Calculation of results for Po-210 in water by alpha spectrometry

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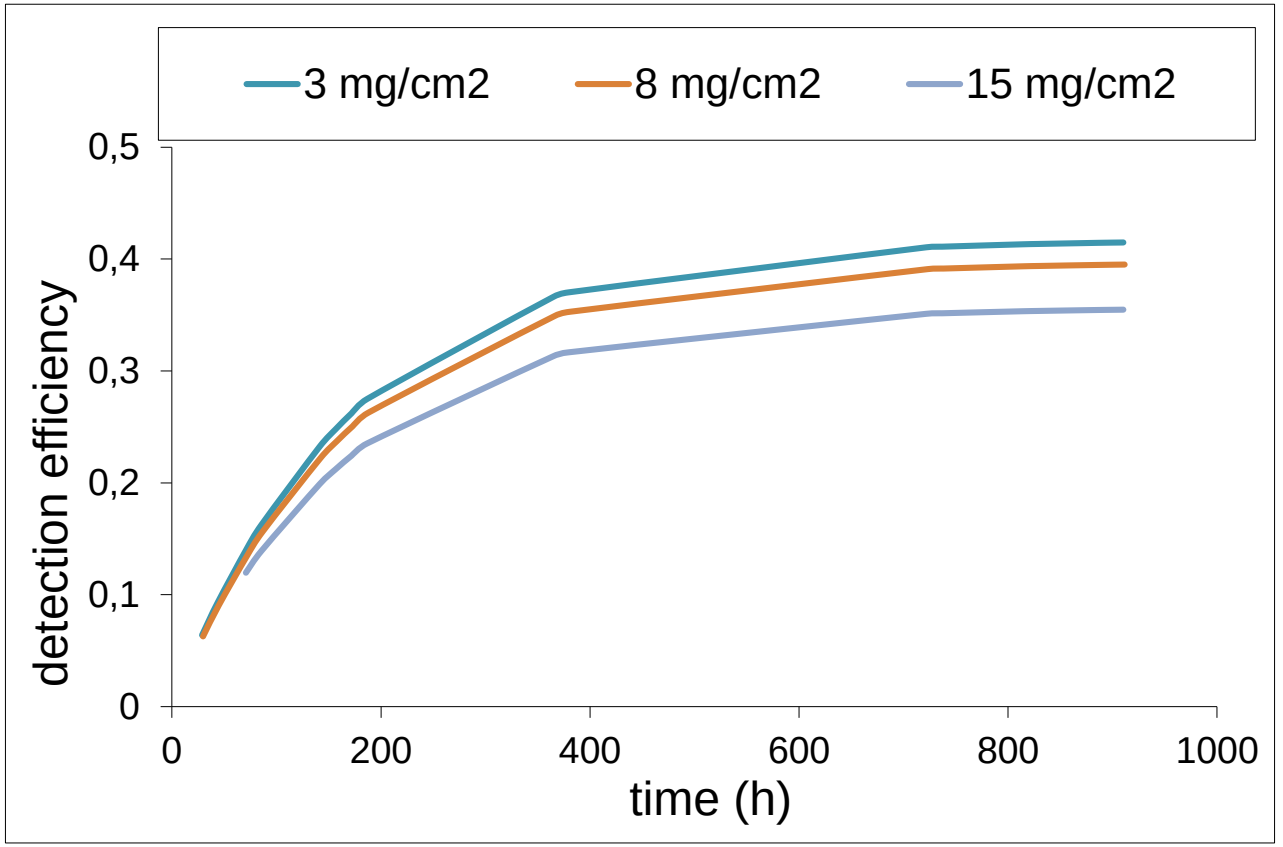
This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Euratom research and training programme 2014-2018 under grant agreement No 754 972

Bi-210 in-growth from Pb-210 at different sample thickness



Calculation of results

$$A_{\mathrm{Pb-210}} = \frac{\left(R_{\mathrm{beta}} - R_{\mathrm{b,beta}}\right)}{\eta_{\mathrm{Pb-210}}\, \varepsilon_{\mathrm{Pb-210}}\, V_{\mathrm{s}}} \qquad (1)$$

$$R_X = \frac{N_{\mathrm{X}}}{t_{\mathrm{m}}} \qquad (2)$$

$$\eta_{\mathrm{Pb-210}} = \frac{m_{\mathrm{PbSO4}}\, M_{\mathrm{Pb}}}{m_{\mathrm{Pb}}\, M_{\mathrm{PbSO4}}} \qquad (3)$$

$A_{\mathrm{Pb-210}}$ → activity concentration of $\mathrm{Pb-210}$ [Bq/L]

R_{beta} → beta count rate [1/s]

$R_{\mathrm{b,beta}}$ → beta background count rate [1/s]

$\eta_{\mathrm{Pb-210}}$ → $\mathrm{Pb-210}$ chemical recovery

$\varepsilon_{\mathrm{Pb-210}}$ → $\mathrm{Pb-210}$ detection efficiency

V_{s} → sample volume [L]

R_{X} → count rate of radionuclide X or background [1/s]

N_{X} → number of counts of radionuclide X or background

t_{m} → measurement time [s]

m_{PbSO4} → mass of $PbSO_4$ on planchet after separation [g]

M_{PbSO4} → molar mass of $PbSO_4$ [g/mol]

m_{Pb} → mass of added Pb carrier before separation [g]

M_{Pb} → molar mass of Pb [g/mol]

Calculation of measurement uncertainty

$$u_{\mathrm{c,Pb-210}} = A_{\mathrm{Pb-210}} \sqrt{\left(\frac{u_{R_{\mathrm{beta}}-R_{\mathrm{b,beta}}}}{R_{\mathrm{beta}} - R_{\mathrm{b,beta}}}\right)^2 + \left(\frac{u_{\eta_{\mathrm{Pb-210}}}}{\eta_{\mathrm{Pb-210}}}\right)^2 + \left(\frac{u_{\varepsilon_{\mathrm{Pb-210}}}}{\varepsilon_{\mathrm{Pb-210}}}\right)^2 + \left(\frac{u_{V_{\mathrm{s}}}}{V_{\mathrm{s}}}\right)^2} \quad (4)$$

$$u_{R_{\mathrm{beta}}-R_{\mathrm{b,beta}}} = \sqrt{\left(u_{R_{\mathrm{beta}}}\right)^2 + \left(u_{R_{\mathrm{b,beta}}}\right)^2} \quad (5)$$

$$u_{R_{\mathrm{X}}} = \frac{1}{\sqrt{N_{\mathrm{X}}}} \quad (6)$$

$u_{\mathrm{c,Pb-210}} \rightarrow$ combined standard uncertainty for $\mathrm{Pb-210[Bq/L]}$

$u_{\mathrm{X}} \rightarrow$ standard uncertainty of X

Reporting of the results

$$U_{\mathrm{Pb-210}} = k\, u_{\mathrm{c,Pb-210}} \quad (7)$$

$U_{\mathrm{Pb-210}} \rightarrow$ expanded uncertainty for $\mathrm{Pb-210}$ activity concentration [Bq/L]

$k \rightarrow$ coverage factor ($k = 2$ for 95% coverage)

$$A_{\mathrm{Pb-210}} = A_{\mathrm{Pb-210}} \pm U_{\mathrm{Pb-210}}$$

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