Neutron Measurement of Moisture in Mineral Matter

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This measurement depends on the hydrogen slowing-downs of fast neutrons. Except moisture in good measurements one then considers the parameters: hydrogen content, density and absorption cross section of the matter.

For this meter I have made Monte Carlo (MC)-calculations [1], the first with Elliott [2] and the last ones with MatLab in my computer. I have supposed a point source S and point detector D in infinite medium.

In the actual calculations, at first, I have taken the AmLi source spectrum of neutrons [3] to pick up the energy for each neutron. The neutrons I follow downwards sequentially. They slow down to the energy E_0 = 1217 eV. q_0 is the slowing-down density at the energy E_0.

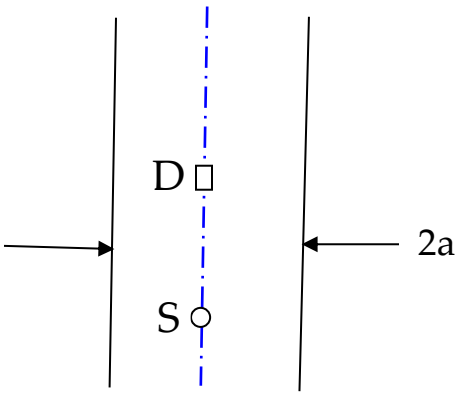

Fig. Neutron meter of moisture

Now also another MC-calculation is needed. That is: starting from the detector D with neutron energy 0.6 eV (epithermal meter) and energy goes upwards. At 1217 eV I find the value for $\mathbf{\Phi}^*$, the adjoint or may be called the quantity of detection. Now in a scattering event the energy and weight of "pseudo-neutron" grow. For hydrogen scattering $E_2=E_1/r$. r is random number (0…1]. The first adjoint MC program MCNA is from the year 1971 [4].

$q_0(r,\mathbf{\Omega})$ from S and $\mathbf{\Phi}^*_0(r,\mathbf{\Omega})$ from D have spherical geometry. They will be multiplied and shall be integrated in cylindrical geometry: r > a and z = (-∞,+∞). The **Ω**s one must consider properly.

References

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[2] S. Kasi and H. Koskinen, *Nuclear Engineering and Design*, 3 (1966) pages 74-82.
[3] A. V. Mozhayev, M. E. Moore and E. K. Mace, *Applied Radiation and Isotopes,* 168 (2021) 109472
[4] C. Josey and A. Sood, *IRRMA 11,* 23-28.7.2023, Bologna, Italy, internet (2023).