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AUSTRALIAN ATOMIC ENERGY COMMISSION
RESEARCH ESTABLISHMENT
LUCAS HEIGHTS

FAST NEUTRON FLUX AND SPECTRUM MEASUREMENTS IN HIFAR

FIRST SUPPLEMENT – AVERAGE FISSION SPECTRUM CROSS SECTION FOR $Ni^{58}(n,p)Co^{58}$

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ABSTRACT

The $Ni^{58}(n,p)Co^{58}$ reaction cross section in a fission spectrum has been re-measured and found to be 102 ± 3 millibarns.

1. INTRODUCTION

A previous report AAEC/E59 (Nicholson and Quealy, 1961) to which this is a supplement, summarized the fast neutron flux and effective fission neutron cross section determinations made by the A.A.E.C. Nuclear Measurements Group using HIFAR. There the $Ni^{58}(n,p)Co^{58}$ fission neutron cross section was reported to be 43 millibarns when compared with an assumed figure of 60 millibarns for the $S^{32}(n,p)P^{32}$ reaction. This was low compared with subsequent determinations made here. It is believed that the error arose from some difficulty with the determination of the cobalt activity in the initial measurements reported.

Roy and Hawton (1960) have summarized various figures for this interaction and their preferred cross section value is 105 millibarns. There is some indication also from a preliminary excitation function for the reaction (J.L.Perkin, private communication) that the cross section averaged over a fission spectrum is 109 millibarns.

Intercalibrations between the Ni^{58} (n,p) Co^{58} and S^{32}(n,p) P^{32} reactions and, in one case between the Ni^{58}(n,p) Co^{58} , S^{32}(n,p)P^{32}, and Al^{27}(n,α) Na^{24} reactions, were carried out by irradiating samples of these materials in the C3, C2, D2, and E1 flux scanning tubes of HIFAR. These results indicate a figure of 102 millibarns for the Ni^{58}(n,p) Co^{58} reaction and they are summarized in Table 1.

2. EXPERIMENTAL PROCEDURES

Four thin spectrographically pure nickel wires each approximately 60 milligrams in weight together with sulphur powder monitors were irradiated in four different flux scanning tubes of HIFAR for one hour at 500 kilowatts. The activities of these materials were determined using counting techniques similar to those described in AAEC/E59. An aluminium sample activated in the C3 flux scanning tube was also counted.

3. RESULTS AND DISCUSSION

The effective fission flux for each irradiation position was determined from the monitor activities using the appropriate fission cross section $\bar{\sigma}$ = 60 millibarns for S^{32}(n,p) P^{32} and $\bar{\sigma}$ = 0.61 millibarns for Al^{27}(n,α) Na^{24} . Each determined flux was then used individually to determine an effective cross section for the Ni^{58}(n,p) Co^{58} reaction. The results are summarized in Table 1.

TABLE 1

Position	C3	E1	D1	C2
Flux from Sulphur Monitor	2.46×10^{12}	1.50×10^{12}	1.40×10^{12}	2.43×10^{12}
$\bar{\sigma}$ * for Ni^{58}(n,p) Co^{58} compared with $\bar{\sigma}$ = 60 for S^{32}(n,p)P^{32}	102 ± 5	103 ± 5	102 ± 5	102 ± 5
Flux from Aluminium Monitor	2.37×10^{12}	–	–	–
$\bar{\sigma}$ for Ni^{58}(n,p) Co^{58} compared with $\bar{\sigma}$ = 0.61 for Al^{27}(n,α) Na^{24}	98 ±10	–	–	–

* All cross sections are in millibarns

Counting difficulties due to the thermal activation of impurities in the aluminium made the result derived from the aluminium activation accurate to 10 per cent. The weighted figure for the $Ni^{58}(n,p)\,Co^{58}$ reaction cross section averaged over the fission neutron spectrum is 102 millibarns.

4. ACCURACY

Errors in the determination of the effective fission neutron cross section for the $Ni^{58}(n,p)Co^{58}$ reaction are due to two factors; deviation in the reactor spectra from a pure fission spectrum and counting errors.

No allowance has been made for the first as the two intercalibrations (Ni–Al and Ni–S) agree within the experimental errors. Counting errors include statistical errors and systematic errors in, for example, half-life data. The sulphur activities were accurate to 1 per cent., the nickel activities accurate to 4 per cent. and the determined cross section accurate to 3 per cent. No account has been taken of possible error in the $S^{32}(n,p)\,P^{32}$ reaction cross section of 60 millibarns.

5. REFERENCES

Roy, J.C., and Hawton, J.J., (1960) – AECL 1181