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A method of determining...

are given against φ, from which it is clearly seen that the optimal ratio L_o/G_o is 1. The dependence of sensitivity of the phase angle method on parameters g, l, φ and a permits determination of the usefulness of the resultant signal method for measuring oscillator parameters for various types of reactors. As an example of application of the above methods certain numerical data are given, which are thought to be required and known before the actual construction of the oscillator begins. These numerical data are worked out from the experimental material obtained during the dynamic measurements of the oscillator installed at Chatillon and quoted by D. Breton (Ref. 3: Materiały I Konferencji Genewskiej, t. 4 ref. 356); the original Breton notation is used. There are 7 figures, 1 table and 7 references: 2 Soviet-bloc and 5 non-Soviet-bloc. The reference to the English-language publication reads as follows: A.M. Weinberg, H.C. Schweinler: Phys. Rev. 74, 851 (1948).

ASSOCIATION: Instytut badań jądrowych PAN, Warszawa, zakład inżynierii reaktorowej (Institute of Nuclear Research, PAS Warsaw, Reactor Engineering Laboratory)

SUBMITTED: November, 1960

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AUTHOR: Weiss, Zbigniew

TITLE: Neutron spectrum temperature distribution in heterogeneous systems with constant absorption

PERIODICAL: Nukleonika, v. 6, no. 4, 1961, 243 - 259

TEXT: In this paper, the first of a series of four on neutron temperature distribution, the author presents a more general formulation of the method of D.A. Kottwitz (Ref. 6: Bull.Am.Phys.Soc. 3, 1 (1958), Abstr. A.7) for determining the effective neutron temperature which enables the calculation of the distribution of effective temperature in a finite or infinite homogeneous assembly with internal or external epithermal neutron sources. The basic assumptions are: (I) Validity of the P_1 approximation for spatial neutron distributions; (II) Representation of energy transfer probability in the 1/M heavy gas model approximation; (III) Isotropic scattering in the laboratory system; (IV) Energy independence of the ab-

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sorption cross-section. These reduce the general Boltzmann equation to the form

$$D\nabla^2\psi - \bar{\Sigma}_a\psi = -\xi\Sigma_s\hat{A}\psi - S(r,E) \quad [2] \qquad (2)$$

where $\Psi(r, E)$ is the neutron spectrum distribution, D the diffusion coefficient, Σ_s the macroscopic scattering cross-section, ξ the mean logarithmic energy decrement, $\bar{\Sigma}_a = \frac{\sqrt{\pi}}{2}\sqrt{\frac{E_0}{T_{eff}}}\Sigma_a^0;\ E_0 = 0.0253\ \text{eV}$

Σ_a^0 is the macroscopic absorption cross-section at energy E_0, T_{eff} the effective neutron temperature, $\hat{A} = TE\frac{\partial^2}{\partial E^2} + E\frac{\partial}{\partial E} + 1$, T is the temperature of the medium, and $S(r, E)$ represents external sources. Expanding $\Psi(r, E)$ in terms of Laguerre polynomials and substituting in (2) gives a set of equations for the moments f_n of the expansion

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$$\nabla^2 f_n(r) - \frac{f_n(r)}{L_0^2} - n\frac{f_n(r)}{L_1^2} = -\frac{S_n(r)}{D(n+1)} \quad [5] \qquad (5)$$

where $L_0^{-2} = \frac{\overline{\Sigma}_a}{D}$, $L_1^{-2} = \frac{\xi\Sigma_s}{D}$ for heavy gas model (or taken from experiment)

$$S_n(r) = \frac{1}{n+1}\int_0^\infty S(E, r)\, L_n^{(1)}\left(\frac{E}{T}\right) dE$$

with

$$f_n(r) = \frac{1}{n+1}\int_0^\infty \psi(E, r)\, L_n^{(1)}\left(\frac{E}{T}\right) dE \quad [4b] \qquad (4b)$$

Solving, $f_1(r) = f_0(r)\left[1 - \frac{T_{eff}(r)}{T}\right]$, where

$$T_{eff} = \frac{1}{2}\langle E\rangle \quad [7] \qquad (7)$$

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Assuming that Eq. (5) correctly represents the neutron spectrum when the heavy gas model is not valid, so long as L_0 and L_1 are chosen properly, then the equations for the first two moments may be written

$$\nabla^2 f_0(r) - \frac{f_0(r)}{L^2} = -\frac{S_0(r)}{D} \quad [9a] \qquad (9a)$$

$$\nabla^2 f_1(r) - \frac{f_1(r)}{L_t^2} = -\frac{S_1(r)}{D} \quad [9b] \qquad (9b)$$

where

$$L^2 = L_0^2 \quad L_t^{-2} = L_0^{-2} + L_1^{-2}$$

Substituting for $f_1(r)$ in (9b), by algebraic manipulation

$$f_0(r)\nabla^2 T_{eff}(r) + 2\,\mathrm{grad}\, f_0(r)\,\mathrm{grad}\, T_{eff}(r) - \left(\frac{1}{L_t^2} - \frac{1}{L^2}\right) f_0(r)\,[T_{eff} - T] = \frac{-S_0(r)}{D}\left(\frac{\langle E\rangle_s}{2} - T_{eff}\right) \quad [12] \qquad (12)$$

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where $\langle E \rangle_s$ is the mean energy of the source spectrum. For two half-spaces with no sources or absorption, divided by the plane $x = 0$, and with temperatures T_1 and T_2,

$$\left.\begin{aligned} \frac{d^2 T^1_{eff}}{dx^2} - \lambda^2 [T^1_{eff} - T_1] = 0 \\ \frac{d^2 T^2_{eff}}{dx} - \lambda^2 [T^2_{eff} - T_2] = 0 \end{aligned}\right\} \quad [13] \qquad (13)$$

with the boundary conditions

$$\left.\begin{aligned} T^1_{eff} = T^2_{eff} \\ \frac{dT^1_{eff}}{dx} = \frac{dT^2_{eff}}{dx} \end{aligned}\right\} x = 0 \quad [14] \qquad (14)$$

where $\lambda^2 = L_t^{-2} - L^{-2}$. The solution of these is

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$$\left.\begin{aligned} T^1_{eff} &= T_1 - \frac{T_1 - T_2}{2} e^{-\lambda x} \quad x > 0 \\ T^2_{eff} &= T_2 + \frac{T_1 - T_2}{2} e^{\lambda x} \quad x < 0 \end{aligned}\right\} \quad [15] \qquad (15)$$

in exact agreement with that obtained by Kottwitz (Ref. 6: Op.cit.), and T. Springer (Ref. 9: Nukleonik, Juli, 1960). Similarly, for an infinite half-space irradiated by neutrons of mean energy $\langle E \rangle_s$,

$$\frac{T_{eff}}{T} = 1 - \frac{f_1}{f_2} = 1 + \frac{\left(\frac{\langle E \rangle_s}{2} - T\right)}{1 + \frac{2D}{L_t}} \left(1 + \frac{2D}{L}\right) e^{-\lambda' x} \quad [16] \qquad (16)$$

where $\lambda^1 = \frac{1}{L_t} - \frac{1}{L}$. For neutrons slowing down from fission energies, the procedure must be modified to treat the epithermal part of the

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spectrum. The epithermal neutrons with a 1/E Fermi spectrum are assumed to form a source one collision interval wide, with mean energy equal to the Fermi cut-off energy, E_c. Solving Eq. (12) for an infinite homogeneous medium with uniform source distribution

$$T_{eff} = T\left[1 - \frac{1}{L^2\lambda^2}\left(\frac{\gamma}{2} - 1\right)\right]^{-1} \quad [18] \qquad (18)$$

where $\gamma = \frac{E_c}{T_{eff}}$. A comparison of this with other results is shown in Fig. 3. Next, an infinite half-space, $x > 0$, containing a uniform homogeneous source, characterized by S_0 and S_1, with $x < 0$ a vacuum of ideal absorber, is considered. With boundary condition $f_0, f_1 \longrightarrow$ constant as $x \longrightarrow \infty$, and $-\frac{D}{2}\frac{df_i}{dx} + \frac{f_i}{4} = 0, i = 0.1$ for $x = 0$, Eqs. (9a) and (9b) give

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$$\frac{T_{eff}(0)-T}{T_{eff}(\infty)-T}=\lambda L\frac{1+\frac{2D}{L}}{1+2D\lambda} \quad [19] \qquad (19)$$

where $\frac{T_{eff}(\infty)}{T}=1+\frac{\left(\frac{\langle E\rangle_s}{2}-T\right)}{L^2\lambda^2}$. For a pure water moderator, Eq. (19) gives a ratio of 3.5, compared with 4.10, obtained in a more exact way by Springer (Ref. 9: Op.cit.). The ratio is increased to 3.66 if the moments f_0 and f_1 are assumed to vanish at the extrapolated boundary. Consider a system of plate fuel elements, each 2b thick, with a moderator between them so that the center of adjoining plates are 2a apart, the assembly being much larger than the cell dimensions. On the assumption that thermal neutron sources exist only in the

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moderator, in uniform distribution, Eqs. (9a) and (9b), together with the appropriate boundary conditions, give

$$\frac{T_{eff}^{(1)}(x)}{T} = 1 + A\frac{L_{l(2)}^2}{L_{(1)}^2}\frac{\dfrac{\mathrm{ch}(x/L_{l(1)})}{\mathrm{ch}(b/L_{l(1)})}}{\dfrac{\mathrm{ch}(x/L_{(1)})}{\mathrm{ch}(b/L_{(1)})}}\cdot\frac{1+\dfrac{D_{(1)}}{D_{(2)}}\dfrac{L_{(2)}}{L_{(1)}}\dfrac{\mathrm{th}\dfrac{b}{L_{(1)}}}{\mathrm{th}\dfrac{a-b}{L_{(2)}}}}{1+\dfrac{D_{(1)}}{D_{(2)}}\dfrac{L_{l(2)}}{L_{l(1)}}\dfrac{\mathrm{th}\dfrac{b}{L_{l(1)}}}{\mathrm{th}\dfrac{a-b}{L_{l(2)}}}} \quad [22] \qquad (22)$$

where $A = \frac{\gamma}{2} - 1$ (as in Eq. (18)) and indices (1) and (2) refer to fuel and moderator respectively. A comparison of this equation with that of E.R. Cohen (Ref. 5: ICPUAE, Geneva, 1955, P/611)

$$T_{eff} = T_0\left(1 + A\frac{\Sigma_a^T}{\xi\Sigma_s}\right) \quad [1] \qquad (1)$$

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for the same value of A and for a typical uranium-graphite lattice is shown in Fig. 6. There are divergences for high and low moderator-uranium volume ratios, although in the region normal for graphite moderated reactors, there is quite good agreement. Eq. (22) is also used to calculate the temperature of the neutron gas in the middle of the fuel elements in the WWR-S "EWA" reactor (Institute of Nuclear Sciences, Warsaw) core. The numerical values are $L_{(1)}$ = 1.80 cm, $D_{(1)}$ = 1.49 cm (averaged over the fuel composition), and $L_{(2)}$ = 2.72 cm, $D_{(2)}$ = 0.164 cm, a = 0.975 cm, effective b = 0.15 cm, $L_{t(1)}$ = 1.78 cm, $L_{t(2)}$ = 0.629 cm. For T = 320°K, Eq. (22) gives T_{eff} = 415°K in good agreement with the value 400°K given in "EWA" reactor documentation [Abstractor's note: No reference for this]. Cohen's equation gave $T_{eff} \approx 350°C$. The author thanks Dr.R. Żelazny of the Reactor Theory Group, Institute of Nuclear Research

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and Miss K. Kowalska. There are 7 figures, 2 tables and 13 references: 1 Soviet-bloc and 12 non-Soviet-bloc. The references to the 4 most recent English-language publications read as follows: D.A. Kottwitz, Bull.Am.Phys.Soc. 3, 1 (1958) Abstr. A7; B. Davison, Neutron Transport Theory, Oxford Edition, 1957; R.A. Bennet, R.E. Heinemann, Nucl.Sci. a. Engng. 8, 294 (1960), M.G. Campbell, R.G. Freemantle, M.J. Poole, ICPUAE Geneva 1958 P/10.

