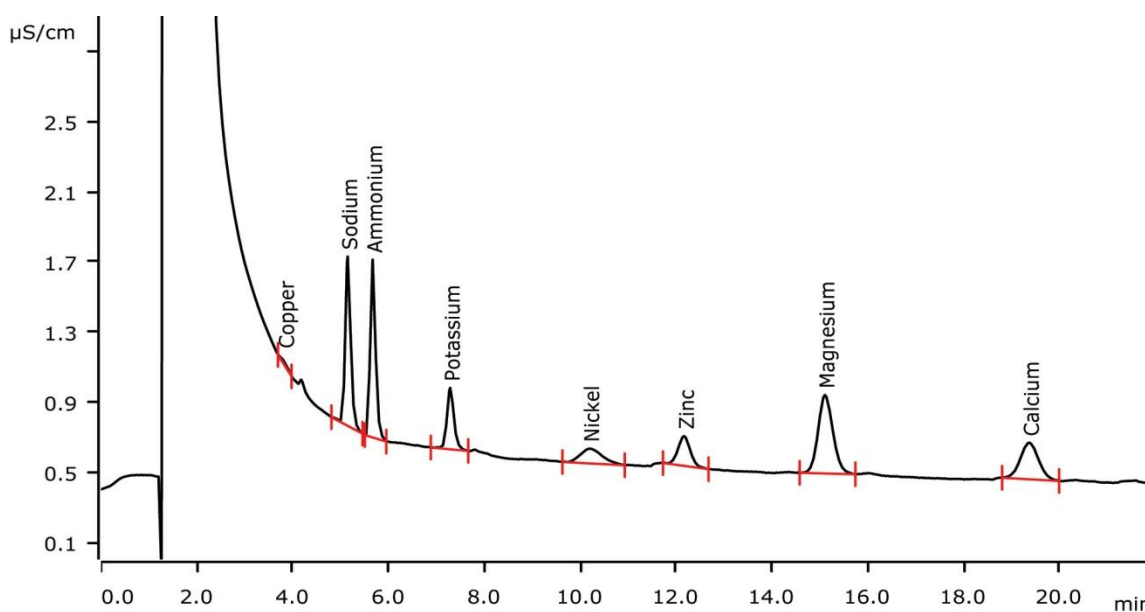


Copper, nickel, zinc, and common cations in the water-steam circuit of a boiling water reactor (BWR)



Water chemistry of the water-steam circuit is crucial for maintaining plant reliability and for ensuring optimal plant operational conditions. Impurities such as corrosion products in ionic, colloidal, or oxide forms are ubiquitous in feedwater, condensate, and reactor coolant. This application shows the determination of sub-ppb levels of Cu, Ni, Zn and standard cations (e.g., Na^+ , NH_4^+ , Mg^{2+} , Ca^{2+}) in the water-steam circuit of a BWR.

Results

Cation	Concentration [$\mu\text{g/L}$]	Cation	Concentration [$\mu\text{g/L}$]
Copper	0.5	Nickel	0.5
Sodium	0.5	Zinc	0.5
Ammonium	0.5	Magnesium	0.5
Potassium	0.5	Calcium	0.5

Sample

Artificial BWR sample matrix

Sample preparation

Inline Preconcentration (MiPCT)

Columns

Metrosep C 4 - 250/2.0	6.1050.230
Metrosep C 4 Guard/2.0	6.1050.600
Metrosep C PCC 1 HC/4.0	6.1010.310

Solutions

Eluent (inline eluent preparation)	2.5 mmol/L nitric acid 0.5 mmol/L oxalic acid
Liquid handling	Ultrapure water

Analysis

Direct conductivity detection

Parameters

Flow rate	0.4 mL/min
Injection volume	9.8 mL (preconcentrated)
P _{max}	25 MPa
Recording time	22 min
Column temperature	32 °C

Instrumentation

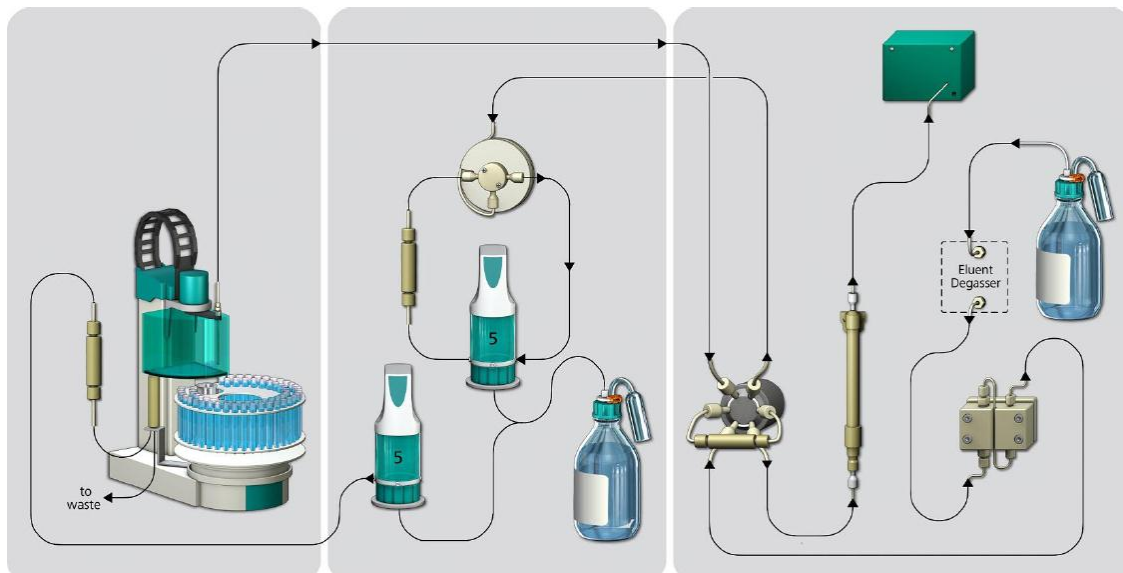
850 Professional IC Cation	2.850.1010
IC Conductivity Detector	2.850.9010
858 Professional Sample Processor	2.858.0010
2 x 800 Dosino (liquid handling)	2.800.0010
849 Level Control for Inline Eluent Preparation	2.849.1030

Calibration MiPCT-ME

Calibration range	Factor of 20
Standard solution:	
All cations	10 µg/L
1. Level	490 µL = 0.5 µg/L
2. Level	980 µL = 1.0 µg/L
3. Level	2450 µL = 2.5 µg/L
4. Level	4900 µL = 5.0 µg/L
5. Level	7350 µL = 7.5 µg/L
6. Level	9800 µL = 10 µg/L



Flow chart



Recovery, reproducibility, and linearity

Cation	Concentration [$\mu\text{g/L}$]	Recovery [%] n = 10	RSD [%] n = 18	Correl. Coef.
Copper	1.0	93.1	6.0	0.9997
Sodium	1.0	93.6	3.5	0.9999
Ammonium	1.0	119.0*	4.2	0.9999
Potassium	1.0	101.4	5.7	0.9997
Nickel	1.0	107.8	4.8	0.9997
Zinc	1.0	96.7	4.9	0.9998
Magnesium	1.0	103.2	3.6	0.9996
Calcium	1.0	102.3	4.4	0.9997

* approximately 0.15 $\mu\text{g/L}$ contribution from system blank