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PROGRESS REPORT TO INDC

NUCLEAR DATA FROM NORWAY.

Compiled by

E. Andersen

Institutt for Atomenergi, Kjeller, Norway

May 1972

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P R E F A C E

This progress report gives information about recent neutron cross section measurements in Norway performed at the Department of Chemistry, University of Oslo, and at Institutt for Atomenergi, Kjeller.

All the reported measurements have been performed using activation methods, and nearly all the samples have been irradiated in JEEP II reactor at Institutt for Atomenergi. A brief description of this reactor facility is given in the Appendix.

The data given in the report should not be quoted or abstracted without the explicit permission of the individual authors.

Requests concerning the nuclear data reported should be addressed directly to

Professor A.C. Pappas, Chemistry Department, University of Oslo, Blindern, Oslo 3, Norway

or to

Dr. E. Steinnes, Isotope Laboratories, Institutt for Atomenergi, P.O. Box 40, 2007 Kjeller Norway

I <u>Contributions from Department of Chemistry, University of Oslo, Blindern, Norway</u>

1). Thermal Neutron Capture Cross Section and Resonance Capture Integral of the Lanthanide Nuclei ^{140}Ce, ^{142}Ce, ^{146}Nd, ^{148}Nd, ^{150}Nd and ^{159}Tb*

by

J. Alstad, T. Jahnsen and A.C. Pappas

The thermal neutron capture cross section σ_{th} and the resonance capture integral I_o for some lanthanide nuclei are measured by an activation method. Thin gold foils (σ_o = 98.8 barn, I_o = 1558 barn) were used as flux monitors. The values found for σ_{th} and I_o are as follows:

	^{140}Ce	^{142}Ce	^{146}Nd	^{148}Nd	^{150}Nd	^{159}Tb
σ_{th}(barn)	0.54±0.04	0.94±0.09	1.3±0.1	2.5±0.2	1.0±0.2	22±2
I_o (barn)	0.49±0.05	1.6 ±0.2	3.0±0.3	14±2	14±4	450±50

The resonance integrals for ^{142}Ce, ^{146}Nd and ^{150}Nd have not been published previously. In addition are given the effective neutron capture cross sections σ_{eff} in the JEEP I reactor at Kjeller.

* Work based on a thesis by T. Jahnsen.

(J. Inorg.nucl.Chem., 1967, Vol. 29, pp. 2155 to 2160)

2). Thermal Neutron Capture Cross Section and Resonance Capture Integral of the Lanthanide Nuclei II, ^{169}Tm, ^{168}Yb, ^{174}Yb and ^{174}Yb**

by

J. Alstad, L. Herzenberg and A.C. Pappas

The thermal neutron capture cross section σ_{th} and neutron resonance capture integral I_o for the nuclides ^{169}Tm, ^{168}Yb, ^{174}Yb and ^{176}Yb are determined by an activation method using thin gold foils (σ_o = 98.8 barn, I_o = 1558 barn) as flux monitors.

** Work based on a thesis by L. Hertzenberg

For σ_{th} and I_o the following values were found:

	^{169}Tm	^{168}Yb	^{174}Yb	^{176}Yb
σ_{th} (barn)	105±3	$(4.4\pm0.2)\cdot10^3$	40.0±1.5	2.4±0.2
I_o (barn)	1710±50	$(3.8\pm0.2)\cdot10^4$	31 ± 2	2.7 ±0.3

In addition are given the effective neutron capture cross sections σ_{eff} in the JEEP I reactor at Institutt for Atomenergi.

The resonance capture integrals for ^{168}Yb, ^{174}Yb and ^{176}Yb have not been published previously.

3) Thermal Neutron Capture Cross Section and Resonance Capture Integral of the Lanthanide Nuclei III. ^{156}Dy, ^{158}Dy, ^{164}Dy and ^{165}Dy *

by

J. Alstad, A.C. Pappas and T. Syversen

Reaction	σ_{th}(barn)	I_o(barn)
$^{156}Dy(n,\gamma)^{157}Dy$	33±3	960±80
$^{158}Dy(n,\gamma)^{159}Dy$	43±6	120±20
$^{164}Dy(n,\gamma)^{165m+g}Dy$	$(2.80\pm0.11)\cdot10^3$	820±60
$^{164}Dy(n,\gamma)^{165m}Dy$	$(1.7\pm0.25)\cdot10^3$	
$^{164}Dy(n,\gamma)^{165g}Dy$	$(1.1\pm0.15)\cdot10^3$	
$^{165}Dy(n,\gamma)^{166}Dy$	$(3.9\pm0.3)\cdot10^3$	$(2.2\pm0.3)\cdot10^4$

* Work based on a thesis by T. Syversen

(Irradiations in the JEEP II reactor at Kjeller)

4) Thermal Neutron Capture Cross Section and Resonance Capture Integral of the Lanthanide N clei IV, ^{162}Er, ^{164}Er, ^{168}Er and ^{170}Er *

by

O. Glomset and A.C. Pappas

The effective neutron capture cross sections of ^{162}Er, ^{164}Er, ^{168}Er and ^{170}Er have been measured by an activation method with and without a cadmium cover. Using definitions given by Stoughton and Halperin, the thermal neutron cross section σ_{th} and resonance integrals I_o have been calculated assuming the cross sections obey a 1/v law in the thermal region. Gold (σ_o = 98.8 barn and I_o = 1558 barn) was used as monitor both for the thermal and the epithermal flux.

