Validation of Cristallini Sampling Method for UF6 by High Precision Double-Spike Measurements Collaboration between JRC-G.2, Team METRO and SGAS/IAEA
Abstract:
The so-called "Cristallini Method" for sampling of UF6 by adsorption and hydrolysis in alumina pellets inside a fluorothene P-10 tube has been developed by the Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials (ABACC) several years ago [1]. This method has several advantages compared to the currently used sampling method, for which UF6 is distilled into a stainless steel tube for transportation, with hydrolysis and isotopic analysis being performed after shipping to the analytical laboratory. Using the Cristallini sampling method the transport is cheaper and relatively
safer concerning radiological protection aspects. In order to be reliable for both scientific and nuclear safeguards applications, the Cristallini sampling method has been subjected to a rigorous validation program. This includes a variety of sampling materials and measurement methods for the isotopic analyses as well as numerous participating laboratories around the world. The involved organizations include laboratories in Argentina, Brazil (collaborating within ABACC), Germany, Belgium (sites of Joint Research Centre, JRC, in Karlsruhe and Geel, respectively), Austria (Safeguards Analytical Services Laboratory of the IAEA) and within the United States, Oak Ridge National Laboratory (ORNL), the NBL-Program office and ASTM. This technical report describes in particular the application of the "Double Spike" method by thermal ionization mass spectrometry (DS/TIMS) for the validation program of the Cristallini method, performed by staff from the unit JRC-G.2 in Geel/Belgium (formerly IRMM) in collaboration with staff from SGAS/IAEA. The results are in good mutual agreement, but they reveal slight differences for the 235U/238U isotope ratios for samples taken by the Cristallini method compared to samples processed in the traditional manner by distillation and subsequent direct hydrolysis. For test samples prepared by ABACC using the IRMM-020 (0.2% 235U) and IRMM-022 (0.72% 235U) certified UF6 reference materials, significant differences of about 0.01%-0.02% were observed, but for test samples prepared from IRMM-023 (3.3% 235U) the differences are insignificant. The reason for the observed differences is not yet known, they can be due to fractionation, contamination or memory effects occurred during the sampling or subsequent chemical processing. The results from JRC-G.2 and SGAS/IAEA using the double spike method play a special role within the validation program due to the high precision of this method. The results are proposed to be included for the intended standardization of the Cristallini sampling method through ASTM, in particular for defining an additional uncertainty component to account for the sampling process and the subsequent sample preparation, which would have to be attributed in the future to all isotopic measurements on samples taken by the Cristallini sampling method.
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