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NEUTRON DATA TESTING FOR CR, FE AND NI IN INTEGRAL AND MACROSCOPIC EXPERIMENTS

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Abstract: Neutron data for Cr, Fe and Ni from the ENDF/B-IV, SOCRATOR and BNAB-78 libraries are compared each other and with the results of the experiments sensitive to the capture, inelastic scattering cross-sections and its resonance structure for the investigated materials. Experiments on the Van-de-Graaf accelerators, reactor beams and critical assemblies was used.

(experiments, constructional materials, BNAB-78, ENDF/B-IV, SOCRATOR system, group constants, results of calculations)

The structural materials in the fast reactor cores are caused nearly 10% of capture events and 30% removals under the U-238 fission threshold. The cross-sections uncertainty for stainless steel components leads to essential contribution to the resulting errors in calculational prediction of the main fast reactor characteristics /1/. That is why the evaluated Neutron Data Files for Cr,Fe and Ni were compiled at Nuclear Data Centre (FEI) on the base of modern microscopic measurements for the SOCRATOR library (the information about this library given in other report to this conference).

Also some integral (with well known neutron spectra) and macroscopic (with spectra depending on the constants under studying) experiments were carried out for the purpose of the structural material constants testing. The results of these experiments interpretation are presented below.

V.M.Lityaev et al /2/ carried out the fission neutron transmission measurements with U-238 fission chamber for sphere samples of materials under consideration. After some calculational corrections the removal cross section:

$$\sigma_r = \int_0^\infty dE'\chi(E')\sigma_f^{28}(E')\int_0^{E'} dE\,\sigma_{in}(E'\to E)\left[1 - \sigma_f^{28}(E)/\sigma_f^{28}(E')\right] \Big/ \int_0^\infty dE'\chi(E')\sigma_f^{28}(E')$$

are found from the values of measured transmissions. These experimentally found values are compared in the Table I with calculated ones.The

Table I. Comparison of removal cross-section values for the thermal neutron U-235 fission spectrum

mater.	experim.	BNAB-78	ENDF/B-IV	CJD
Fe	0.70+0.02	0.66	0.70	
Cr	0.66+0.02	0.67	0.67	0.67
Ni	0.74+0.02	0.81	0.75	0.77
steel	0.69+0.02	0.68	0.70	

calculations used the BNAB-78 constants /3/,the constants CJD evaluated files from SOCRATOR library and the ENDF/B-IV data . It can be seen that microscopic data evaluations lead to removal cross section values which agree with the results of the latest integral measurements.

A number of experiments with neutron of T(p,n) reaction and at the reactor beams was devoted to the refinement of total cross section resonance structure by the measurements of neutron transmission nonexponentiality (see /4/ and references there). The self-schielding factors for capture and total cross sections calculated for BNAB energy groups from the data of ENDF/B-IV, SOCRATOR (CJD evaluation) and BNAB-78 libraries are compared with experimental values (see fig.1).

The ignoring of unresolved resonance structure for capture cross sections at ENDF/B-IV library resulted in overestimation of f_c values. Effect is the most appreciable in the case of Fe. The CJD evaluation, on the other hand, leads to underestimation (relative to BNAB-78) values f_c for Cr and Ni. Direct experimental data about f_c are fulfilled for Fe only /5/ where disagreement just does not exist. Such an experiment for Cr and Ni seems to be very desirable.

At the KBR critical assembly the set of macroexperiments was carried out /6/ aimed at the checking of accepted neutron constants for Cr,Fe and Ni. The central regions of studied assemblies were made from the materials under investigation which contained the U-235 admixture for the providing k_∞ =1. The investigated region had been surrounded by the driving core with similar neutron spectrum. The spectrum in the centrum of each researched region was closed to the assimptotic one.

The composition of the regions under investigation is shown in the Table II.

Table II. The characteristics of KBR assemblies

	KBR-3	KBR-7	KBR-9	KBR-10	KBR-11	KBR-12	KBR-14
U-235	1.0	1.0	1.0	1.0	1.0	1.0	1.0
U-238	0.1	0.1	0.1	0.1	5.0	5.0	4.2
O	-	2.2	2.2	2.2	12.0	12.0	10.5
Cr	35.1	2.5	33.4	26.5	12.5	28.5	81.5
Fe	134.3	9.7	127.5	101.2	47.6	72.6	14.9
Ni	19.2	126.1	18.0	14.3	6.7	1.3	2.1
Mn	2.4	0.2	2.3	1.8	0.9	0.5	0.3
Mo	-	-	-	3.4	-	-	-
k_∞	1.042	1.042	1.070	1.033	1.030	0.978	1.040
fraction of neutrons below 10keV	16.3	17.5	16.5	14.0	12.0	12.5	11.0
fraction of absorbtion at steel	40	43	38	42	15	18	21
year	1975	1978	1980	1982	1984	1986	1987