ASSOCIATION: Polish Academy of Sciences, Institute of Nuclear Research, Warsaw. Reactor Theory Group. /Abstractor's note: This article is written in English/.

SUBMITTED: February, 1961

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Fig. 3.

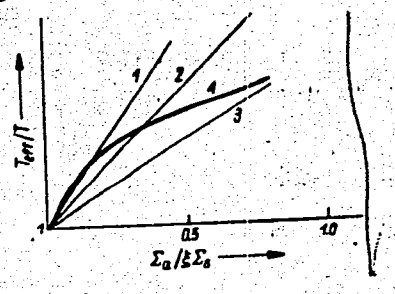

Fig. 3. The temperature of neutron spectrum in an infinite homogeneous absorbing medium (effect of "spectrum hardening")

1 — asymptotic form obtained from theoretical calculations for very small absorption to scattering cross-section ratio (5): $T_{eff} = T\left(1+\frac{2}{\sqrt{\pi}}\frac{M\Sigma_a}{\Sigma_s}\right)$; 2 — results of Monte Carlo calculations given by Coveyou et al (12)*): $T_{eff} = T\left(1+0.91\frac{M\Sigma_a}{\Sigma_s}\right)$; 3 — Cohen's formula: $T_{eff} = T\left(1+0.6\frac{M\Sigma_a}{\Sigma_s}\right)$; 4 — results obtained by using formula (18)

*) Ref. 12: R.R. Coveyou, R.R. Bate, R.K. Osborn, J. Nucl. Energy 2, 153 (1956).

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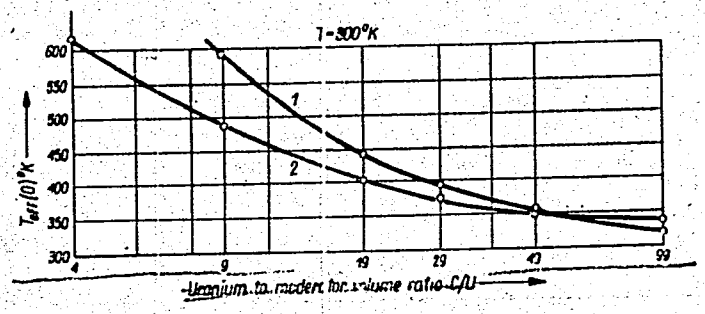
Fig. 6. [Abstractor's note: The abscissa should read "Moderator to uranium volume ratio"]. Effective neutron temperature in the center of a 2 cm thick fuel element plate vs. moderator - uranium volume ratio.
Legend: 1 - Extrapolation of Eq. (1); 2 - Eq. (22) A = 1.5 in both cases.

Fig. 6.



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AUTHOR: Weiss, Zbigniew

TITLE: Neutron spectrum temperature distribution in heterogeneous media with energy dependent absorption

PERIODICAL: Nukleonika, v. 6, no. 7-8, 1961, 443-460

TEXT: This paper follows a previous one by the author (Ref. 1: Neutron Spectrum Temperature Distribution in Heterogeneous Media with Constant Absorption, Nukleonika, 6, 243, 1961.) on the same subject. The assumption of energy independence of the absorption cross-section used in the earlier paper is not employed here, but the other basic assumptions, in which the neutron migration is described in the P_1 approximation and the moderator is represented by the heavy gas model, are unchanged. The thermalization equation in P_1 and 1/M approximation with energy dependent absorption cross-section is

$$\left.\begin{aligned} \Sigma_a(E) &= \Sigma_a^0\sqrt{E_0/E} \\ D\nabla^2\psi - \Sigma_a(E)\psi &= -\xi\Sigma_s A\psi - S \end{aligned}\right\} \quad \text{Eq. (1)}$$

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where the author defines his notation as in his previous paper. Expanding the solution of this into a set of Laguerre polynomials with variable coefficients

$$D\,E/T^2 \exp(-E/T)\,\Sigma_n\,\nabla^2 f_n(r)\,L_n(E/T) - \Sigma_n f_n(r)\,\Sigma_a(E)\,L_n(E/T)\times$$
$$\times E/T^2 \exp(-E/T) = \xi\Sigma_s\,E/T^2 \exp(-E/T)\,\Sigma_n\,n f_n(r)\,L_n(E/T) - \qquad \text{Eq. (3)}$$
$$-E/T^2 \exp(-E/T)\,\Sigma_n\,S_n(r)\,L_n(E/T)$$

and the equations for the $f_n(r)$ moments are obtained

$$-D\nabla^2 f_n(r) + \Sigma_a^T \Sigma_m \frac{a_{nm} f_n(r)}{1+n} + \xi\Sigma_s\,n f_n(r) = S_n(r) \qquad \text{Eq. (5)}$$

where

$$a_{nm} = \frac{1}{\Sigma_a^T}\int_0^\infty \Sigma_a(E)\,\frac{E}{T^2}\exp(-E/T)\,L_n(E/T)\,L_m(E/T)\,dE \qquad \text{Eq. (6)}$$

The infinite set of Eqs. (5) cannot be solved exactly, but in the Nth (or L_N) approximation, in which for $n > N$ all moments are assumed negligible.

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$$\left.\begin{array}{l} -D\nabla^2 f_0(r)+\Sigma_a^T a_{00} f_0(r)+\Sigma_a^T a_{01} f_1(r)+\ldots+\Sigma_a^T a_{0N} f_N(r)=S_0(r) \\ 1/2a_{10}\Sigma_a^T f_0(r)+(-D\nabla^2+\xi\Sigma_s+\Sigma_a^T 1/2a_{11})f_1(r)+\ldots+\Sigma_a^T 1/2a_{1N} f_N(r)=S_1(r) \\ \ldots \\ \Sigma_a^T a_{N0} 1/(1+N) f_0(r)+\cdots+\left(-D\nabla^2+N\xi\Sigma_s+\Sigma_a^T\frac{a_{NN}}{1+N}\right)f_N(r)=S_N(r) \end{array}\right\} \quad \text{Eq. (9)}$$

The solution of the homogeneous set of Eqs. (9) may be written as a superposition, with arbitrary coefficients A_i, of the solutions of

$$\nabla^2\Phi(\nu r)-\nu^2\Phi(\nu r)=0 \qquad \text{Eq. (10)}$$

where ν^2 is determined by

$$\left.\begin{vmatrix} -L^2\nu^2+a_{00}, a_{01}, \ldots, a_{0N} \\ 1/2a_{10}, -L^2\nu^2+\Delta^{-1}+1/2a_{11}, \ldots, \frac{a_{0N}}{2} \\ \ldots \\ a_{N0}/(1+N) \ldots, -L^2\nu^2+N\Delta^{-1}+\frac{a_{NN}}{1+N} \end{vmatrix}=0\right\} \quad \text{Eq. (11)}$$

where $L^2=D\Big/\frac{1}{2}\sqrt{\pi}\,\Sigma_a^T$, $\quad \Delta=\frac{1}{2}\sqrt{\pi}\,\Sigma_a^T/\xi\Sigma_s$.

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[Abstractor's note: ξ not defined.] having 2(N+1) roots for $\pm\nu_j$. The solu- solution of the homogeneous equations may then be written

$$f_n(r) = \sum_{j=0}^{j=N} A_j^+ C_n^j \Phi(\nu_j r) + \sum_{j=0}^{j=N} A_j^- C_n^j \Phi(-\nu_j r) \qquad \text{Eq. (12)}$$

where $A_j^{\pm}$ are arbitrary constants dependent on boundary conditions, and C_n^j coupling constants. From Eq. (11), products $\nu_j^2 L^2$ and the coefficients C_n^j are independent of geometry and may be tabulated. Also, the product $\nu^2 L^2$ depends only on the order of approximation and on Δ, so that

$$\nu_j^2 = 1/L^2 h_j(\Delta) \qquad \text{Eq. (13)}$$

From Eq. (12) and the fact that an orthogonality relation

$$\sum_{n=0}^{n=N} (1+n) C_n^j C_n^k = \delta_{jk} G^j$$

is established, a particular solution of the inhomogeneous equations (9) may be determined. A solution

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$$f_n^0(r) = \sum_{j=0}^{j=N} C_n^j R_j(r) \qquad \text{Eq. (14)}$$

is postulated. Substituting this in Eqs. (9), multiplying by $C_n^k(1+n)$ and summing over n, and using the above orthogonality relation

$$-D\nabla^2 R_k(r) G_k + D\gamma_k^2 G^k R_k(r) = \sum_{n=0}^{n=N} (1+n) C_n^k S_n(r) \qquad \text{Eq. (18)}$$

is obtained. There are only (1+N) equations for the 2(1+N) arbitrary functions $A_j^{\pm}(r)$ and a further (1+N) additional conditions

$$\nabla A_j^+ \Phi(\nu_j r) + \nabla A_j^-(r) \Phi(-\nu_j r) = 0 \qquad (j = 0, 1, \ldots N) \qquad \text{Eq. (19)}$$

are added, giving solutions

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$$\nabla A_j^+(r)\,\Phi(\nu_j r)+\nabla A_j^-(r)\,\Phi(-\nu_j r)=0$$

$$\nabla A_j^+(r)\,\nabla\Phi(\nu_j r)+\nabla A_j^-(r)\,\nabla\Phi(-\nu_j r)=-\frac{1}{DG^j}\sum_{n=0}^{n=N}(1+n)\,C_n^j\,S_n(r)\ \ldots \qquad \text{Eq. (20)}$$

for each pair of functions, so that the general solution is

$$f_n(r)=\sum_{j=0}^{j=N}[A_j^+ + A_j^+(r)]\,\Phi(\nu_j r)+\sum_{j=0}^{j=N}[A_j^- + A_j^-(r)]\,\Phi(-\nu_j r) \qquad \text{Eq. (21)}$$

The general boundary conditions will be satisfied in the Nth approximation if the moments fn(r) satisfy

$$f_n^{(1)}(r)=f_n^{(2)}(r)$$

$$D^{(1)}\frac{\partial f_n^{(1)}(r)}{\partial n}=D^{(2)}\frac{\partial f_n^{(2)}(r)}{\partial n} \qquad \text{Eq. (23)}$$

$(n=0,1,2,\ldots N)$ at the boundary between two media (1) and (2).

