A MODEL FOR DETERMINATION OF IONIZATION IN CAVITY CHAMBERS

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The existing cavity chamber theories(1) are not applicable for determination of ionization in cavity chambers exposed to soft γ-radiations (below 150 keV). In this paper a model is developed for calculating ionizations in cavity chambers exposed to soft γ-rays. The model is based on the assumptions that the total ionization consists of two components, the wall component and the gas component. The gas component is the ionization originating from the electrons created by direct interaction of γ-rays and the filling gas. The wall component is the ionization caused by electrons coming from the chamber walls. Assuming the radial distributions of the flux of slowed-down electrons is of the form shown in Fig. 1, an expression is obtained for the ionization in the chamber, normalized by the gas ionization in electron equilibrium conditions:

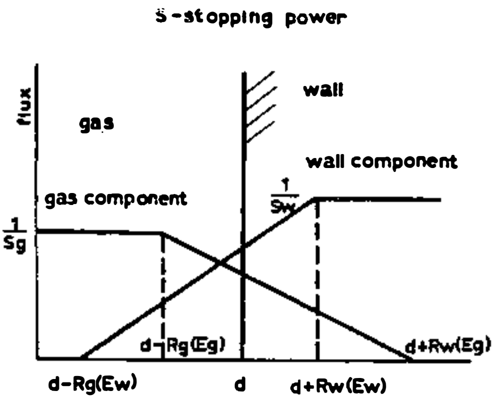

Fig.1 Radial distribution of slowed-down electrons

$$J_g = \frac{x'}{x+x'} + \frac{1-(1-x)^4}{4(x+x')} \; ; \quad x = 1$$

$$J_w = \frac{1}{s}\,\frac{(\mu_{en})_w}{(\mu_{en})_g}\left(\frac{y}{y+y'} - \frac{1-(1-y)^4}{4(y+y')}\right); \quad y = 1$$

and

$$J_g = \frac{4x'+1}{4(x+x')} \; ; \quad x = 1$$

$$J_w = \frac{1}{s}\,\frac{(\mu_{en})_w}{(\mu_{en})_g}\left(\frac{4y-1}{4(y+y')}\right); \quad y = 1$$

where: $x = R_g(E_g)/d$, $x' = R_w(E_g)/d$, $y = R_g(E_w)/d$, $y' = R_w(E_w)/d$, $R(E)$ is range of electrons of energy E, d is chamber radius, indices g and w denote gas and wall components respectively; μ_{en} is the mass energy-transfer coefficient, s is the stopping power ratio. The spectrum of primary electrons is replaced by two mono-energetic sources of energies E_g and E_w:

$$E_{g,w} = \left(\frac{\tau}{\sigma_a + \tau}\right)_{g,w} h\nu + \left(\frac{\sigma_a}{\sigma_a + \tau}\right)_{g,w} T$$

where: τ is atomic cross section for photoelectric effect, σ_a is atomic absorption cross sections for Compton effect, $h\nu$ is photon energy, T is average energy of recoil electrons. Electron ranges in the gas and the wall are calculated for the above two energies. Preliminary checks of the model gave an agreement with the experiment within 5% for γ-rays energies ranging from 20-150 keV.

References

1. T.E. Burlin, Cavity-Chamber Theory, (1968). In "Radiation Dosimetry", second edition, vol. I, edited by F.H. Attix, W.C. Roesch, Academic Press, New York and London.