



Dissolved Metal Analysis with 3Awater Multimetal Water Analysis System (MWAS) and Hitachi X-MET8000

Introduction

Conventional dissolved metal analysis of waters involves sampling followed by analysis with laboratory instruments such as ICP-MS, ICP-OES, or AAS. The inherent delay between sampling and obtaining results can be considerably long due to the logistics involved in delivering samples to the laboratory.

3Awater Multimetal Water Analysis System (MWAS) is a portable and fast system to analyse dissolved metals in waters. It employs Hitachi X-MET8000 X-ray fluorescence spectrometer (XRF) for the quantification. The water quality information provided by MWAS on-site practically in real-time enables fast decision-making, for example, for industrial water management purposes without delays unavoidable in conventional laboratory analysis.

Instrumentation and principle

MWAS water analysis requires three parts 1) Set of Consumables, 2) an Accessory Kit both provided by 3Awater and 3) Hitachi X-MET8000 XRF.

The core of MWAS analysis is a nanomaterial-based permeable Metal Collector included in the Set of Consumables. A syringe and a syringe pump are used to controllably push either 10 ml or 50 ml water sample through a 0.45 μm syringe filter and the Metal Collector. Solid particles are removed by the syringe filter and dissolved metal ions are gathered to the Metal Collector. Correspondingly, similar syringe filters are used in sample preparation for standard dissolved metal analysis in laboratories.

The dissolved metals are captured into a solid form and concentrated in the Metal Collector 200 – 1000 -fold compared to the water sample. Metals are quantified from the Metal Collector surface with X-MET8000 spectrometer in a radiation shield, which is also working as a sample holder. Integrated calibrations in XRF show the results in ppm on the screen. The syringe pump and the radiation shield are included in the backpack included in the Accessory Kit. Click the following link to see a video demonstration of the analysis; <https://www.youtube.com/watch?v=-P2A7t6j6is>.

Calibrations and Analytical performance

Default calibrations:

MWAS is delivered with default calibrations integrated in the X-MET8000 for the analysis of Mn, Ni, Cu, Zn, Pb and U with 10 ml sample volume. These calibrations are intended for analysis of range of natural waters limited in pH between 3.5 – 7.5 and electric conductivity (EC) < 1000 µS/cm. Portable pH and EC meter must be used to verify suitable water conditions. The example of the detection limits is presented in Table 1 and validation against analyses in accredited laboratories in Figure 1.

| Element | Mn | Ni | Cu | Zn | Pb | U |
|-------------------|----|----|----|----|----|----|
| LoD (µg/l or ppb) | 60 | 30 | 30 | 20 | 20 | 30 |

Table 1: Detection limits in relatively clean natural waters for default calibrations (May vary according different XRF model and water conditions)

Customer calibrations:

Complex water chemistry may influence MWAS analysis. 3AWater offers customer calibrations tailored to specific waters of customers to ensure optimal performance outside typical natural water conditions such as acid mine drainage, industrial or process waters. Several other analytes can be added to customer calibration and include lower detection limits with 50 ml samples volume. Tables 2 – 3 show examples of detection limits achieved with customer calibrations prepared for industrial and natural waters.

| Element | Mn | Fe | Co | Ni | Cu | Zn | Pb | U |
|-------------------|-----|-----|-----|-----|----|----|----|----|
| LoD (µg/l or ppb) | 550 | 300 | 200 | 150 | 50 | 20 | 20 | 60 |

Table 2: Example detection limits for an industrial water (pH ~ 8.7 and EC ~ 66 000 µS/cm) 10 ml customer calibration.

| Element | Mn | Co | Ni | Cu | Zn | Pb | U |
|-------------------|----|----|----|----|----|----|----|
| LoD (µg/l or ppb) | 20 | 10 | 8 | 5 | 10 | 7 | 11 |

Table 3: Example detection limits for a natural type of water for 50 ml customer calibration.

Summary

3AWater Multimetal Water Analysis System (MWAS) widens the analytical capabilities of Hitachi X-MET8000 XRF to low concentrations of dissolved metals in waters. The system is fast, easy to operate and reliable with detection limits down to ppb or µg/l level. The calibrations can be tailored for analysis of complex industrial waters or single digit ppb detection limits.

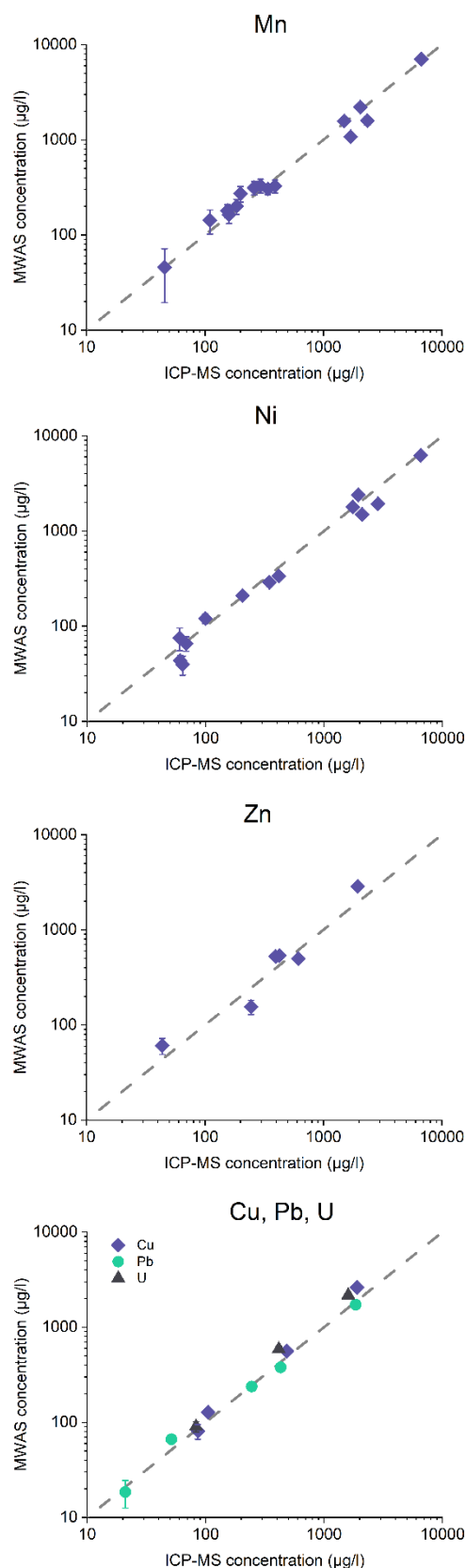


Figure 1: Validation of MWAS default 10 ml calibrations with 18 real mine and environmental water samples (n=10) against accredited laboratory analysis.