The simplest possible case is the L_1 approximation in a homogeneous medium. Eq. (11) becomes

$$\begin{vmatrix} -L^2\nu^2+1, & 1/2, \\ 1/4, & -L^2\nu^2+\Delta^{-1}+7/8 \end{vmatrix}=0 \qquad \text{Eq. (24)}$$

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which, for small Δ and $\Sigma_a^T/\xi\Sigma_s \gg 1$, gives

$$\left.\begin{aligned} \nu_0^2 &= \frac{1}{L^2}(0.57847+0.58717\Delta^{-1}-0.33760\Delta^{-2}+\ldots) \\ \nu_1^2 &= \frac{1}{L_1^2}(1.29652+0.41293\Delta^{-1}+0.33760\Delta^{-2}+\ldots) \end{aligned}\right\} \quad \text{Eq. (26)}$$

The coefficients C_n^j may be written

$$\left.\begin{aligned} C_0(\nu_0^2) &= C_1(\nu_1^2) = 1 \\ C_1(\nu_0^2) &= 2(L_1^2\nu_0^2-1) \\ C_0(\nu_1^2) &= \frac{\Delta}{2(L_1^2\nu_1^2-\Delta)} \end{aligned}\right\} \quad \text{Eq. (27)}$$

To examine the significance of these results, the contribution of neutrons in the Fermi tail to the absorption rate during thermalization is neglected. The effective temperature of the spectrum remains a variable, so that the remaining absorption will be

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$$A^* = -\sum_a^T {}_{eff} M[T_{eff}(r)] f_0(r) \qquad \text{Eq. (30)}$$

where

$$M[T_{eff}(r)] = \frac{T^2}{T_{eff}^2} s \exp\left[-s\frac{T}{T_{eff}}\right], \quad s = \frac{E}{T} \qquad \text{Eq. (31)}$$

and, expanding $\sum_a M[T_{eff}(r)]$ in Laguerre polynomials, an inhomogeneous set of equations for $f_0(r)$ and $f_1(r)$ in the L_1 approximation are obtained

$$-D\nabla^2 f_0(r) + \Sigma_a^T \frac{\sqrt{\pi}}{2} \frac{f_0(r)}{\sqrt{1 - f_1(r)/f_0(r)}} = S_0(r)$$

$$-D\nabla^2 f_1(r) + \xi\Sigma_s f_1(r) + \Sigma_a^T \frac{\sqrt{\pi}}{2} \frac{f_0(r)}{\sqrt{1 - \frac{f_1(r)}{f_0(r)}}}\left[1 - \frac{3}{4}\left(1 - \frac{f_1(r)}{f_0(r)}\right)\right] = 1/2\, S_1(r) \qquad \text{Eq. (37)}$$

If f_1/f_0 1, Eqs. (37) may be linearized

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D249/D302

Neutron spectrum temperature...

$$-D\nabla^2 f_0(r)+\Sigma_a^T \frac{\sqrt{\pi}}{2} f_0(r)\left[1+\frac{1}{2}\frac{f_1(r)}{f_0(r)}+\ldots\right]=S_0(r)$$

$$-D\nabla^2 f_1(r)+\xi\Sigma_s f_1(r)+\Sigma_a^T \frac{\sqrt{\pi}}{2} f_0(r)\left[1+\frac{1}{2}\cdot\frac{f_1(r)}{f_0(r)}+\ldots\right]\times$$

$$\times\left[1-\frac{3}{4}\left(1-\frac{f_1(r)}{f_0(r)}\right)\right]=S_0(r)\left(1-\frac{(\varepsilon)S}{2}\right) \qquad \text{Eq. (38)}$$

which may be shown to be exactly equation (9) for N=1. The method is now used to find the distribution of neutron temperature in a plate of natural uranium surrounded by an infinite graphite moderator. Constant neutron source distribution is assumed in the cases a) S_0= const., S_1= 1.5 S_0 (neutron slowing down source), and b) S_0= const., S_1= 0 (source neutron temperature = moderator temperature). The particular solution of equation (9) gives

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$$\left.\begin{aligned} f_0(\infty) &= \frac{S_0(\xi\Sigma_s+7/8\,\Sigma_a^T)-1/2\,\Sigma_a^T S_1}{\Sigma_a^T(\xi\Sigma_s+3/4\,\Sigma_a^T)} \\ f_1(\infty) &= \frac{\Sigma_a^T S_1-1/4\,\Sigma_a^T S_0}{\Sigma_a^T(\xi\Sigma_s+3/4\,\Sigma_a^T)} \end{aligned}\right\} \qquad \text{Eq. (39)}$$

The equations are evaluated for L = 50 cm., L_t = 5 cm., and the diffusion length in uranium = 1.14 cm. and the calculated flux and mean energy distributions are shown. Comparison with the results of Ref. 1 (Op. cit.) shows that more detailed investigations are required. For high N, the applicability of the L_N approximation is limited by the P_1 approximation, and the condition

$$\frac{N\xi\Sigma_s+\Sigma_a^+}{\Sigma_s} < 1 \qquad \text{Eq. (43)}$$

will be shown to apply in a subsequent paper. The neutron spectrum distribution in the fuel seems to be more conveniently treated by approximate matrix expressions due to the complicated boundary conditions, although it

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may be described by an equation only parametrically dependent on energy. The change of spectrum distribution produced by the variable absorption cross-section is considerable in strong absorbers, but of little significance in weak absorbers. For semiphenomenological considerations, Eq. (1) may be written

$$\left(-\sum_{n=0}^{n=1} D_{mn}\nabla^2 + \frac{a_{mn}}{1+m}\Sigma_a^T - \gamma_{mn}\Sigma_s\right) f_n = S_m \quad (m = 0,1)$$

Eq. (45)

where

$$D_{mn} = \frac{1}{1+m}\int_0^\infty M(E)D(E)L_m(E)L_n(E)\mathrm{d}E$$

$$\gamma_{mn} = \frac{1}{1+m}\int_0^\infty\int_0^\infty M(E)\frac{\Sigma_s(E\to E')}{\Sigma_s}(L_m(E')-L_n(E))L_m(E)\mathrm{d}E'\cdot\mathrm{d}E$$

and for heavy moderators it may be assumed that D(E) does not vary significantly nor affect much the orthogonality of the Laguerre polynomials.

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Thus, terms D_{01} and D_{10} may be neglected, and γ_{0n}, γ_{n0} and γ_{00} are all zero, since $L_0(E)$ is defined = 1. From equation (45) it may be shown that

$$\left.\begin{aligned}(-\nabla^2+k_0^2)f_0+1/2k_1^2 f_1 &= S_0'\\ 1/4k_0^{1'}f_0+(-\nabla^2+k_1^2)f_1 &= S_1'\end{aligned}\right| \qquad \text{Eq. (46)}$$

where $k_0^{2'} = k_0^2\frac{D_{00}}{D_{11}}$; $S_0' = \frac{S_0}{D_{00}}$; $S_1' = \frac{S_1}{D_{11}}$.

with $\frac{\alpha_{00}\sum_a^T}{D_{00}} = k_0^2(T)$; $\frac{\frac{1}{2}\left\langle(E-E')^2\right\rangle}{D_{11}} + \frac{\sum_a^T \alpha_{11}}{D_{11}} = k_1^2(T)$

$\frac{1}{2}\left\langle(E-E')^2\right\rangle$ is the mean energy transfer square. Hence k_0^2 and k_1^{22} may be evaluated experimentally by flux and energy measurements in simple geometrical conditions. The author thanks Doctor R. Żelazny and Miss K. Kowalska for their help. There are 2 figures, 2 tables and 2 Soviet-bloc references.

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D249/D302

Neutron spectrum temperature...

ASSOCIATION: Polish Academy of Sciences Institute of Nuclear Research, Warsaw, Reactor Engineering Department

SUBMITTED: May, 1961

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"APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1

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P/046/61/006/011/001/004
D216/D304

24.6500

AUTHOR: Weiss, Zbigniew

TITLE: The transport theory of thermal neutrons in a heavy gas moderator

PERIODICAL: Nukleonika, v. 6, no. 11, 1961, 691 - 701

TEXT: This is the third in a series of four papers by the author on neutron temperature distribution. The solution of the multivelocity Boltzmann equation is reduced to solving set of single-velocity Boltzmann equations for the energy moments of the expansion of the distribution function in Laguerre polynomials. The requirement for more exact information about neutron spectra has arisen with the development of the sperical harmonics approach to reactor theory. The Boltzmann equation is written in the form

$$\Omega \cdot \mathrm{grad}\,\psi + \sigma_{tot}\,\psi = \int_0^\infty dE' \iint \langle \sigma(E' \to E, \Omega \cdot \Omega') \rangle_T \psi(r, \Omega', E')\, d\Omega' + S \qquad (1)$$

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with $\psi = \psi(\mathbf{r}, \Omega, E)$ representing the neutron distribution; $\sigma_{tot}(E)$ the total macroscopic cross-section; $\langle \sigma(E' \to E, \Omega \cdot \Omega') \rangle_T$ the energy transfer cross-section; and $\Omega \cdot \Omega'$ the cosine of the angle through which the neutron is scattered. Expressing the energy transfer cross-section analytically, and in the 1/M approximation,

$$\sigma_{tot}(E) = \sigma_a(E) + \sigma_o \left(1 - \frac{2}{M} + \frac{T}{2\,ME}\right) \sigma_o + \sigma_a(E) - \sigma_o \sigma_1(E) \lambda \quad (5)$$

where σ_o is the bound atom scattering cross-section, σ_a the absorption cross-section, $\lambda = 1/M$, and $\sigma_1(E) = (2 - T/2E)$. Also, putting the expression for the energy transfer cross-section in the right-hand side of Eq. (1), the equation becomes

$$\Omega \cdot \operatorname{grad} \psi + \sigma_o [1 - \lambda \sigma_1(E)] \psi + \sigma_a(E) \psi =$$

$$= \frac{\sigma_o}{4\pi} \iint \{[1 - \lambda \sigma_1(E)] (1 + 2\lambda \hat{a}) - 2\lambda \Omega \cdot \Omega' (\hat{a} - 1)\} \psi(\mathbf{r}, \Omega', E)\, d\Omega' + S \quad (1')$$

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with $\hat{\alpha}$ representing the operator $ET\frac{\partial^2}{\partial E^2} + E\frac{\partial}{\partial E} + 1$, so long as the restriction to the first order of the 1/M approximation is observed. Eq. (1') may further be rewritten

$$(\hat{I}_o - \lambda \hat{I}_1)\psi(\mathbf{r},\Omega,E) = S(\mathbf{r},\Omega,E) \qquad (1'')$$

where the operators $\hat{I}_o$ and $\hat{I}_1$ are given by

$$\hat{I}_o = \Omega\,\mathrm{grad} + \bar{\sigma}_a + \sigma_o - \frac{1}{4\pi}\sigma_o \iint (1 + 2\lambda\hat{\alpha}) \ldots d\Omega' \qquad (7a)$$

$$\hat{I}_1 = \sigma_o \sigma_1(E)\left[1 - \frac{1}{4\pi}\iint \ldots d\Omega'\right] - [\sigma_a(E) - \bar{\sigma}_a]/\lambda$$
$$- \sigma_o \frac{1}{2\pi}(\hat{\alpha} - 1)\iint \Omega\cdot\Omega' \ldots d\Omega' \qquad (7b)$$

and the absorption cross-sections are assumed to be small. The equation for the zeroth order approximation in

$$\hat{I}_o \psi_o = S \qquad (8)$$

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gives the isotropic constant cross-section approximation. The eigenfunctions of $\hat{Q}$ form a complete set of Laguerre ploynomials which are, in vector notation,

$$|j\rangle = \frac{E}{T^2} \exp\left(-\frac{E}{T}\right) L_j^1 \ (E/T)\rangle \qquad (9)$$

