# Comparative analysis of the transmission properties of radiologically equivalent materials

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Tissue equivalent materials have as main requirement to have the effective atomic number and/or linear attenuation coefficient close to the tissue to be simulated, in order to reproduce its ionizing radiation transmission properties. Previous works [1] proposed a method for formulating compounds of this kind of material. This work presents results of a comparative analysis of transmission properties of samples of these new tissue-equivalent materials.
Four sets of compositions containing six plates each were designed by the application of the proposed methodology [1]. These samples are water-equivalent in terms of radiation transmission of x-ray beams in the range of energy between 15-150 keV. The four sets of plates and different thicknesses of water were then subjected to radiation transmission tests by applying voltages of 60, 80, 100 e 120 kV from an x-ray tube (SMART 300HP, YXLON, Germany). Transmitted radiation were measured using an ionization chamber (TW 23361, PTW, Inc., Germany). A manipulation of Archer's equation [2] was used to compare the transmission properties of the samples and water:

$$\frac{T_S(x)}{T_W(x)} = \frac{\left[\left(1+\frac{\beta_S}{\alpha_S}\right)e^{\alpha_S\gamma_S x} - \frac{\beta_S}{\alpha_S}\right]^{\frac{-1}{\gamma_S}}}{\left[\left(1+\frac{\beta_W}{\alpha_W}\right)e^{\alpha_W\gamma_W x} - \frac{\beta_W}{\alpha_W}\right]^{\frac{-1}{\gamma_W}}} \quad (1)$$

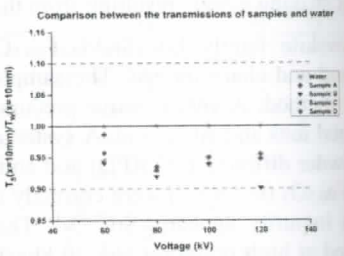


Figure 1: Ratio between the transmissions of evaluated samples and water considering 10 mm of thickness. The dashed red lines represent the range of ±10%.

In the equation $T_s(x)$ and $T_W(x)$ are the transmission by a thickness $x$ of the samples and water, respectively; $\alpha, \beta$ and $\gamma$ are fitting parameters obtained using Levemberg-Macquardt method. Figure 1 shows that, for $x = 10$ mm, the transmission of all samples for all voltages differ less than 10% from the transmission of water. Figure 1 also shows that all the samples present transmissions lower than the water. This means that a material thickness greater than that of water is required for the exact representation in terms of radiation transmission. The manipulation of equation (1) also allows estimating the equivalent-thickness of these materials. In the case of 100 kV it is noted that sample A is closest to the water thickness, while sample C is the one that differs most. It is believed that these compounds can be used to local production of phantoms for image quality and dosimetric applications for diagnostic image range of energy.

*Keywords:* tissue equivalent materials, Archer's equation, transmission measurements.
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