LETTER TO THE EDITOR

COMMENTS ON IN-CORE FLUX DETECTOR

Dear Sir:

The recent article on an in-core detector[1] presented some very interesting results. The purpose of this letter is to indicate how additional data can be obtained with the same detector. As pointed out by Todt, the vacuum-chamber detector displays asymmetry in applied voltage vs current plots for both thermal-neutron flux and photon fields. The straightforward analytical treatment below indicates how both neutron- and photon-flux components in a combined field can be measured with the detector.

The total current measured from the detector for either polarity of applied voltage is the sum of the thermal-neutron contribution and the gamma-photon contribution. Thus, the following two equations relating measured current to flux- and detector-sensitivity can be written:

$$M_+ = A_+ \phi_n + B_+ \phi_\gamma \quad (1)$$

$$M_- = A_- \phi_n + B_- \phi_\gamma \quad (2)$$

where M_+, M_- = measured detector current (amperes),

A_+, A_- = thermal-neutron sensitivity of detector [A per n/(cm^2 sec)], and

B_+, B_- = gamma-photon sensitivity of detector (A per R/h).

The subscripts indicate the polarity of the potential applied to the center electrode of the detector. By solving the above equations simultaneously for ϕ_γ and ϕ_n, one obtains the following expressions:

$$\phi_n = \frac{[M_+ B_-] - [M_- B_+]}{[A_+ B_-] - [A_- B_+]} \ \frac{\text{neutrons}}{\text{cm}^2 \text{ sec}} \quad (3)$$

$$\phi_\gamma = \frac{[A_+ M_-] - [A_- M_+]}{[A_+ B_-] - [A_- B_+]} \ \text{R/h} \quad . \quad (4)$$

Using the sensitivity factors stated[1] for the detector (for ±500 V potential), the expressions can be reduced to

$$\left.\begin{aligned} A_+ &= 2.4 \times 10^{-19} \\ A_- &= 4.4 \times 10^{-19} \end{aligned}\right\} \ \text{A per n/(cm}^2 \text{ sec)}$$

$$\left.\begin{aligned} B_+ &= 3.9 \times 10^{-15} \\ B_- &= 5.0 \times 10^{-15} \end{aligned}\right\} \ \text{A(R/h)}^{-1}$$

$$\phi_n = \left| \left(\frac{5M_- - 3.9M_+}{12.6}\right) \times 10^{19} \right| \ \text{n/(cm}^2 \text{ sec)}$$

$$\phi_\gamma = \left| \left(\frac{4.4M_+ - 2.4M}{12.6}\right) \times 10^{15} \right| \ \text{R/h}$$

The above analysis indicates that it is possible to measure both thermal-neutron flux and gamma-photon flux from a complex field with one vacuum detector by simply reversing the applied potential polarity. The next obvious extension of the use of the detector is to monitor continuously both neutron- and gamma-flux components. This could be accomplished by applying an alternating square or sine wave voltage with 500-V amplitude to the detector. Suitable electronics would then condition the output so that continuous readings of both neutron and gamma fluxes would result.

The results from Eqs. (3) and (4) should be directly applicable to pulsed reactors where two pulses would be used to make the determination.

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REFERENCE

1. W. H. TODT, "An In-Core Radiation Detector for Monitoring Pulsed Reactor Excursions," *Nucl. Appl.*, **5**, 173 (1968).

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