The solution of Eq. (8) may then be represented as an infinite expansion

$$\psi_o\ (\mathbf{r},\Omega,E) = \Sigma_j\ |\ j\rangle\langle j|\psi_o\rangle \qquad (10)$$

with the coefficients $\langle j|\psi_o\rangle = f_j(\mathbf{r},\Omega)$ satisfying

$$\Sigma_j \langle i|I_o|j\rangle\langle j|\psi_o\rangle = \langle i|S\rangle \quad (i = 0,1,2, \ldots) \qquad (11)$$

Since the operator $\hat{I}_o$ is diagonal with respect to the variable E, a separate transport equation is given for each energy moment $f_j\ (\mathbf{r},\Omega)$

$$\Omega\ \mathrm{grad}\, f_j(\mathbf{r},\Omega) + \sigma f_j(\mathbf{r}\Omega) = \frac{c_j\sigma}{4\pi} \iint f_j(\mathbf{r},\Omega')\ d\Omega' + s_j \qquad (12)$$

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where $f_j(\mathbf{r},\Omega) = \langle j | \psi_o \rangle = \frac{1}{j+1} \int \psi_o (\mathbf{r},\Omega,E) L_j (E/T) dE$

$s_j(\mathbf{r},\Omega) = \langle j | S \rangle = \frac{1}{j+1} \int S (\mathbf{r},\Omega,E) L_j (E/T) dE$

and

$c_j = c_o (1 - 2 \lambda j)$ $\qquad \sigma = \sigma_o + \bar{\sigma}_a$

[Abstractor's note: $\bar{\sigma}_a$ not defined.] Hence the multivelocity thermalization equation has been reduced to an uncoupled set of one velocity Boltzmann equations with different effective numbers of secondaries c_j. Assuming the functions to be known, then from equation (1*)

$$\psi(\mathbf{r},\Omega,E) = \psi_o (\mathbf{r},\Omega,E) + \lambda \psi_1 \tag{15a}$$

where

$$\hat{I}_o \psi_1 = \hat{I}_1 \psi_o \tag{15b}$$

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giving the correction term Ψ, of the order of 1/M which must be added to the isotropic constant cross-section approximation to obtain the consequent 1/M solution. From Eq. (9) and the conjugate vectors

$$\langle k | = \langle \frac{1}{k+1} L_k (E/T) \tag{9'}$$

Eq. (15b) becomes

$$\Sigma_j \langle i | \hat{I}_o | j \rangle \langle j | \Psi_1 \rangle = \Sigma_k \langle i | I_1 | k \rangle \langle k | \Psi_o \rangle \tag{16}$$

$\langle i | \hat{I}_o | j \rangle$ is as in the zeroth approximation, but $\langle i | I_1 | k \rangle$ is given by

$$\langle i | I_1 | k \rangle = \hat{p}_\Omega \sigma_o \beta_{ik} - \bar{\sigma}_a \gamma_{ik} + \sigma_o \delta_{ik} (k+1) \hat{q}_\Omega \tag{17}$$

where

$$\hat{p}_\Omega = 1 - \frac{1}{4\pi} \iint \ldots d\Omega'$$

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$$\hat{q}_{\Omega} = \frac{1}{2\pi}\int\int \Omega\cdot\Omega' \ldots \, d\Omega'$$

are operators acting only on the angular coordinates of the distribution function, $\beta_{ik} = 2\delta_{ik} - 1/2$ are the matrix elements of $\sigma_1(E)$, defined as

$$\frac{1}{i+1}\int_0^{\infty} M(E)\, L_i(E)\left(2 - \frac{1}{2E}\right) L_k(E)\, dE \quad \text{and}$$

$$\gamma_{ik} = \frac{\sigma_a^T{}_1}{\bar{\sigma}_a (k+1)}\alpha_{ik} - \delta_{ik} \qquad (17d)$$

where $\alpha_{ik} = \int_0^{\infty} M(E)\, L_i(E)\, L_k(E)\, E^{-1/2}\, dE$

[Abstractor's note: M(E) not defined]. Consequently

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$$\Psi(\mathbf{r},\Omega,E) = M(E)\sum_j \left[f_j(\mathbf{r},\Omega) + \frac{1}{M} g_j(\mathbf{r},\Omega) \quad L_j(E/T) \right] \tag{18}$$

where $f_j(\mathbf{r},\Omega)$ and $g_j(\mathbf{r},\Omega)$ satisfy

$$\Omega \operatorname{grad} f_j + \sigma f_j - \frac{c_j \sigma}{4\pi} \iint f_j(\mathbf{r},\Omega')\, d\Omega' = S_j(\mathbf{r},\Omega) \tag{18a}$$

$$\Omega \operatorname{grad} g_j + \sigma g_j - \frac{c_j \sigma}{4\pi} \iint g_j(\mathbf{r},\Omega')\, d\Omega) =$$

$$= [\sigma_o (j+1)\, \hat{q}_\Omega + 2\sigma_o \hat{p}_\Omega] f_j(\mathbf{r},\Omega) + \bar{\sigma}_a \cdot f_j(\mathbf{r},\Omega) -$$

$$- \sum_k \left[\frac{\sigma_o}{2} \cdot \hat{p}_\Omega + \frac{G_a^T \alpha_{jk}}{1+k} \right] f_k(\bar{\mathbf{r}},\Omega) \tag{18b}$$

Each g_j function, being dependent on the whole set of f_j functions, is not

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exact in a finite approximation, but for not too large absorption, the moments converge rapidly since the spectrum is not much different from the Maxwellian. The operator p gives the difference between the actual distribution and its mean value, and the operator q is connected with the neutron current. The restriction on the order of the Laguerre polynomial expansion in the P_1 approximation, shown in the author's previous two papers, is avoided here, and some of its inadequacies are shown up. In the P_1 approximation, the first roots of the determinant equation obtained by expanding the energy moments into Legendre polynomials increased with increasing order of the moment index, so that the appropriate attenuation length were decreasing - a contradiction since these cannot be less than the neutron mean free path. This does not occur in the method presented here, in fact, for j M/2 c_j becomes negative, and there are no " diffusion" solutions. There are 11 references, 4 Soviet-bloc and 7 non-Soviet-bloc. The 4 most recent references to English-language publications read as follows: E.R. Cohen, Nucl. Science and Engineering 2 227 - 245 (1957); Jr. Hurvitz, M.S. Nelkin, G.J. Habetler, Nucl.Sciences and Engineering 1 280 - 312 (1956); S. Iha. Sunhanshu, J. of Nuclear Energy June (1960); D.A. Kottwitz, Ther-

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The transport theory of ...

mal Neutron Flux in a Nonabsorbing Heavy Gas Medium with a Temperature Discontinuity, ORNE - 2739

ASSOCIATION: Polish Academy of Sciences. Institute of Nuclear Research Warsaw. Reactor Engineering Department, Reactor Theory Group

SUBMITTED: July, 1961

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D216/D304

24.6500

AUTHOR: Weiss, Zbigniew

TITLE: The $P_N L_J$ approximation of neutron thermalization in a heavy gas moderator

PERIODICAL: Nukleonika, v. 6, no. 11, 1961, 703 - 716

TEXT: This is the last of 4 papers by the author on neutron temperature distribution and illustrates the method of solving the multivelocity Boltzmann equation developed in the third of these, together with a solution of the Milne problem in P_3L_J approximation. From the third paper, the neutron distribution function in space, in consequent 1/M approximation may be written

$$\psi(x,\mu,E) = \psi^{(o)} + \frac{1}{M}\psi^{(1)} = \frac{E}{T^2}\exp\left(-\frac{E}{T}\right)\sum_j\left[f_j(x,\mu) + \right.$$

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$$+ \frac{1}{M} g_j (x, \mu) \Big] L_j \frac{E}{T} \qquad (1)$$

with f_j and g_j satisfying

$$\mu \frac{\partial f_j}{\partial x} + f_j - \frac{c_j}{2} \int_{-1}^{+1} f_j(x, \mu') d\mu' = S_j(x, \mu) \quad (j = 0, 1, \ldots) \qquad (2a)$$

and

$$\mu \frac{\partial g_j}{\partial x} + g_j - \frac{c_j}{2} \int_{-1}^{+} g_j(x, \mu') d\mu' = c_0 [(1 + j) \hat{q}_\mu] f_j(x, \mu) + c_0 \hat{p}_\mu \sum_{k=0} \beta_{jk} f_k(x, \mu) + (1 - c_0) \sum_{k=0} \gamma_{jk} f_k(x, \mu) \qquad [2b]$$

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where $c_o = \frac{\sigma_o}{\sigma_o + \bar{\sigma}_a}$; $\hat{q}_\mu = \mu \int_{-1}^{+1} \mu' \ldots d\mu'$; $\hat{p}_\mu = 1 - 1/2 \int_{-1}^{+1} \ldots d\mu'$ (3)

Throughout the paper, the notation used is: - Legendre vectors $|M\rangle = \frac{2M+1}{2}$ $P_M(\mu)\rangle$, and their conjugates $\langle N| = \langle P_N(\mu)|$; Laguerre vectors $|j| = |E/T^2 \exp(-E/T) L_j(E/T)\rangle$ and their conjugates $\langle k| = \langle 1/k + 1$ $L_k(E/T)$. All the problems involved concern the general solution of the inhomogeneous one-velocity transport equation, and this is next found. In the vector notation, the equation to be solved is

$$\sum_{M,j} \langle N,k|I_o|j,M\rangle \langle M,j|\psi\rangle = \langle N,k|F\rangle \quad (k = 0,1,2,\ldots) \quad (N = 0,1,2,\ldots) \qquad (5')$$

with F an arbitrary function of x, μ, E, and $\hat{I}_o$ is a transport operator defined in the author's previous paper (Nukleonika, 6,691, 1961). The solution of the homogeneous equation in P_N approximation may be written

$$\psi_n^j = c^j \exp(\nu x) \qquad (10)$$

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where C^j are column vectors, the elements C^j_M of which are simply numbers. Since the matrix elements $\langle N,k \mid I_c \mid j,M \rangle$ are diagonal with respect to energy variable, and since, from the recurrence formulae of Legendre polynomials $\langle N \mid \mu \mid M \rangle$ may be written

$$\langle N \mid \mu \mid M \rangle = \frac{1}{2N+1}\left[(N+1)\delta_{N+1,M} + M\delta_{n-1,M}\right] = \frac{(\hat{\omega})_{NM}}{2N+1} \qquad (8)$$

then the homogeneous equation to be solved becomes

$$\nu\left[\hat{\omega}\, c^j\right] + c^{*j} = 0 \qquad (6'')$$

where

$$c^{*j}_M = (2M+1)\,(1 - c_j \delta_{0M})\, c^j_M \qquad (6'')$$

and $c_j = c_0\,(1 - 2j/M)$. The matrix $\hat{\omega}$ is symmetric, so that there are N+1 (for odd N) eigenvalues for $\nu - \pm\nu^j_1, \pm\nu^j_2 \ldots \pm\nu^j_{(N+1)/2}$ and also the $c^j(\nu_r)$ vectors are orthogonal to each other. Thus the general solution of

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the homogeneous equation is

$$\Psi_h^l = \sum_{r=1}^{r=\frac{N+1}{2}} A_r^{l+} C(\nu_r^l) \exp(\nu_r^l x) + \sum_{r=1}^{r=\frac{N+1}{2}} A_r^{l-} C(-\nu_r^l) \exp(-\nu_r^l x) \quad [12]$$

where $C_M^l(-\nu_r) = (-1)^M C_r^l(\nu_r)$.