The effect of neutron self shielding on the measurements has been considered, and target weights were chosen to reduce this effect to negligible proportions.

Irradiations were performed in the JEEP II reactor at Kjeller. The results obtained were:

	^{162}Er	^{164}Er	^{168}Er	^{170}Er
σ_{th} (barn)	19±2	13 ± 2	2.1±0.1	5.8±0.3
I_o (barn)	480±50	105 ± 10	20±3	18±2

* Work based on a thesis by O. Glomset

II. Contributions from Isotope Laboratories, Institutt for Atomenergi, Kjeller, Norway

1) Resonance Activation Integrals of some Nuclides of Interest in Neutron Activation Analysis.

by

E. Steinnes

The following previously unreported resonance activation integrals I_o were determined: ^{46}Ca, 0.32±0.12 b; ^{84}Sr, 10.6±1.1 b; ^{130}Ba, 270±70 b; ^{152}Gd, 3000±300 b; ^{158}Gd, 84±20b. In addition, the I_o values for 21 nuclides were re-determined. The determinations were based on cadmium ratio measurements and known values for the thermal neutron activation cross sections. Small samples of ^{197}Au (σ_o = 98.8 b, I_o = 1550 b) were used as flux monitors. The thermal neutron activation cross section for ^{152}Gd was determined and found to be 1100±100 b.

(J. Inorg.Nucl. Chem., in press)

2) Cross Sections of (n,p) Reactions Induced in Nickel Isotopes by Reactor Fast Neutrons*

by

J.R. Hansen and E. Steinnes

Cross sections of some (n,p) reactions induced in nickel by reactor fast neutrons have been determined. A fast radiochemical method based on anion exchange in strong hydrochloric acid and subsequent precipitation with α-nitroso-β-naphtol was used for the isolation of the cobalt reaction products. The following results were obtained:

^{60}Ni (n,p)^{60m}Co, 1.98±0.20 mb; ^{60}Ni (n,p)^{60}Co (total), 4.4±1.0 mb;
^{61}Ni (n,p)^{61}Co, 1.63±0.12 mb; ^{62}Ni (n,p)^{62}Co, (9±3)·10^{-3} mb.

All cross sections are based upon the value 105 mb for the reaction ^{58}Ni (n,p)^{58}CO.

* Based on a thesis by J.R. Hansen

(Radiochim. Acta, in press)

A P P E N D I X

The JEEP II Reactor at Institutt for Atomenergi, Kjeller, Norway

The JEEP II research and isotope production reactor is a tank type slightly enriched UO_2, heavy water moderated and cooled reactor. Reactor power is 2 MW and the max. thermal flux is about $2.0 \cdot 10^{13}$ n/cm^2 sec in the positions available for irradiations of samples in the core.

The core of the reactor has cylindrical shape of 88.7 cm diameter and 90 cm height. Normally during a fuel cycle 16 - 19 fuel element of special design containing 3.5 % enriched UO_2 is in the reactor core. (Each fuel element consisting of 11 stringers arranged in a circle between 2 concentric tubes).

The reactor is equipped with a number of horizontale neutron beam channels of which one is going through and designed for a cold neutron facility, vertical isotope production channels, pneumatic rabitt irradiation facility. Near to the reactor is a water pool having a wide channel penetrating the shield and connecting the reactor tank and the pool which is very suitable for irradiation of large objects. Thermal neutron flux in the water pool near to the port of the wide channel is about 10^{12} n/cm^2 sec at 2MW power of the reactor.

For a detailed technical description reference is made to "Directory of Nuclear Reactor", Vol. VI, Research, Test and Experimental Reactors", International Atomic Energy Agency, Vienna, 1966.

JEEP II went critical in 1966 and has been in operation since then. The JEEP I reactor which was in operation from 1951 to 1967 at Institutt for Atomenergi, Kjeller was a heavy water moderated natural uranium fuelled tank type reactor having a maximum thermal neutron flux of about $2 \cdot 10^{12}$ n/cm^2 sec at a power level of 450 kW. For a detailed description of the JEEP I reactor see: Directory of Nuclear Reactor, Vol. II, Research, Test and Experimental Reactors. The International Atomic Energy Agency, Vienna 1959.