For each case the calculated absorbtion in

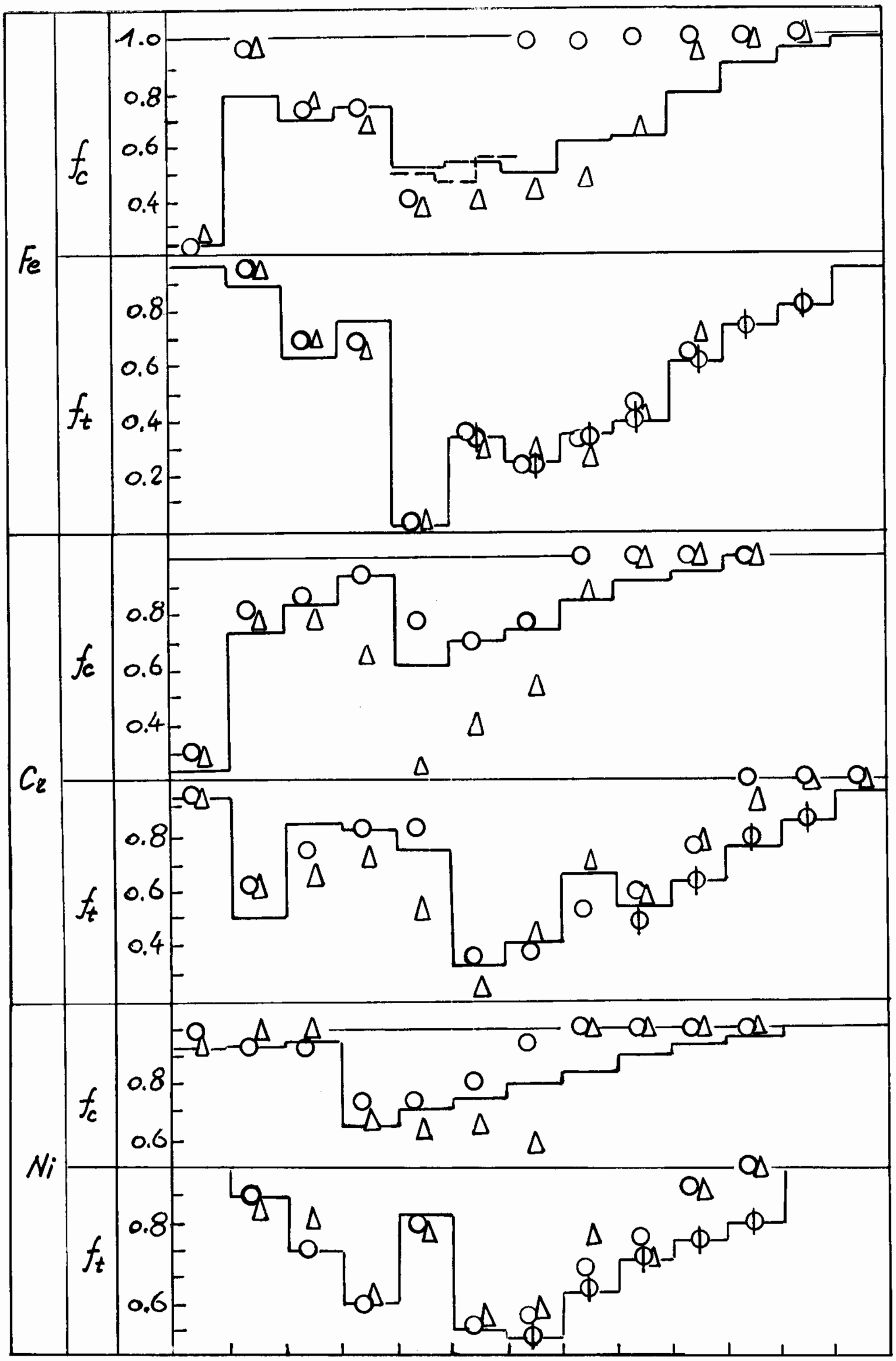

Fig.1. Self-shielding factors energy dependence:
____ - BNAB-78, ○ - ENDF/B-IV, △ - CJD,
Φ - /4/, ---- - /5/

structural materials as well as the neutron spectrum portion below 10 keV are given. The k_∞ values are evaluated experimentally. At the centre of the researched regions the ration of reactivity of little Cr,Fe and Ni samples to that of U-235 were measured too. These data are compared (fig.2) with the calculations based on data of ENDF/B-IV, SOCRATOR (CJD evaluation) and BNAB-78 libraries. As a whole the calculation based on CJD evaluations leads to better agreement with experiment then calculation with BNAB-78 data, and the calculation with ENDF/B-IV - to worse one. Only for ρ_{Ni}/ρ_{25} in the case of KBR-7 assembly (nickel medium) the calculation based on BNAB-78 becomes worse then the using of ENDF/B-IV. It looks like σ_c for Ni is overestimated in BNAB-78 library.