For the particular solution , column vectors

$$F^k = \begin{pmatrix} \langle 0,k, \mid F \rangle \\ \langle 1,k \mid F \rangle \\ \cdots\cdots\cdots \\ \langle M,k \mid F \rangle \end{pmatrix} \quad (13)$$

are defined, and the solution

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$$\Psi_p^k = \sum_{s=1}^{s=\frac{N+1}{2}} B_s^{k+}(x)\, C(\nu_s^k) \exp(\nu_s^k x) + \sum_{s=1}^{s=\frac{N+1}{2}} B_s^{k-}(x)\, C(-\nu_s^k) \exp(-\nu_s^k x) \quad [14]$$

is postulated. Putting this Eq. (5′), for each k

$$\sum_{s=1}^{s=\frac{N+1}{2}} \frac{dB_s^{k+}(x)}{dx} [\hat{\omega}\, C(\nu_s^k)] \exp(\nu_s^k x) + \sum_{s=1}^{s=\frac{N+1}{2}} B_s^{k+}(x) \{\nu_s^k [\hat{\omega} C(\nu_s^k)] + C^*(\nu_s^k)\} \cdot \exp(\nu_s^k x) + \{\text{for the } (-\nu_s^k) \text{ roots}\} = [\hat{D} F^k] \quad [15]$$

where D is a diagonal matrix, with $D_{NN} = 2N + 1$. From Eq. (6″), and the definition of the vector C^k, multiplying by $C^k(\nu_s^k)$, and integrating

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The $P_N L_J$ approximation of ...

$$B_s^k \pm (x) = -\frac{\pm \nu_s^k}{h(\nu_s^k)} \int_0^x \left(C(\pm\nu_s^k)\left[D\cdot F^k(\xi)\right]\right) \exp\left(\mp \nu_s^k \xi\right) d\xi \tag{17}$$

so that the general solution of the problem may be written

$$\langle M,k|\psi\rangle = \sum_{s=1}^{s=\frac{M+1}{2}} \left[A_s^{k+} - \frac{\nu_s^k}{h(\nu_s^k)} \sum_{M'} (2M'+1)\, C_{M'}(\nu_s^k) \int_0^x e^{-\nu_s^k \xi} \langle M',k|F(\xi)\rangle d\xi\right] \cdot M(\nu_s^k) \exp(\nu_s^k x) + \{\text{for negative roots} - \nu_s^k\} \quad [18]$$

where

$$h(\nu_s^j) = (N+1)(\nu_s)^2\, C_N(\nu_s^j) \left.\frac{dC_{N+1}(\nu_s^j)}{d\nu}\right|_{\nu=\nu_s^j} \tag{11b}$$

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In the general case, this procedure is repeated twice. Ψ is found first from the real sources S ($\Psi = \Psi^{(0)}$, F = S) and then the new fictitious source term $\langle M,k | S_1 \rangle$ is found from Eq. (2b) and Eq. (18) gives the first correction term ($\Psi = \overset{(1)}{\Psi}$, F = S_1). The method is applied to calculate the Milne problem in $P_3 L_J$ approximation, with $c_0 \to 1$. From the boundary conditions at infinity, $\overset{(0)}{\Psi} = 0$ for $j > 0$, and Ψ^0 may be written

$$\overset{(0)}{\Psi}{}^0 = \begin{pmatrix} z_0 + x + Ae^{-\nu_1^0 x} \\ -1/3 \\ AC_2 e^{-\nu_2^0 x} \\ AC_3 e^{-\nu_3^0 x} \end{pmatrix} \qquad [19]$$

[Abstractor's note: In Eq. (19), the last 2 terms in the matrix should read $AC_2 e^{-\nu_2^0 x}$; $AC_3 e^{-\nu_2^0 x}$]

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with, in P_3 approximation, the extrapolation length $z_o = 0.70509$, $A = -0.10247$, and $\nu_2^o = 1.972027$, and x is measured in σ_o^{-1} units. The F^k vectors (Eq. 13) are found by acting on $\overset{(o)}{\Psi}$ with the operator $\hat{I}_1$ as defined in the previous paper (Nukleonika, 6,691, 1961) For $c_o \to 1$, the matrix elements of $\hat{I}_1$ in $|k,N\rangle$ representation are

$$\langle M,j \mid I_1 \mid k,N \rangle = \left\{ \delta_{jk} \left[\frac{2}{3} (1 + j) \delta_{1,N} \right] + \beta_{jk} (1 - \delta_{OM}) \right\} \delta_{N,M} \qquad (20)$$

so that

$$F^0 = \begin{pmatrix} 0 \\ -\frac{1}{3}\left(\beta_{00} + \frac{2}{3}\right) \\ \beta_{00} A C_2 e^{-\nu_2^o x} \\ \beta_{00} A C_3 e^{-\nu_3^o x} \end{pmatrix} \qquad F^k = \begin{pmatrix} 0 \\ -\frac{\beta_{0k}}{3} \\ \beta_{0k} A C_2 e^{-\nu_2^o x} \\ \beta_{0k} A C_3 e^{-\nu_3^o x} \end{pmatrix} \qquad [22a]$$

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and thus

$$[D\hat{F}^0] = \begin{pmatrix} 0 \\ -\left(\beta_{00} + \frac{2}{3}\right) \\ 5\beta_{00} A C_2 e^{-\nu_2^0 x} \\ 7\beta_{00} A C_3 e^{-\nu_2^0 x} \end{pmatrix} \qquad [D\hat{F}^k] = \begin{pmatrix} 0 \\ -\beta_{0k} \\ 5\beta_{0k} A C_2 e^{-\nu_2^0 x} \\ 7\beta_{0k} A C_3 e^{-\nu_2^0 x} \end{pmatrix} \qquad [22b]$$

From Eq. (17), and using the boundary conditions of the problem, the first component (total flux) is given by

$$\langle 0,0 \mid \binom{1}{\psi} \rangle = z_0 \left(\beta_{00} + 2/3\right) + A\left(\beta_{00} + 2/3\right) \exp\left(-\nu_2^0 x\right) + A \nu_2^0 x \exp\left(-\nu_2^0 x\right) \qquad (28)$$

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$$\overset{(1)}{\Psi}{}^0 = \begin{pmatrix} z^0\left(\beta_{00}+\frac{2}{3}\right)+A\left[\beta_{00}+\frac{2}{3}-\nu_2^0 x\right]\exp(-\nu_2^0 x) \\ -\frac{\beta_{00}+2/3}{3} \\ (C_2 A(\nu_2^0 x+\beta_{00}+2/3)\exp(-\nu_2^0 x) \\ (C_3 A(\nu_2^0 x+\beta_{00}+2/3)\exp(-\nu_2^0 x) \end{pmatrix} \qquad [29]$$

The zeroth energy moment of the flux distribution may be written

$$\Psi^0 = \overset{(0)}{\Psi}{}^0 + \frac{1}{M}\overset{(1)}{\Psi}{}^0 \qquad (30)$$

with $\overset{(0)}{\Psi}{}^0$ and $\overset{(1)}{\Psi}{}^0$ given by Eqs. (19) and (29). Solving Eq. (17) for the functions $B^k(x)$, and substituting in Eq. (18)

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$$\overset{(1)}{\psi}{}^k = \sum_{r=1}^{r=2} B_r^{k'} C(-\nu_r^k) \exp(-\nu_r^k x) + U^k \exp(-\nu_2^o x) + Z^k \qquad (34)$$

where

$$(U^k)_N = \sum_r \left[\frac{b_r^{k-} C_N(-\nu_r^k)}{\nu_r^k - \nu_2^o} - \frac{b_r^{k+} C_N(\nu_r^k)}{\nu_r^k + \nu_2^o} \right] \qquad (35a)$$

$$(Z^k)_N = \sum_r \frac{a_r^{k+} C_N(\nu_r^k) - a_r^{k-} C_N(\nu_r^k)}{\nu_r^k} \qquad (35b)$$

and the integration constants $B_r^{k'}$ may be evaluated from the Marshak plane surface boundary conditions. The extrapolation length exact to the order of $1/M^2$ becomes

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$$z_0' = z_0 \left[1 + \frac{1}{M}\left(\beta_{00} + \frac{2}{3}\right)\right] = z_0 \left(1 + \frac{3}{2M} + \frac{2}{3M}\right) \qquad (40)$$

the term 2/3M for first order anisotropy of scattering coinciding with that of Davison (Neutron Transport Theory, Oxford), and the correction 3/2M for the variable scattering cross-section being the same as that obtained by Nelkin (Nucl. Sci. and Engineering, 7, 6, 1960) by a variational method. Other problems may easily be solved, and a similar procedure may be used for other geometries. There are 1 figure, 3 tables and 4 references: 1 Soviet-bloc and 3 non-Soviet-bloc. The references to English-language publications read as follows: B. Davison, Neutron Transport Theory, Oxford, 1957; M.S. Nelkin, Nucl. Sci. and Engineering, 7, 6, 1960; B. Davison, Neutron Transport Theory, Oxford 1957, formula 17.32

ASSOCIATION: Polish Academy of Sciences. Institute of Nuclear Research, Warsaw. Reactor Engineering Department, Reactor Theory Group

SUBMITTED: July, 1961

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AUTHORS: Boużyk Jacek, Dąbek Wacław, Dąbrowski Cyryl, Józefowicz Krystyna, Koźmiński Jerzy, Suwalski Witold, Topa Jerzy, and Weiss Zbigniew

TITLE: Experimental analysis of the use of the "EWA" reactor for some pile-oscillator measurements

PERIODICAL: Nukleonika, v. 6, no. 11, 1961, 717 - 734

TEXT: This paper investigates the sensitivity of moderator purity determinations in the WWR-S "EWA" reactor of the Polish Academy of Sciences at Swierk using various methods. A priliminary report of the work has already been published (Ref. 6: W. Dąbek Nukleonika, 5, 415, 1960). The periodic change in neutron density caused by harmonic oscillation of an absorbing sample causing small reactivity changes may be written

$$\frac{n(t) - n_{av}}{n_{av}} = \sum_{m=1}^{\infty} G^{(m)} e^{j(m\omega t + \varphi^{(m)})} + \sum_{m=1}^{+} L^{(m)} e^{j(m\omega t + \alpha)} -$$

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$$= \sum_{m=1}^{\infty} R^{(m)} e^{j(m\omega t + \theta^{(m)})} \qquad (2)$$

where $n(t)$ and n_{av} are the time dependent and average neutron densities, $G^{(m)}$ $L^{(m)}$ $R^{(m)}$ are the relative amplitudes of the m-th harmonics of the global (general reactor), local and resultant signals, $\varphi^{(m)}$, α and $\theta^{(m)}$ are the phase angles of the global, local and resultant signals, and the period of oscillation of the sample $T = 2\pi/\omega$. Fundamental harmonics only are considered, the other being eliminated by the apparatus or by computation. G and L depend upon the absorber content of the sample, and the global and local signal sensitivities g and l may be expressed

$$g = \frac{1}{x} \cdot \frac{G_x - G_o}{G_o} \qquad (8a)$$

$$l = \frac{1}{x} \cdot \frac{L_x - L_o}{L_o} \qquad (8b)$$

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where x = equivalent number of boron nuclei per million moderator nuclei, and the subscripts x and o refer to signals for samples with and without absorbing impurities respectively. Similarly, the sensitivity of the resultant signal, , may be defined in terms of the phase angle

$$\vartheta = \frac{1}{x} (\theta_x - \theta_o) \qquad (8c)$$

Measurements were made at 300 W reactor power with as low xenon poisoning as possible. The sample was oscillated in the core in an empty fuel channel with one detector in an adjacent fuel channel and one in the thermal column (detecting the resultant and global signals respectively). For reactor stability, the cooling system is not operated. Samples were made of 200 - 250 ccs. of moderator with varying contents of boric acid (100-1000 ppm of boron), and were contained in aluminum or plexiglass. The large amounts of poison were necessary due to the low sensitivities of signals and apparatus. The detectors were differential ionization chambers, used with mirror galvanometers, electrometric dc amplifiers with 100 % feedback and a constant current compensating circuit. 1. Static method: Eq. (8a)

