

A study on the traceability of radioactivity measurement using an isothermal microcalorimeter

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Calorimetric method using isothermal calorimeter has the advantage of being able to measure high-level radioactive sources in a non-destructive way. The KRISS develops a primary standard for activity measurement using the isothermal microcalorimeter (IMC). Therefore, a study was conducted to ensure traceability of the radioactivity measurement of calorimeter. In the isothermal state, the decay energy of the radionuclides inside the system is absorbed and converted into measurable heat flow rate (by Seebeck effect). If we know the decay energy of a given radionuclide, the absorption efficiency of the absorber, and calibration factor of calorimeter, then we can determine the radioactivity of the radionuclide by measuring the heat flow rate in the calorimeter. We measured the heat flow rate of the ³²P source (pure beta-emitter) in calorimeter, and divided it by the decay energy of the radionuclide absorbed in calorimeter per Bq, and calculated the radioactivity by applying the calibration factor. We obtained the calibration factor of the calorimeter in the form of a linear equation ($y = 1.015x + 0.078$) by using the joule heating method.

We determined the absorbed energy of ³²P to be 695.5 keV by an use of Monte Carlo simulation. Based on the information, the activity of ³²P was measured for two half-lives (half life = 14.284 d) in the calorimeter, and the initial radioactivity was calculated by fitting to an exponential decay equation with the reference value of the half life of ³²P. We then attempted to validate the activity measurement by comparing the result with that of the other national primary system, i.e., the TDCR (Triple-to-Double Coincidence Ratio) system. The relative difference between the two measurements was 3.14 %.

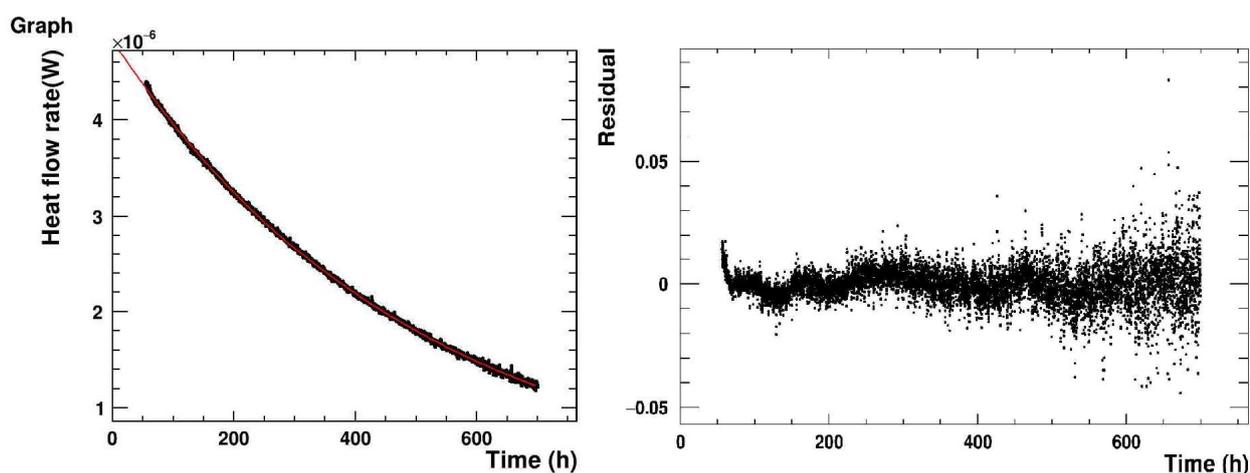


Fig. 1. Graph showing fitting for radioactivity measurement results of ³²P radioactivity of IMC (left) and residual between fitting and measurement results (right)

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