The disagreements in ρ_{Cr}/ρ_{25} and ρ_{Fe}/ρ_{25} for nickel assembly KBR-7 and ρ_{Ni}/ρ_{25} for KBR-12 assembly (without nickel) are little and nearly eq-

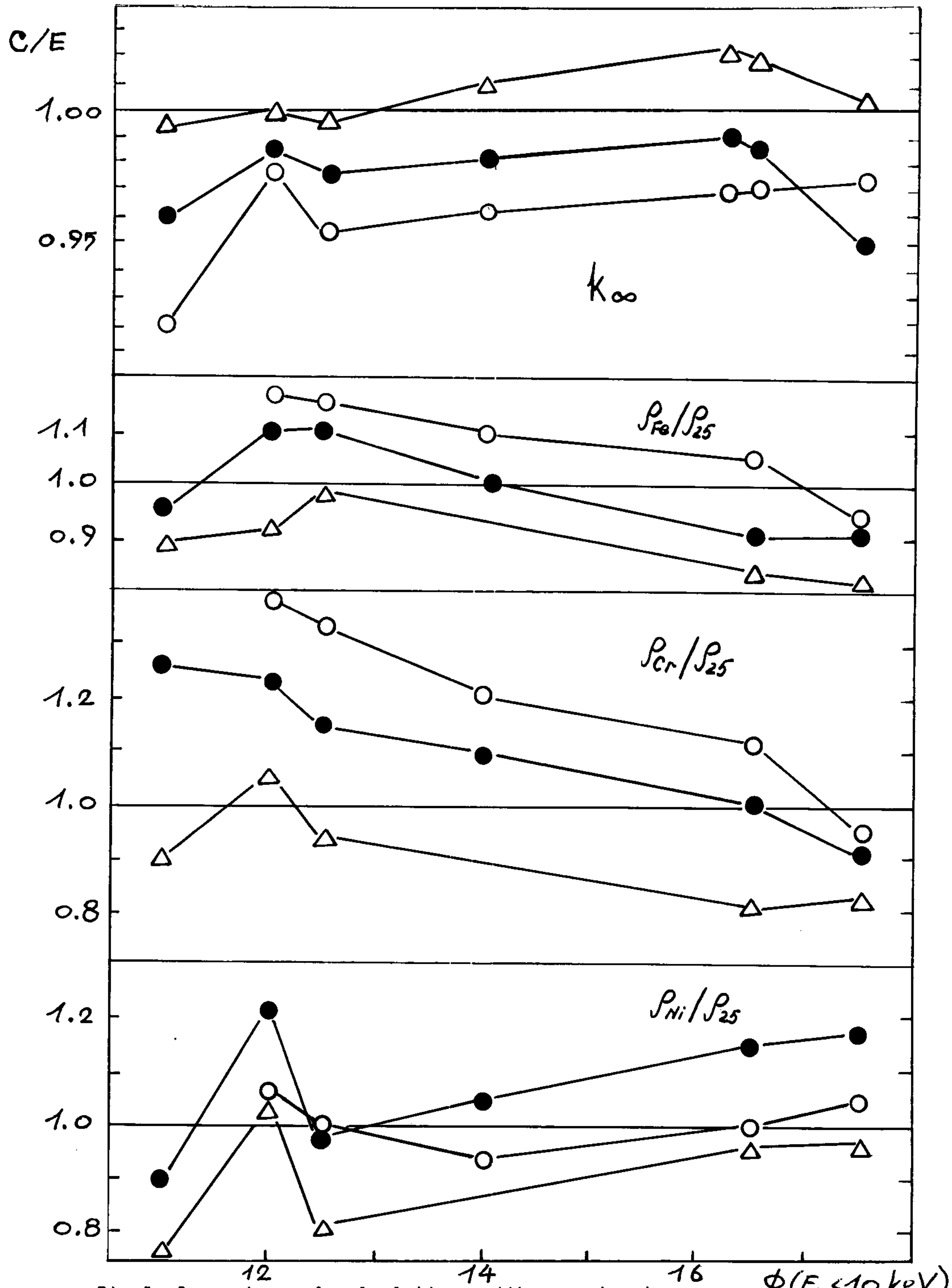

Fig.2. Camparison of calculations with experiment:
●-● - BNAB-78, ○-○ - ENDF/B-IV, △-△ - CJD

ual for the data ENDF/B-IV and SOCRATOR libraries.

It shows that most of observed disagreements are connected with uncertainty of taking into account the resonance self-shielding effects.

The macroexperiments aimed at checking the neutron constants for Cr,Fe and Ni were fulfilled also at assemblies ERMINA at Cadarashe and RB-2 at Ispra. The conclusions made from these results does not completely agreed with the ones made above (see for example /7/) . Note, however, that neutron capture in the investigated materials in the case of ERMINA (8-13%) and RB-2 (4-5%) were much lower then for KBR assemblies (see Table II). It seems that this sircumstance somewhat reduces the reliability of these results.

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