature	Air-conditioned environment (recommendation 23 °C +/- 2 °C)
Operation humidity	Non-condensing
Power supply	100 – 240 VAC, 45 – 65 Hz
Average power consumption	< 300 W
Analyser dimensions (W x H x D)	600 mm x 1 360 mm x 840 mm 600 mm x 1 200 mm x 840 mm without wheels
Analyser weight	140 kg
Product compliance	CE • EMC Directive 2014/30/EU • Low Voltage Directive 2016/35/EU
Typical Maintenance	Visual inspection: once per week Replacement of Peristaltic Pump Tubing: 3 months Replacement of electrodes: 6 months Other: yearly maintenance

METALS COVERED BY μ DOES®

Sensmet μ DOES® is designed to simultaneously measure the concentrations of selected metals across a broad range, spanning from $\mu\text{g/L}$ concentrations to mg/L levels. While the primary μ DOES® applications are centred around battery metals, it is noteworthy that Sensmet's application laboratory has successfully tested Sensmet μ DOES® for a diverse array of metals, including:

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| ✓ Aluminium (Al) | ✓ Manganese (Mn) |
| ✓ Barium (Ba) | ✓ Mercury (Hg) |
| ✓ Cadmium (Cd) | ✓ Nickel (Ni) |
| ✓ Calcium (Ca) | ✓ Potassium (K) |
| ✓ Chromium (Cr) | ✓ Rubidium (Rb) |
| ✓ Cobalt (Co) | ✓ Scandium (Sc) |
| ✓ Copper (Cu) | ✓ Silver (Ag) |
| ✓ Erbium (Er) | ✓ Sodium (Na) |
| ✓ Gallium (Ga) | ✓ Strontium (Sr) |
| ✓ Gold (Au) | ✓ Thulium (Tm) |
| ✓ Indium (In) | ✓ Titanium (Ti) |
| ✓ Iron (Fe) | ✓ Vanadium (V) |
| ✓ Lead (Pb) | ✓ Ytterbium (Yb) |
| ✓ Lithium (Li) | ✓ Yttrium (Y) |
| ✓ Magnesium (Mg) | ✓ Zinc (Zn) |



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