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Standardization of k₀-NAA for short-lived nuclides using pneumatic carrier facility (PCF) at BARC

Neutron Activation Analysis (NAA) using short-lived radionuclides is advantageous in terms of less turn-around time of analysis. As a part of k0-based NAA (single comparator NAA) standardization program for short-lived nuclides, pneumatic carrier facilities (PCF) at CIRUS and Dhruva reactors of Bhabha Atomic Research Centre (BARC) were characterized by determining sub-cadmium-to-epithermal neutron flux ratio (f) and epithermal neutron flux shape factor (alpha), which are two reactor based input parameters. Bare triple monitor method using 197Au-94Zr-96Zr as well as 197Au-50Cr-98Mo were used for alpha determination since there is a restriction in cadmium mass to be used as a wrapper/cover for sample irradiation. The f-value was calculated using bare bi-isotopic method.

The k0-factors of the short-lived nuclides (half-lives of nuclides 11 s to 60 min) of elements namely F, Se, Sc, Rb, Al, V, Ti, Cu, Ca, Mg, Br, I, Cl and In with respect to gold (197Au) were determined in the present work. Gold standards (5-10 micro gram) were prepared on filter paper matrix. The elemental standards were prepared using primary standards in solid or liquid form and were irradiated with gold standard for 1 min in Dhruva reactor and 1-3 min in CIRUS reactor. The measurement of gamma-rays was carried out using a 40 % relative efficiency HPGe-detector coupled to a digital spectrometer with loss-free counting facility and the sample-to-detector distance was maintained at 10-15 cm distance. The absolute detection efficiency of the detector was obtained using 133Ba and 152Eu multi gamma-ray standard sources. The determined experimental k0-factors of the isotopes were found to be in good agreement with the recommended k0-factors in most of the cases. The k0-factors of isotopes with widely varying Q0 factors with respect to 197Au (15.7) were compared with recent literature values. The method was validated by determining concentrations of elements like Al, V, Ti, Cu, Ca, Mg, Br and Cl in IAEA reference materials (RMs) namely SL-3, SL-1, Soil-7 and V-10 and Cu, V, I and Cl in synthetic multielement standards (SMELS-I) obtained from SCK-CEN, Belgium.

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