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may be also expressed in terms of the fundamental harmonics of the k_{eff} change for samples with and without impurities, and these may be computed from statically measured characteristics of the change in k_{eff} obtained during the sample oscillation. Simultaneously, the adjacent detector determines the characteristics of the local change in neutron density and 1 may be found from Eq. (8b). Finally, ϑ may be obtained from Eq. (8c) by

$$\vartheta = \frac{d\theta}{dx}\Big|_{x=0} = \mp (\varepsilon + 1) \frac{\sin\varphi}{\frac{1}{a} \mp a^2 \mp 2\cos\varphi} \qquad (10)$$

where $a = L_0/C_0$ and the upper and lower signs refer to $\alpha = 0$ and π (in-phase and counter-phase oscillations) respectively. φ and the relation between G and the change in k_{eff} may be computed or determined experimentally. The sample was positioned at the required point, and the reactor was balanced by a fine control rod which gave the appropriate value of k_{eff} 2. Kinetic method: Global and resultant signals are recorded on oscillograms during oscillations of the sample. Parasitic phase shifts σ_G and σ_H

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of the global and resultant signals occur, and are eliminated by performing two oscillations, one with $\alpha = 0$ and one with $\alpha = \pi$, of the same sample. Since the parasitic effects are the same for both oscillations, they may be removed by combining the observations. φ is determined from this by a method of successive approximations, and the correct L and θ values and hence l and ϑ are computed. The analysis becomes even simpler for small φ and $(L/G)_{\alpha=\pi} > 2$. The sample was mechanically oscillated with T variable from 1 - 22 seconds and amplitude from 50 - 430 mms. The reactor was balanced before and during the oscillations and once the oscillations were constant, a set of about 10 was recorded on oscillograms. At least 5 periods of the R and G signals were harmonically analyzed with accuracy up to the third harmonic. For measurements in the core with graphite samples, the signal sensitivities are, to an accuracy of 20%, - g and l both ~0.8 %o/ppm, and $\vartheta \sim 0.3$ °/ppm - all for optimum experimental conditions. These are lower by two orders of magnitude than those obtainable in thermal reactors, and similar results are found for other moderators. They are due to the high contribution of the slowing-down process to G and L, in comparison with which the absorption contribution is hardly observed. The self-shielding effect of boron is a factor 0.5 for samples containing 500-

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-1000 ppm of boron. Measurements in a horizontal channel in the water reflector gave slightly lower sensitivities, but were not pursued due to experimental difficulties and unpromising results. Static method measurements in the horizontal thermal column channel gave promising results for 1. The results indicate a considerable increase in the effective delayed neutron fraction in comparison with the data of Keepin, Wimett and Zeigler (Ref. 7: Phys. Rev., 107, 1044, 1957). Preliminary estimates give this as 0.0081 ± 0.0009, and the mean prompt neutron lifetime as 100 ± 30 sec. The static and kinetic methods give consistent sensitivities. The authors acknowledge W. Frankowski, Head of Reactor Engineering Division IBJ, P. Szulc and L. Labno, in charge of teams of Reactor Operation Division IBJ, Dobrski, Kulman and Kwiatek for cooperation in reactor measurements, Post for elaborating the oscillator mechanical drive, Miss Brozyna and Miss Maniecka for scanning the oscillograms, and Mrs. Sawicka, leader of the computer team from the Applied Mathematics Division IBJ. There are 8 figures and 8 references: 5 Soviet-bloc and 3 non-Soviet-bloc. The references to the English-language publications read as follows: D. Breton, First Geneva Conferences Paper P/356, 1955; G.R. Keepin, T.F. Wimett, R.K. Zeigler, Phys. Rev., 107, 1044, 1957

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Experimental analysis of ...

ASSOCIATION: Polish Academy of Sciences, Institute of Nuclear Research, Warsaw, Reactor Engineering Department

SUBMITTED: July, 1961

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L 19670-65 EWT(m)/EPF(c)/EPF(n)-2/EPR Pr-4/Ps-4/Pu-4 SSD

ACCESSION NR: AP4045667 P/0046/64/009/07-/0575/0585

AUTHOR: Adamski, L.; Arkuszewski, J. (Arkushevski, Ya.); Bednarz, R. (Bednarzh, R.); Jozefowicz, E. T. (Yuzefovich, E. T.); Jozefowicz, K. (Yuzefovich, K.); Kaczmarek, W. (Kachmarek, V.); Kulikowska, T. (Kulikovska, T.); Malewski, S. (Malevski, S.); Mika, J. (Mika, Ya.); Szechter, A. (Shekhter, A.); Weiss Z. (Vayss, Z.); Bryhn-Ingebrigtsen, K. (Bry*n-Ingebrigt*sen, K.); Smit, J. (Smit, I.); Stamm'ler, R. J. J. (Stamm'ler, R. I. I.); Jockovic, M. (Iotskovich, M.); Pop-Jordanov, J. (Pop-Iordanov, I.); Takac, S. (Takach, M.)

B

TITLE: Microscopic neutron flux distributions in unit cells of critical assemblies of the NPY Project

19

SOURCE: Nukleonika, v. 9, no. 7-8, 1964, 575-585

TOPIC TAGS: neutron distribution, reactor physics, intracell neutron distribution, unit cell, critical reactor, NPY project

ABSTRACT: This article, which is one of the first official reports

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of the NPY Project, contains a preliminary study of intracell neutron distributions in three critical assemblies operating in Norway, Poland, and Yugoslavia. The NPY lattices that were studied and the experimental techniques used in three zero-power reactors (NORA, ANNA, and RB) are discussed and experimental and theoretical results are given in tabular form (refer to the Enclosures). The computational methods used in Norway and applied to the NPY lattices involved the use of two integral transport codes (available for use on the Ferranti Mercury computer) developed by the Netherlands-Norwegian K-7 Project at Kjeller-K-7 THERMOS and K-7 TRANSPO; cross-sections used in these codes are given in tables. Two analytical methods were used in Poland: the first, used for NORA and ANNA, made use of a one-group Amouyal-Benoist approach applied to a multilayer system; the second used the Laguerre polynomial expansion for distributions in the moderator. Two computational methods were employed in Yugoslavia: a standard one-velocity P_3 method with isotropic flux return at the outer boundary and an improved analytical neutron thermalization method developed in Yugoslavia. The experimental and theoretical results obtained for NORA lattices show that the experimental values

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of the disadvantage factors lie within the range of theoretical values obtained by different methods. Orig. art. has: 3 figures and 6 tables.

ASSOCIATION: Institute of Atomic Energy, Kjeller, Norway; Institute of Nuclear Research, Swierk, Poland; Boris Kidrich Institute of Nuclear Sciences, Vincha, Yugoslavia

SUBMITTED: 00 ENCL: 04 SUB CODE: NP

NO REF SOV: 002 OTHER: 000

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"APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1

WEISSBERG, A.

Rumania/Chemical Technology. Chemical Products and Their Application -- Fats and oils. Waxes. Soap. Detergents. Flotation reagents, I-25

Abst Journal: Referat Zhur - Khimiya, No 2, 1957, 6427

Author: Anastasiu, St.; Jelescu, Eugenia; Weissberg, A.

Institution: None

Title: Detergents of Alkyl Aryl Sulfonate Type Obtained from Cracking Gas Oil

Original Publication: Rev. chim., 1956, 7, No 5, 283-290

Abstract: Preliminary results are described of laboratory work on preparation of detergents from gas oil (fractions of boiling range 180-260°, 260-315° and 180-315°) of cracking with removal therefrom (after sulfonation and neutralization of sulfonic acids) of the paraffin, and also from the same fractions of gas oil with addition of benzene (benzene:gas oil = 0.65). Alkylation is carried out in the presence of $AlCl_3$ and H_2SO_4. To utilize the non-alkylated olefins they were treated according to the method described in German Patent 5 859 454 which yielded a new detergent -- a mixture of alkyl aryl sulfonates and sulfuric ester of glycerol.

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"APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1

WEISSBERG, Roland; DABKOWSKA, Danuta

Functional examinations of the skin in pulmonary tuberculosis; preliminary communication. Gruzlica 24 no.3:183-189 Mar 56.

1. Z Miejskiej Przychodni Skorno-Wenerologicznej w Jeleniej Gorze Kierownik: dr. R. Weissberg, Z Miejskiej Porodni Przeciwgruzliczej w Jeleniej Gorze Kierownik: dr. D. Dabkowska, Jelenia Gora, Wzgorze Partyzantow 25.

(TUBERCULOSIS, PULMONARY, physiology,
McClure-Aldrich & Waldman tests (Pol))
(SKIN,
McClure-Aldrich & Waldman tests in pulm. tuberc. (Pol))

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"APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1

WEISSEIBERG, A.

TECHNOLOGY

Periodicals: AUTOMATICA SI ELECTRONICA. Vol. 2, no. 4, July/Aug. 1958

WEISSEIBERG, A. A new design for the magnetoelastic dynamometer. p. 153.

Monthly List of East European Accessions (EEAI) LC, Vol. 8, No. 2, February 1959, Unclass.

APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1"

"APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1

WEISSELBERG, A.

Generator with special functions. Bul Inst Petrol Rum no. 10:171-180 '63.

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9,2580

AUTHORS: Weisselberg, Al, Engineer, and Racoveanu, N., Instructor, Engineer

TITLE: A new circuit for a linear-variable voltage generator

PERIODICAL: Telecomunicații, no. 2, 1962, 67-70

TEXT: The article describes a new linear-variable voltage generator and its operational elements, i.e. the linear dipole, the thyratron, and the cathode follower. Figure 8 shows the circuit of the generator. The charging or discharging control of the capacitor is accomplished by "self-excitation". The capacitor is charged by a gas discharge tube, which has an increasing slope of the anodic current of approx. 0.25 v/μsec. The time constant of the circuit is very small. The rough variation of the output voltage frequency is accomplished by the switch c, while the fine variation of the frequency is achieved by the potentiometer P, which may also be used for the control of the amplitude of the output voltage. The potentiometer P_1 is used for the compensation of the amplitude variation of the output voltage and for the fine tuning of the frequency.

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A new circuit for ...

The generator has the following performances: recovery time, $T_{\lambda} = (1.5 \div 12.0)$ msec; time of the linear variation, $T_{\lambda} = (0.1 - 2)$ sec; maximum amplitude of the linear-variable voltage,

$$U_{max} = 280 \text{ v};$$

increasing speed of the linear-variable voltage,

$$\frac{U_{max}}{T_{\lambda\,max}} = 140 \text{ v/sec};$$

non-linearity factor,

$$\beta = \frac{\left(\frac{dU}{dt}\right)_{in} - \left(\frac{dU}{dt}\right)_{fin}}{\left(\frac{dU}{dt}\right)_{in}} \times 100 = 0.5\%.$$

There are 9 figures. The most important English-language reference reads as follows: I. Millman and H. Taub "Pulse and digital circuits" New York, McGraw Hill Book Co., 1956.

