Precise Measurement of Decay Half Lives of n-Rich Iodine Isotopes after Radiochemical Separation

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Introduction

The half-life of a radionuclide is an indispensable parameter both for fundamental nuclear physics and the application of any particular radionuclide. The measurement of half-life provides a direct route to determine the nuclear matrix element involved in the corresponding β-decay process. Again the half-life determines the application of a radionuclide both in nuclear physics (as standard source for calibration of detector) and in nuclear medicine. In general, a radionuclide with a long half-life (~few years) is preferred to be used for instrument calibration and a radionuclide with intermediate half-life (few hours) is preferred to be used in nuclear diagnostics purpose.

Hence a precise database of half-life is always desirable and the same for radioisotopes having several application is significantly important. Iodine (I)-isotopes have several such application, viz., $^{123\text{-}125}$I & ^{131}I are used in medicine and biology, ^{125}I is important in nuclear reactor physics as its decay product ^{135}Xe has a very high thermal n-absorption cross section etc., to name a few. Present work aims at the half-life measurement of n-rich I-isotopes($^{130\text{-}135}$I) as these isotopes are difficult to populate by fusion-evaporation reaction and most viable route is through nuclear fission. As fission reaction produces a large number of fission products involving a wide range of elements, it is always recommended to radio chemically separate the element of interest. A clean radiochemical separation of I-isotopes from the rest of the fission products within a limited time period considering the shortest half-life of ^{135}I (52.5m) is the major challenge of the present work. Although there exists the half-lives of the above n-rich I-isotopes in the literature [1], there are several values reported for ^{130}I [2-5]. For other I-isotopes also, it is worth performing a precise measurement of half-life with radio chemically separated I-isotopes. The production of n-rich I-isotopes by a-induced fission of ^{238}U and measurement of decay half-lives after radiochemical separation has been attempted in the present work.

Experiment

The α-irradiation of ^{238}U target was performed in K=130 AVF Cyclotron at VECC with 40MeV α-beam. The U-target was electro-deposited on 1mil Al-backing and thickness was kept between 500-600μg/cm^2. Two irradiations with different duration were performed. One irradiation was done for 1h to attempt shorter-lived I-isotopes and other was performed for 40h to address the longer-lived ones.

The irradiated target and Al-catcher foils were dissolved in sodium hydroxide solution and I-tracer was added to the reaction mixture. All iodide was oxidized to Iodine and extracted in CCl_4 medium. The Iodine was then back-extracted from organic phase in the form of Iodide and used for subsequent counting with HPGe detector. Both 50% HPGe and Compton-suppressed Clover-HPGe detector was used for counting the sample. Here, data from 50% HPGe detector are presented and the data from Clover detector will be presented during the conference if the paper is accepted for presentation.

Results and Discussion

The γ-ray spectrum obtained after radiochemical separation of I-isotopes from the rest of the fission products is shown in Fig. 1. The figure represents the γ-spectrum acquired immediately after the radiochemical separation performed for short-irradiation of 1h. All the peaks could be assigned only due to the decay of I-isotopes to the corresponding Xe-isotopes.

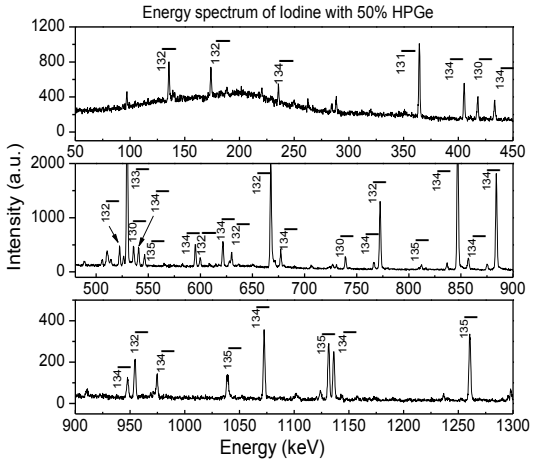

Fig 1: γ-ray spectrum taken with 50% HPGe detector after radiochemical separation of I-isotopes from other fission products

From the above spectrum, it may be realized that the radiochemical separation of I-isotopes was very clean and no other contamination peak was observed. The decay plots for some of the I-isotopes are shown in Fig. 2

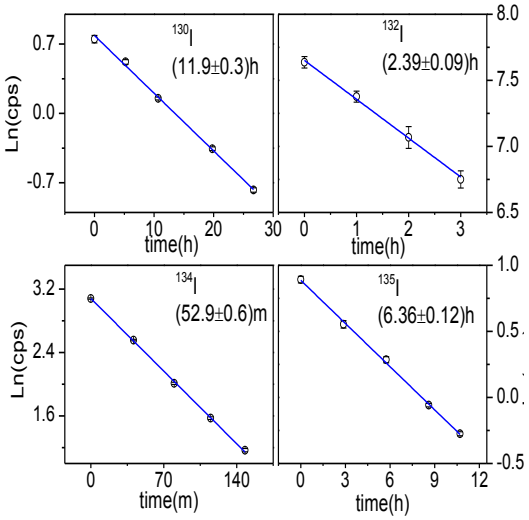

Fig. 2: Decay plots of separated I-isotopes

The decay half-lives of ^{130}I and $^{132\text{-}135}$I isotopes were measured. Only the measurement for ^{131}I (8d) could not b given in the abstract as data for sufficient duration could not be accummulated till date. However, same will be presented during the conference along with measurement for all I-isotopes with Clover HPGe detector as already mentioned. The half-lives obtained from the present measurement are tabulated in Table 1:

I-isotope	Half life	
	This work	Lit.
^{130}I	11.9(3)h	12.36(1)h
^{131}I	-	8.0252(6)d
^{132}I	2.39(9)h	2.29(1)h
^{133}I	20.8(1)h	20.83(8)h
^{134}I	52.9(6)m	52.5(2)m
^{135}I	6.36(12)h	6.58(3)h

The half-lives obtained from the present measurement agree well with the existing literature.

Conclusions

From the present work, it may be realized that the radiochemical separation of n-rich I-isotopes could be done successfully from the rest of the fission products. The γ-ray spectrum shows only the peaks originating from the decay of I-isotopes only. A precise measurement of half-lives could also be performed.

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