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LETTERS TO THE EDITORS

Measurement of fast neutron flux in a reactor by means of threshold detectors

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COWAN and O'BRIEN (1956) and COHEN (1951) suggested the (n, p) threshold reaction on ^{31}P yielding 2·62 hr ^{31}S for the measurement of the yield of neutrons from accelerators. This reaction has advantages over the ^{32}S $(n, p)^{32}P$ (half-life 14·3 days) process for the measurement of fast neutron fluxes in a reactor since the latter process which has formed the standard procedure to date (REINHARDT and DAVIES, 1958) requires a neutron flux about 70 times higher in order to give the same activity.

The interpretation of fast neutron flux measurements by activation is somewhat ambiguous since it involves on the one hand a definition of the lower energy limit of the fast neutrons and on the other hand a knowledge of the neutron energy spectrum. In the case of a reactor the only reasonable choice for the latter is to use the fission spectrum.

In view of the changes in the neutron energy spectrum as the neutrons diffuse through the moderator it is important to know how far measurements with ^{31}P $(n, p)^{31}Si$ and with $^{32}S(n, p)^{32}P$ are equivalent at different neutron energies. A study of the cross-sections RICAMO (1951), GRUNDL *et al.* (1958), HUBER and HURLIMANN (1955) and ALLEN *et al.* (1957) indicates that the extrapolated threshold energies are equal and that the ratio of the cross-sections is roughly constant at different energies if the resonances are smoothed out.

To check this conclusion, we have irradiated pairs of samples (one of phosphorus and one of sulphur) in thermal fluxes of 10^{10} n/cm² sec in the R.A.1 reactor (ALSINA FUERTES and GAMBA 1958). The irradiations were carried out in various positions in the graphite and between the fuel elements so as to give a range of fast fluxes varying by a factor of 300. The activities of ^{31}Si and ^{32}P showed the same ratio in all cases within the accuracy of our measurements.

Examination of the published cross-sections for the fission neutron energy spectrum gives $\sigma^{32}P/\sigma^{32}S = 0{\cdot}44$, whereas HUGHES, SPATZ and GOLDSTEIN measured 0·63. Our experimental value is 0·51 with a probable error around 0·03. With our ratio and the published cross-sections of the $^{32}S(n, p)^{32}P$ process we calculate 0·085 barn for the effective cross-section of the $^{31}P(n, p)^{31}Si$ reaction using a lower neutron energy limit of 2·0 MeV and 0·115 barn for 2·5 MeV.

As a rule either red phosphorus is irradiated (washed with alcohol to facilitate spreading of thin layers for counting) or lithium phosphate. If too much ^{32}P is formed by thermal neutron activation its effect can be reduced by means of a cadmium container, chemical separation or both. For chemical separation irradiated lithium phosphate or ammonium hydrophosphate is dissolved in water containing a known quantity of H_2SiF_6 with a drop of HF and H_2O_2. The ^{31}Si is precipitated by adding saturated KCl and alcohol. The K_2SiF_6 is filtered off and washed with alcohol and then the ^{31}Si is counted, corrections being applied for potassium activity if necessary. The yield of K_2SiF_6 is determined by weighing and it should be noted that ^{31}Si is transferred quantitatively to $SiF_6^{=}$.

This method may be used as a very sensitive test for fast neutrons if red phosphorus is counted with a thin-walled glass counter surrounded by a removable glass cylinder. With a counter 140 mm long and 20 mm diameter we have counted ^{31}Si in 20 g of phosphorus with an efficiency of 9 per cent. In this way a flux of very roughly 100 fast neutrons/cm² sec can be observed or a single burst of about 2×10^6 n/cm².

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Cadmium ratio measurements with thin and thick gold foils and their relation to reactor spectra

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IN this note a method is given for obtaining corrections to cadmium ratio measurements for flux depression in the foil and flux perturbation effects in order that the result may be used in descriptions of the reactor neutron energy spectrum.

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