

## **DETERMINATION OF DISSOLVED METALS BY INDUCTIVELY COUPLED PLASMA-OPTICAL EMISSION SPECTROSCOPY (ICP-OES)**

- 1. Principle of Method:** Dissolved metals, S, and P are analyzed by ICP-OES. This instrument is appropriate for the analysis of water samples, aqueous solutions/soil extracts, and acid digests containing HNO<sub>3</sub> or HNO<sub>3</sub>/HCl. This method is appropriate for total dissolved solids (TDS) concentrations <2000 mg/L. This system is not compatible with samples containing hydrofluoric acid, HF, or organic solvents. Samples are aspirated by a nebulizer into an argon plasma, where they are atomized at temperatures of approximately 5500 – 8000 K. Analyte atoms are excited, producing characteristic emission patterns unique to each element. These emission lines are detected by a spectrometer, permitting the simultaneous analysis of several elements at once. An internal standard solution containing yttrium (Y) is used during analysis to correct for matrix effects. Analyte emission lines, viewing positions (radial vs. axial), and sample dilution factors are chosen to minimize inter-element interferences. Elements like Li, Na, K, Mg, and Ca are typically viewed radially to minimize Easily-Ionizable-Element (EIE) interferences.

**Standard Elements:** Na, K, Ca, Mg, Fe, B, Mn, Zn, Cu, Mo, Ni, S, P

**Full List of Elements:** Al, Ag, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Na, Ni, P, Pb, S, Sb, Se, Si, Sn, Sr, Ti, Tl, V, Zn

- 2. Instrumentation Used:**

Thermo iCAP6300 Duo (N. America) inductively coupled plasma-optical emission spectrometer (ICP-OES). Manufactured by Thermo Fisher Corp. Registration No. 441506, SOLAAR House, 19 Mercers Row, Cambridge, CB5 8BZ, United Kingdom, 2012.

- 3. References:**

- 3.1** iCAP 6000 Series ICP-OES Spectrometer Hardware Manual v3.5, Thermo Fisher Scientific, 2010.
- 3.2** iCAP 6000 Series ICP-OES Spectrometer User Guide v2.0, Thermo Fisher Scientific, 2010.
- 3.3** Atomic Emission Spectrometry: Chapter 10 in Principles of Instrumental Analysis, 6<sup>th</sup> Edition. D.a. Skoog, F.J. Holler, S. R. Crouch, Eds. Belmont, CA, USA, 2007. Pgs. 254-280.
- 3.4** EPA 6010d
- 3.5** EPA 200.7

- 4. Standards Used:**

Multi-element certified standard solutions purchased from SCP Scientific are used for calibration, and separate certified multi-element solutions are used as external reference standards. For digestions, certified external reference materials are prepared and analyzed along with samples. The exact standards and reference materials used will depend on the elements analyzed – please inquire for more information.