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D014/D105

A new circuit for ...

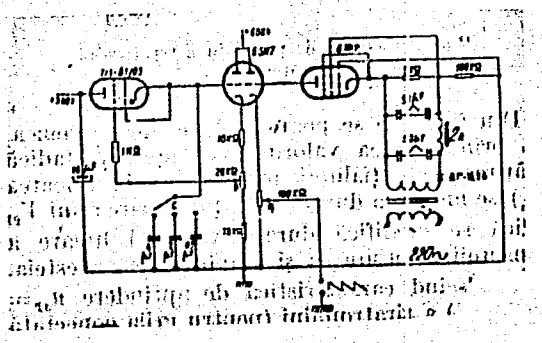

Fig. 8: The principle of the generator arrangement.

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WEISSENBERG, M.; CIUNGU, S.

Effect of the mineralogical composition of cement on adhesion between the concrete and the reinforcement. p. 571. Academia Republicii Populare Romine. Institutul de Mecanica Aplicata. STUDII SI CERCETARI DE MECANICA APLICATA. Bucuresti. Vol. 6, no. 3/4, July/Dec. 1955.

So. East European Accessions List Vol. 5, No. 9 September, 1956

APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1"

"APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1

WEISSENBERG, M.

Variation of the adherence of the beton to the armature in the function of the length of anchorage.

P. 527(Academia Republicii Populare Romine. Institutul De Mecanica Aplicata. STUDII SI CERCETARI DE Mecanica APLICATA. Vol. 7, no. 2, Apr./June 1956. Bucuresti, Romania)

Monthly Index of East European Accessions (EEAI) LC.Vol. 7, no. 2, February 1958

APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1"

"APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1

WEISSEMBERG, M.

Considerations regarding plans for continuous girders from prestressed concrete. I.

p. 386 (Industria Constructiilor Si A Materialelor De Constructii. Vol. (7) no. 7, 1956. Bucuresti, Rumania)

Monthly Index of East European Accessions (EEAI) LC. Vol. 7, no. 2, February 1958

APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1"

"APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1

SIMA, Jiri, inz.; WEISSER, Milan, inz.

Inventions and patents. Automatizace 6 no.11:284-285 N '63.

APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1"

"APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1

SIMA, Jiri, inz.; WEISSER, Milan, inz.

Inventions and patents. Automatizace 7 no. 3:72-73 Mr '64.

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"APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1

ULRYCH, Milos, inz.; SIMA, Jiri, inz.; WEISSER, Milan, inz.

Inventions and patents. Automatizace 7 no.5:133-135 My'64.

APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1"

"APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1

SIMA, Jiri, inz.; WEISSER, Milan, inz.

Inventions and patents. Automatizace 7 no. 7:186-187 Jl '64.

APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1"

"APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1

SIMA, Jiri, inz.; WEISSER, Milan, inz.

Inventions and patents. Automatizace 7 no.9:240-241 S '64.

APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1"

"APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1

SIMA, Jiri, inz.; WEISSER, Milan, inz.

Inventions and patents. Automatizace 7 no.10:269-270 O '64.

APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1"

"APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1

SIMA, Jiri, inz.; WEISSER, Milan, inz.

Two-way regulator of motor vehicle dynamo voltage. Automatizace 7 no.11:300 N '64.

APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1"

"APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1

SIMA, Jiri, inz.; WEISSER, Milan, inz.

Inventions and patents. Automatizace 8 no.1:14-15 Ja '65.

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"APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1

SIMA, Jiri, inz.; VEISSER, Milan, inz.

Inventions and patents. Automatizace 8 no.3:77-78 Mr '65.

APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1"

"APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1

SIMA, Jiri, inz.; WEISSER, Milan, inz.

Inventions and patents. Automatizace 7 no.12:325 D '64.

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"APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1

PHASE I BOOK EXPLOITATION CZECH/4225

Weisser, Oldřich, Docent, Engineer, František Jansa, State Prize Winner, Professor, Engineer, and Karel Jarolím, Engineer

Užití elektrické energie (Utilization of Electric Power) Prague, Státní nakladatelství technické literatury, 1959. 329 p. 5,200 copies printed.

Reviewers: Miroslav Bauer, Engineer, Doctor, Ladislav Cigánek, Academician, Josef Ferdinand, Engineer, Jan Hanák, Engineer, Josef Ipser, Doctor of Medical Sciences, Jaroslav Netušil, Štěpán Peleňský, Engineer, and František Provazník, Docent, Engineer, Doctor; Tech. Ed.: Ludvík Charvát; Resp. Ed.: František Kašpar, Engineer, Doctor.

PURPOSE: The book, approved by the Ministry of Education as of July 7, 1955, is a textbook for students of four-year industrial schools in electrical engineering.

COVERAGE: The book outlines applications of electricity in lighting, heating and cooling, in medicine, electric

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traction, and electric drives. It explains the purposes, principles and operation of related electrical equipment and gives information on their design, construction, and operation. References are given after each part. No personalities are mentioned.

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II. Electric Light Sources 28
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"APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1

Weisser, Otto

Preparing pure hydrocarbons by hydrogenation on molybdenum disulfide. Hydrogenation of alcohols, ketones, acids, and esters. Stanislav Landa and Otto Weisser (Tech. Univ., Prague). *Chem. Listy* 50, 569-72(1956). Thermally stable alcs., ketones, acids, and esters are hydrogenated at 350° and 120 atm. in the presence of MoS_2 or $(NH_4)_2MoS_4$, yielding hydrocarbons with the same arrangement of C atoms. A single C_6H_6 ring is not hydrogenated, whereas in compds. with 2 or more condensed aromatic rings there is hydrogenation of 1 ring. α-Naphthol gives a mixt. of 59% naphthalene (I) and 23% Tetralin; I is partially hydrogenated to tetrahydronaphthalene (81%), anthracene to 9,10-dihydroanthracene (60%), and phenanthrene to tetrahydrophenanthrene (49%). Examples are given of 23 expts. showing normal hydrogenation. $(NH_4)_2MoS_4$ is prepd. by dissolving 60 g. $(NH_4)_6Mo_7O_{24}$-$4H_2O$ in a mixt. of 80 ml. water and 100 ml. concd. NH_4OH, followed by addn. of 500 ml. NH_4OH and satn. with H_2S yielding crystals of $(NH_4)_2MoS_4$. Hydrogenation of $(NH_4)_2MoS_4$ in toluene at 300° and 100-20 atm. for 30 min. gives MoS_2 which is filtered off and washed with MeOH and Et_2O.

L. J. Urbánek

Chem

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WEISSER, OTTO

CZECHOSLOVAKIA/Organic Chemistry - Theoretical and General Questions on Organic Chemistry. G-1

Abs Jour: Referat Zhur-Khimiya, No 5, 1958, 14320.

Author : Landa Stanislav, Weisser Otto, Mostecky Jiri
Inst :
Title : Properties of Sulfide Catalysts. IV. Concerning the Mechanism of Hydrogenation of Oxygen-Containing Substances.

Orig Pub: Sb. chekhosl. khim. rabot, 1957, 22, No 3, 1006-1013.
Also — Chem. Listy 51, 452-458, 1957

Abstract: On hydrogenation of oxygen-containing compounds over MoS_2 (I) and WS_2 (II), under pressure, alcohols are formed at first; the major portion of alcohols is dehydrated to olefins which are hydrogenated further to saturated compounds. The minor portion of alcohols is hydrogenated directly to paraffin. In the course thereof compounds of the type of neopentyl alcohol undergo mostly a retropinacolin rearrangement and yield only little paraffin retaining the carbon skeleton. Hydroge-

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CZECHOSLOVAKIA/Organic Chemistry - Theoretical and General Questions on Organic Chemistry.

G-1

Abs Jour: Referat Zhur-Khimiya, No 5, 1958, 14320.

nation of aldehyies, ketones and esters, over I and II at 180-240°, results in a mixture of alcohols and olefins; at temperatures above 300° paraffins are formed (hydrogenation procedure, see RZhKhim, 1955, 45783). Listed hereinafter are: starting substance; catalyst; temperature in °C; duration in minutes; H_2 pressure on filling, in atmospheres; reaction products; in parentheses, their yields in %: CH_3CHO, I, 240, 30, 120, C_2H_5OH (77.2) + high-boiling fraction; acetone, I, 240, 30, 120, C_3H_6 (10.4) + iso-C_3H_7OH (26.7); acetone, II, 240, 60, 100, C_3H_6 (39.3); acetone, II, 180, 60, 100, iso-C_3H_7OH (25.5); methyl ethyl ketone, I, 220, 30, 120, mixture of butenes (7.0) + butanol-2 (64.3); cyclohexanone, I, 240, 30, 120, cyclohexane (4.4) + cyclohexene (44.1) + cyclohexanol (29); cyclohexanone, II, 240, 60, 100, cyclohexene (13) + cyclohexanol (35.3); $C_2H_5COOCH_3$, I, 240, 20,

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CZECHOSLOVAKIA/Organic Chemistry - Theoretical and General Questions on Organic Chemistry. G-1

Abs Jour: Referat Zhur-Khimiya, No 5, 1958, 14320.

112, n-C_3H_7OH (11) + C_3H_6 (3.6); $C_{15}H_{31}COOCH_3$, II, 240, 60, 100, n-$C_{16}H_{33}OH$, MP 48-49° (13.9) 2,2-dimethyl-butanol-3, I, 320, 30, 120, mixture of 4.5% 2,2-dimethylbutane (III) and 75.3% 2,3-dimethyl-butane (IV) (determined from infra-red spectrum); 2,2-dimethyl-butanone-3, I, 320, 30, 120, mixture of 11.5% III and 72.5% IV (determined from infrared spectrum); pinacone hexahydrate, I, 350, 30, 110, mixture of 6.1% III and 70.8% IV (infrared spectrum) + high-boiling products; $(CH_3)_3CCOOCH_3$, I, 340, 45, 130, neopentane (V) (0.4) (infra-red spectrum) + iso-C_5H_{12} (VI) (74.0); $(CH_3)_3CCOOCH_3$, I, 320 30, 120, (CH) CCH OH (7.5); $(CH_3)_3CCH_2OH$, I, 340, 45, 130, V (24.6) + VI (30). Prior communications see RZhKhim, 1957, 22857, 22876.

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"APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1

LANDA, Stanislav; HALA, Slavoj; WEISSER, Otto; STRILEK, Vladislav; SONSKY, Jan

Composition of lighter portions of Hodonin crude oil. Sbor.pal.vod. VSChT 1958:21-43. (MRAI 9:4)

1. Katedra synthetickych pohonnych latek, Vysoka skola chemicko-technologicka, Praha.
(Czechoslovakia--Petroleum)

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"APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1

CZECHOSLOVAKIA/Physical Chemistry. Kinetics. Combustion: Explosions, Topochemistry, Catalysis. B

Abs Jour: Ref Zhur-Khim., No 1, 1959, 513.

Author : Landa S., Weisser O., Mostecky J.
Inst :
Title : The Properties of Sulfide Catalysts. VI. The Dehydrogenating and Dehydrating Properties of Molybdenum Disulfide and Tungsten Disulfide.

