Calculation of results for Pb-210 in fish by proportional counter

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

![Graph showing the in-growth of Bi-210 from Pb-210 over time for different sample thicknesses: 3 mg/cm², 8 mg/cm², and 15 mg/cm². The graph plots detection efficiency against time (h).]
Calculation of results

\[
A_{\text{Pb-210}} = \frac{(R_{\text{beta}} - R_{\text{b,beta}})}{\eta_{\text{Pb-210}} \varepsilon_{\text{Pb-210}} m_s} \tag{1}
\]

\[
\eta_{\text{Pb-210}} = \frac{m_{\text{PbSO}_4} M_{\text{Pb}}}{m_{\text{Pb}} M_{\text{PbSO}_4}} \tag{3}
\]

\[R_X = \frac{N_X}{t_m} \tag{2}\]

- \(A_{\text{Pb-210}}\) → activity concentration of Pb – 210 [Bq/L]
- \(R_{\text{beta}}\) → beta count rate [1/s]
- \(R_{\text{b,beta}}\) → beta background count rate [1/s]
- \(\eta_{\text{Pb-210}}\) → Pb – 210 chemical recovery
- \(\varepsilon_{\text{Pb-210}}\) → Pb – 210 detection efficiency
- \(m_s\) → fresh sample mass [g]
- \(R_X\) → count rate of radionuclide X or background [1/s]
- \(N_X\) → number of counts of radionuclide X or background
- \(t_m\) → measurement time [s]

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Calculation of measurement uncertainty

\[ u_{c,Pb-210} = A_{Pb-210} \sqrt{\left( \frac{u_{R_{beta-R_{b,beta}}}}{R_{beta} - R_{b,beta}} \right)^2 + \left( \frac{u_{\eta_{Pb-210}}}{\eta_{Pb-210}} \right)^2 + \left( \frac{u_{\varepsilon_{Pb-210}}}{\varepsilon_{Pb-210}} \right)^2 + \left( \frac{u_{m_s}}{m_s} \right)^2} \] (4)

\[ u_{R_{beta-R_{b,beta}}} = \sqrt{(u_{R_{beta}})^2 + (u_{R_{b,beta}})^2} \] (5)

\[ u_{R_X} = \frac{1}{\sqrt{N_X}} \] (6)

- \( u_{c,Pb-210} \rightarrow \) combined standard uncertainty for Pb − 210 [Bq/g]
- \( u_X \rightarrow \) standard uncertainty of X
Reporting of the results

\[ U_{\text{Pb-210}} = k \ u_{c, \text{Pb-210}} \quad (7) \]

- \( U_{\text{Pb-210}} \rightarrow \) expanded uncertainty for Pb – 210 activity concentration [Bq/g]
- \( k \rightarrow \) coverage factor (\( k = 2 \) for 95% coverage)

\[ A_{\text{Pb-210}} = A_{\text{Pb-210}} \pm U_{\text{Pb-210}} \]