

Radiological characterization of graphite from thermal column of VVR-S research reactor in view of intermediary storage

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Abstract

Our paper aims to presents the experiments which were performed in order to determine the ^{14}C and ^3H accumulation during the functioning time of about 50 years in the thermal column of VVR-S reactor. A new facility and method for determination of tritium (^3H or T) and radiocarbon (^{14}C) in incinerable solid wastes are described. The protocol consists of oxidation in two steps of the samples in oxygen atmosphere, HTO and $^{14}\text{CO}_2$ kept separately and determination of T and ^{14}C activities at Liquid Scintillation Counter.

Introduction

Isotopes of interest:

^3H (pure β^- emitter $E_{\max}$ 18 keV) and ^{14}C (pure β^- emitter $E_{\max}$ 156 keV);

Secondary target group:

^{36}Cl (β^- $E_{\max}$ 708.6 keV/ e^- capture transition X, e^- Auger abundance <2%),

^{63}Ni (pure β^- emitter $E_{\max}$ 65.9 keV),

^{55}Fe (γ /X 6 keV (~25% abundance) 7 keV (~3%) e^- Auger 5.2 keV);

Schematic diagram of the experimental set up for ^{14}C and ^3H determination in irradiated graphite

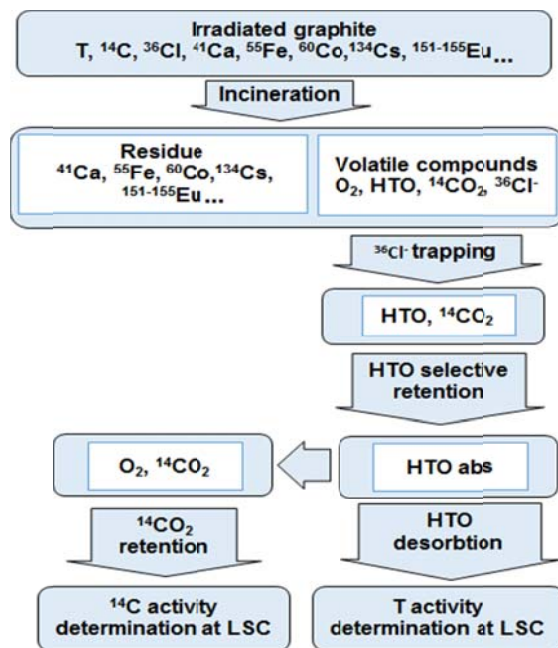


Figure 1: Experimental method for simultaneous determination of ^3H and ^{14}C in irradiated graphite

Equipment

The equipment used in the experiment consists in:

- Pressure oxygen tub with pressure regulator and flow control Rota meter
- 2 tube furnace with temperature controller (RT 50-250/11 Nabertherm type), one for graphite oxidation (at 800^o C temperature) and secondary for catalytic oxidation of resulted gases at water and carbon dioxide. (700-800^o C in presence of CuO wires or ~ 450^oC in presence of Pt/Alumina catalysts)
- Cooling units for flue gases with two-stage cooling, first with air and secondary using a recycling cooler DLK 40 Lauda type coupled at a Proline thermostat.
- Trapping unit for retention of tritiated water over sicative CaCl₂
- Trapping unit for retention of carbon dioxide using Carbo-sorb E+
- Radioactive gas monitor (RGM) with Ionizing Chamber Overhoff type

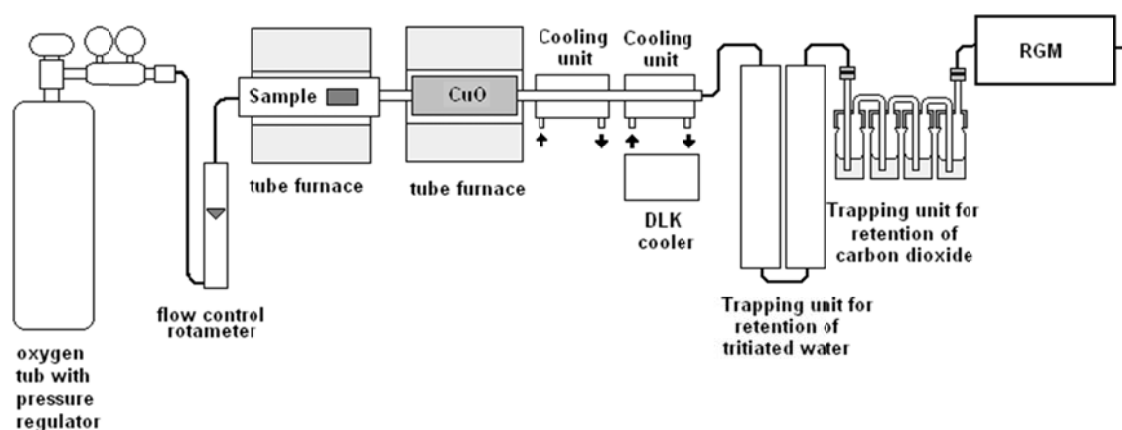


Figure 2: Facility for determination of total T and ¹⁴C inside of graphite

Conclusion

An apparatus based on silica gel/ CaCl₂ column and oxidation at high temperature over a CuO catalyst, was designed and built for T and ¹⁴C determination in irradiated graphite. A preliminary experimental protocol for the combustion of irradiated graphite and retaining separate of T and ¹⁴C was established. The retention yield of the oxidation compounds was 98%. T and ¹⁴C specific activity distribution in the thermal column of the VVR-S reactor were determined. The first disc of the thermal column of the VVR-S reactor, located near the reactor core, contained over 90% of the total activity of T and ¹⁴C.

References and Citations

- [1] X. HOU, Radiochemical analysis of radionuclides difficult to measure, for waste characterization in decommissioning of nuclear facilities, J. Radioanal. Nucl. Chem. 273, 43–48 (2007)
- [2] X. HOU, Rapid analysis of ¹⁴C and ³H in graphite and concrete for decommissioning of nuclear reactor, Appl Rad Izot, 62, 871–882 (2005)
- [3] D. ANCIUS and colab., Evaluation of the activity of irradiated graphite in the Ignalina Nuclear Power Plant RBMK-1500 reactor, NUKLEONIKA, 50 (3), 113-120 (2005)
- [4] V .Fugaru, C. Postolache, M.R. Ioan, M. Dragusin, ¹⁴C determination in irradiated graphite from thermal column of the VVR-S reactor- The 8th Annual International Conference on Sustainable Development through Nuclear Research and Education- May, 27-29,2015, Pitesti, Romania