Letters to the Editors

An Upper Limit for the Effective Capture Cross Section of Po^{210} for Thermal Neutrons

Measurements were carried out to determine the thermal-neutron-capture cross sections of 138-day Po^{210} for the formation of both isomers of the capture product, Po^{211}. Although large quantities of Po^{210} have been widely used for many years and although it would be formed in large quantities by radiative capture in any reactor using bismuth or its compounds as a reactor coolant or fuel carrier, no measurement of its cross section seems to have been made.

The 0.52-sec isomer of Po^{211} emits primarily 7.43-Mev alpha particles, and the 25-sec isomer largely 7.14-Mev alpha particles, with several more energetic alphas in low abundance. These alpha groups are all sufficiently energetic to be readily distinguishable from the 5.30-Mev alphas of Po^{210}. The irradiations were carried out in the pneumatic tube facility of the Oak Ridge Research Reactor, where a maximum thermal flux of about 7×10^{13} neutrons cm^{-2} sec^{-1} is available and where the ratio of thermal flux to resonance flux per ln E interval is about 25. The alpha particles were measured with a silicon semiconductor radiation detector of the surface barrier type (capable of 1% energy resolution for Po^{210} alphas) and counted through a filter sufficiently thick to just absorb the Po^{210} alphas. The energy calibration was made with a radium source using Po^{214} (Ra C′) of 7.68 Mev and Po^{218} (Ra A) of 6.00 Mev alphas. Transit time from the face of the reactor to the detector was about 2 sec; no chemical separations were required.

Using sources of Po^{210} ranging in intensity up to about 20 μC and counted in geometry configurations as high as ~30%, no evidence was found for the production of either of the isomers of Po^{211} (or for that matter of any alpha emitting product of energy in excess of ~6.0 Mev). On the basis of a capacity to detect activity levels of the product Po^{211} equal to that of the background, upper limits were set for the activation cross sections of Po^{210}. The thermal cross sections were thus shown to be <30 mb for the formation of the 0.52-sec isomer and <0.5 mb for the 25-sec isomer.

A low cross section for Po^{210} is not unexpected, since it contains a closed shell of 126 neutrons and one pair of protons beyond the closed shell of 82. The isotones of $_{84}Po^{210}_{126}$, namely $_{82}Pb^{208}_{126}$ and $_{83}Bi^{209}_{126}$ have similarly low thermal cross sections: 0.6 and 34 mb, respectively (*1*). It is also of interest to note that radiative capture with thermal neutrons is exoergic by 4.5 Mev for the 0.52-sec and 3.2 Mev for the 25-sec isomers of Po^{211}. These low energies for radiative capture (in contrast to the more usual ~6 Mev in the heavy mass region) again reflect the enhanced stability of the closed shell nuclide. This enhanced stability of the closed shell tends to lead to wider level spacings and, consequently, to lower thermal cross sections.

REFERENCES

1. Neutron cross sections, edited by D. J. HUGHES AND R. B. SCHWARTZ, BNL-325 (2nd ed.) Supt. of Documents, U. S. Govt. Printing Office, Washington 25, D. C., $4.50 (1958).

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Radiation Damage to Freon-11, CCl_3F

Numerous inquiries concerning Freon-11 (CCl_3F) for use as a refrigerant in radiation fields, have prompted the authors to publish experimental results previously reported (*1*) in a laboratory memorandum.

The radiation stability of some organic compounds containing a single halogen had been summarized in a review by Tolbert and Lemmon (*2*). Davidge (*3*) had given some data for the production of fluorine induced by reactor irradiations of CF_4 at about 70°C. Data for the effect of temperature on G values of a multihalogenated organic compound (CCl_3Br) were reported by Firestone and Willard (*4*). However, no specific information was available for compounds of this type containing fluorine.

Freon-11 was used as a refrigerant in an early ORNL reactor installation, the Homogeneous Reactor Experiment (1952). No data were obtained on its stability. However, the Freon was subjected to relatively low radiation dosage. When the same refrigeration system was considered for use in the Homogeneous Reactor Test (1955), to be subjected to radiation fields 100-fold greater than those previously encountered, the question of radiation damage to Freon-11 and possibly subsequent corrosion in a mixed metal system was considered. A mass spectrographic cracking pattern of technical grade Freon-11, performed in this Laboratory (*5*), showed no parent ion (CCl_3F^+). The relative abundances of the most prevalent ions were CCl_2F^+ (100), Cl^+ (15), $CClF^+$ (10.6) and CCl^+ (7.0).[1] This indicated

* Operated by Union Carbide Corporation for the U. S. Atomic Energy Commission.

[1] The cracking pattern of Freon-22, $CHClF_2$, indicated that the parent ion was less than 0.9% of all the ions observed from m/e 13 through 88 (*5*).