Orig Pub: Chem listy, 1958, 52, No 1, 60-67.

Abstract: The catalytic properties of MoS_2, WS_2 and industrial catalyst 5058 were investigated in an autoclave and a circulating contact apparatus. Upon heating alcohols (CH_3OH - C_4H_9OH, cyclohexanol) and diethyl ether with those catalysts up to a temperature of $\sim 300^\circ$ C., it was established that first of all, a dehydration of

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CZECHOSLOVAKIA/Physical Chemistry. Kinetics. Combustion: B

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CZECHOSLOVAKIA/Physical Chemistry. Kinetics. Combustion: D
Explosions, Topochemistry, Catalysis.

Abs Jour: Ref Zhur-Khim., No 1, 1959, 513.

the alcohols takes place with a formation of olefine and ethers, and to a lesser dehydrogenation - with a formation of aldehydes, ketones and a small amount of saturated hydrocarbons. Hydrogen, methane, ethane carbon monoxide and sometimes other gaseous hydrocarbons are formed as by-products. For communication V see R.Zh. Khim., 1958, 67472. -- Karel Setinek.

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"APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1

Distr: 1E2d(b) 2 cys

Refining selenium for electrotechnical purposes. Stanislav Landa, Jiří Mostecký, and Otto Weisser. Czech. 90,-377, June 15, 1959. A mixt. of 20 parts crude Se and 15 parts MoS_2 is heated for 30 min. to 350° in a rotating autoclave filled with H under pressure so that the mol. ratio of Se:H is 1:4. The contents are cooled and H_2S is removed with steam to give Se in 98-9% purity and quant. yield.

L. J. Urbánek

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"APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1

COUNTRY : Czechoslovakia B-9
CATEGORY :

ABS. JOUR. : RZKhim., No. 23 1959, No. 81432

AUTHOR : Landa, S.; Weisser, O.; Mostecky, J.
INST. : Not given
TITLE : Properties of Sulfide Catalysts. VI. Dehydrating and Dehydrogenating Properties of Molybdenum and Tungsten Disulfides.
ORIG. PUB. : Collect. Czechosl. Chem. Communs, 1959, 24, #4, 1036-1044.
ABSTRACT : See RZKhim, 1959, #1, 513.

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"APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1

LANDA, S.; MOSTECKY, J.; WEISSER, O.

Properties of sulfide catalysts. X. Preparation of isoparaffins by the hydrogenation of aldol. Coll Cz Chem 25 no.4:1165-1173 Ap '60. (EEAI 9:12)

1. Institut fur synthetische Treibstoffe, Technische Hochschule fur Chemie, Prag.

(Sulfides) (Catalysts) (Paraffins)
(Aldol) (Hydrogenation)

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9.4300 (1043,1138,1143)

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E112/E153

AUTHORS: Mostecký, Jiří; Weisser, Otto; Landa, Stanislav

TITLE: Hydrogenation Refining of Selenium

PERIODICAL: Chemický Průmysl, 1961, No.1, pp.2-7

TEXT: The present paper is the thirteenth in a series of investigations dealing with sulfide catalysts in hydrogenation processes and describes specifically the hydrogenation of selenium, using the sulfides of molybdenum and tungsten as catalysts. The work was undertaken in order to establish the possibility of refining selenium by hydrogenation and of utilising domestic sources of selenium for the rectifier and photoelectric cell industry. Although germanium and silicon have superior properties as semiconductors, the rectifier industry of Czechoslovakia is still based on selenium, and it is not anticipated that changes will take place within the next few years. The production of highly purified selenium presents an important economic problem. A process consisting of the following steps is suggested by the authors. 1) Hydrogenation of selenium under pressure of 100-110 atm at 350 °C in presence of molybdenum as

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E112/E153

Hydrogenation Refining of Selenium

catalyst; reaction time 60-120 minutes. Thermodynamic data and comparisons between sulfur and selenium are tabulated. It is shown that the hydrogenation of selenium proceeds less readily than that of sulfur, but that nevertheless, in presence of catalysts and an excess of hydrogen, conversions were favourable. 2) Hydrogen selenide, thus produced, is reoxidised to elementary selenium, and three possible approaches are suggested: a) using 30% hydrogen peroxide; b) selenic acid as oxidant; and c) burning in a current of air. A sketch of the laboratory method for the burning of hydrogen selenide in a current of air is shown, but details of the other two methods of oxidation are not provided. The paper is mainly concerned with the purity of the refined selenium and analytical methods for an assay of mercury, tellurium and ash content are presented. Results of spectrographic analyses are submitted. Analytical methods have confirmed the efficiency of the hydrogenation refining method. Iron and tellurium were completely removed, and silicium and magnesium were reduced to trace concentrations. Mercury contents were reduced beyond the

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E112/E153

Hydrogenation Refining of Selenium

permitted limits and spectrographic analysis indicated the absence of arsenic. Ash contents, however, were higher than permissible, and this is explained by a secondary contamination of the hydrogen selenide during its oxidation to elementary selenium. The durability of the catalysts in the present process was not studied but it is proposed to publish more data in the near future. The authors are of the opinion that the suggested process is economical and that it can be applied particularly usefully to lower-grade raw materials. Acknowledgements are made to L. Ješinová, test laboratories ČKD Modřany n.p., Rectifier Research, Běchovice. There are 7 figures, 3 tables and 17 references: 6 Czech, 6 German, 1 Soviet, 1 French and 3 English.

ASSOCIATION: Katedra syntetických paliv, VŠCHT Praha a Miroslav Ruprych, ČKD Modřany n.p., Výzkum usměrňovačů, Běchovice u Prahy (Chair of Synthetic Fuels, University of Chemical Technology, Prague, and Miroslav Ruprych, CKD Modřany, Rectifier Research, Běchovice, near Prague)

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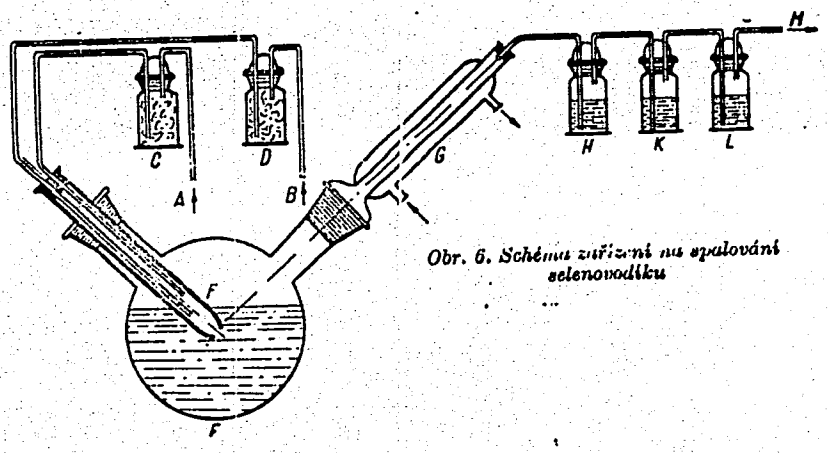
Hydrogenation Refining of Selenium



Obr. 6. Schéma zařízení na spalování selenovodíku

SUBMITTED: June 23, 1960

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"APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1

LANDA, S., prof., dr., ing., D.Sc. (Praha 6, Technicka 1905, CSSR); WEISSER, O., ing., Cand.Sc. (Praha 6, Technicka 1905, CSSR); MOSTECKY, J., doc., ing., Cand.Sc. (Praha 6, Technicka 1905, CSSR); SZEBENYI, Imre, Cand.Sc. (Budapest XI., Gellert ter 4)

Data on the properties of sulfide catalysts. XII. Preparation of hydrocarbons by hydrogenation of hydroxyesters. Acta chimica Hung 29 no.2:237-244 '61.

1. Lehrstuhl fur synthetische Brennstoffe, Chemisch-Technologische Hochschule, Prague (for Landa, Weisser and Mostecky). 2. Institut fur chemische Technologie, Technische Universitat, Budapest (for Szebenyi).

(Catalysts) (Sulfides) (Hydrocarbons) (Hydrogenation)

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"APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1

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Prague, Collection of Czechoslovak Chemical Communications, Vol 27, No 4, April 1962 (continued)

18. "The Obtaining of Sodium Ferrate with Electrochemical Methods," J. TOUSEK, Slovak Technological Institute, Bratislava; pp 914-919.

19. "The Theory of the Boundary Layer of a Finite Adsorbent Crystal," K. KLIER, Institute of Physical Chemistry at the Czechoslovak Academy of Sciences, Prague; pp 920-927.

20. "A Contribution to the Problem of the Kinetics of Adsorption on a Semiconductor," K. KLIER, Institute of Physical Chemistry at the Czechoslovak Academy of Sciences; pp 928-930.

21. "The Flotatability of Graphite. Part II. A Contribution to the Theory of the Flotation of Graphite in Electrolytic Solutions," J. SPUNY and B. DOBIAS, Institute of Geochemistry and Mineral Raw Materials, at the Czechoslovak Academy of Sciences, Prague; pp 931-937.

22. "The Sorption of Radioisotopes on Sediments. Part VI. The Ferric Hydroxide - Strontium Solution System, and the General Rules of Sorption by Ferric Hydroxide," Z. KOLARIK, Nuclear Research Institute of the Czechoslovak Academy of Sciences, Řež near Prague; pp 938-950.

23. "The Sorption of Radioisotopes on Sediments. Part VII. Sorption of Strontium by Manganous Hydroxide," Z. KOLARIK, Nuclear Research Institute of the Czechoslovak Academy of Sciences, Řež near Prague; pp 951-959.

24. "Halogen Complexes of Ruthenium with Pyridin and Its Methyl Homologues. Part III. Tetrachlororuthenium and Trichlororuthenium Complexes," J. SOUCEK, Research Institute for Macromolecular Chemistry, [illegible]; pp 960-968.

25. "Automatic Paper Electrophoresis," J. HRDIKA, M. FECHMAN and J. SEIDA, Development Workshop and Institute of Organic Chemistry and Biochemistry, Czechoslovak Academy of Sciences, Prague; pp 969-973 (English article).

26. "Organo-Silicon Compounds. Part XXIX. The Kinetics of the Direct Synthesis of Silicon Methylbromides," J. JOKLIK, M. KRAUS and V. BAZANT, Institute for the Theoretical Basis of Chemical Engineering, at the Czechoslovak Academy of Sciences, Prague; pp 974-978.

27. "On the Properties of Sulphide Catalysts. Part XIV. The Hydration of Acids," S. LANDA and O. WEISSER of the Institute of Synthetic Fuels and Petroleum, at the Advanced School of Chemistry in Prague

WEISSER, O.

— 3/6 —

APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1"

"APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1

WEISSER, Otto; TRDLICKA, Vaclav

Thirty years of hydrocarbon research in the Department of Synthetic Fuels. Sbor pal vod VSChT Vo.5:7-33 '61 [publ. '62].

1. Katedra synthetickych paliv a ropy, Vysoka skola chemickotechnologicka, Praha.

APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1"

"APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1

WEISSER, O.; LANDA, S.; MOSTECKY, J.

Contribution to gas odorization. Ropa a uhlie 5 no.7:201-204 Jl'63.

1. Vysoka skola chemicko-technologicka, katedra syntetickych paliv, a ropy. Praha.

APPROVED FOR RELEASE: 09/01/2001 CIA-RDP86-00513R001961520006-1"