Specific absorbed fraction of energy and relative dose in Zinc alloys

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I. Introduction

Due to the desirable corrosion characteristics and biocompatibility, Zinc alloys can be used as the biodegradable metals. In the present work we have investigated the specific absorbed fraction (SAF) of energy, energy absorption buildup factors (ABFs) and relative dose (RD) in the energy range 15keV–15 MeV for zinc alloys of different composition such as alloy A (Cu 20 %, Ni 40 %, Zn 40 %), alloy B (Cu 30 %, Ni 35 %, Zn 35%), alloy C (Cu 40 %, Ni 30 %, Zn 30%), alloy D (Cu 50 %, Ni 25 %, Zn 25%), alloy E (Cu 60 %, Ni 20 %, Zn 20%) and alloy F (Cu 70 %, Ni 15 %, Zn 15%) up to the penetration depth (PD) of 40 mfp using GP fitting method. It is found that both SAF and RD are larger for alloy F (Cu 70 %, Ni 15 %, Zn 15%) than the other studied zinc alloys. Hence, we can conclude that the alloy F (Cu 70 %, Ni 15 %, Zn 15%) is a good absorber of X-rays, neutrons and gamma among the investigated zinc alloys. This work finds its usefulness in the radiation dosimetry and shielding of radiation.

On entering a medium, X-rays and gamma rays undergo scattering and the energy gets degraded, due to which secondary radiation are produced. These secondary radiations can be calculated using buildup factor. Manjunatha and Rudraswamy [1-2] evaluated the photon relative dose distribution and buildup factors in various parts of teeth. Manjunatha and Rudraswamy [3] studied energy absorption buildup factors as well as exposure buildup factors in hydroxyapatite. Previous researchers used exposure buildup factors for the investigation of secondary radiation dose like bremsstrahlung [4-5]. By injecting radioactive seeds into the patient's body, cancerous tumors can be destroyed in brachytherapy [6-7]. Cancerous tumors can be destroyed by multiplying the contribution of uncollided photons with the energy absorption buildup factors [8-9]. For designing the shielding of radiation, previous researchers gave the data for buildup factors [10-14]. In the computations of radiation dose absorbed by the cancer cells it is necessary to assume photon buildup factors.

To estimate the absorbed dose in certain organs using photons, the interaction of the primary photons in the target medium is not much accurate. Hence specific absorbed fraction of energy is required for the accurate estimation of absorbed dose. Specific absorbed fraction of energy is defined as the ratio of the energy absorbed by the target to the energy emitted by the source. In the present work, we have estimated the energy corresponds to SAF and RD up to the penetration depth of 40 mfp in energy range 15keV–15 MeV in zinc alloys of different composition.

I. Theory

II.1. Specific absorbed fraction of energy

The procedure for the determination of the specific absorbed fraction of energy is explained in detail in our previous work [15]. It is given by the expression

$$\Phi(x) = \frac{\exp(-\mu x)\mu_{en} B_{en}}{4\pi r^2 \rho} \quad (1)$$

II.2. Relative dose

The procedure for the determination of the Relative dose is explained in detail in our previous work [1]. It is given by the expression

$$\frac{D_r}{D_0} = \frac{B}{r} e^{-\mu r} \quad (2)$$

III. Results and discussions

For the studied zinc alloys of different composition, the comparison of SAF with energy is as shown in figure 1. It is observed that among the studied zinc alloys, SAF is larger for the alloy of composition (Cu 70 %, Ni 15 %, Zn 15%). The comparison of RD with energy is as shown in figure 2. It is found that among the studied zinc alloys, RD is larger for the alloy of composition (Cu 70 %, Ni 15 %, Zn 15%). The variation of SAF and RD with energy for the studied alloy of composition (Cu 70 %, Ni 15 %, Zn 15%) is shown in figure 3. It is found that SAF and RD rises up to the E_{pe} and then decreases. SAF and RD is maximum at an energy of 0.5 MeV. E_{pe} is the value of energy at which the Compton interaction coefficients matches with photo electric interaction coefficients

IV. Conclusion

We have investigated the EABFs, SAF of energy and RD for zinc alloys. From this study, it is clear that for the alloy of composition (Cu 70 %, Ni 15 %, Zn 15%), the SAF of energy and RD is maximum among all the studied zinc alloys. From this study we can suggest that the zinc alloy of composition (Cu 70 %, Ni 15 %, Zn 15%) can be used as a good absorber of gamma rays, neutrons and X-rays

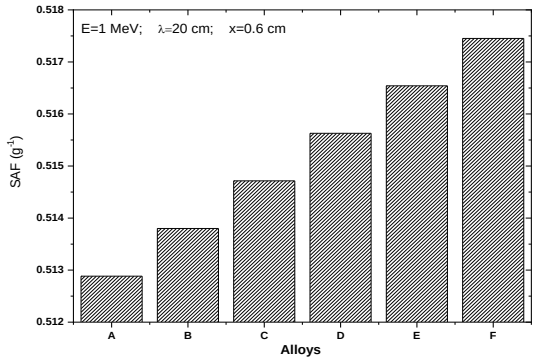

Fig 1. Comparison of SAF for the studied alloys at a particular energy

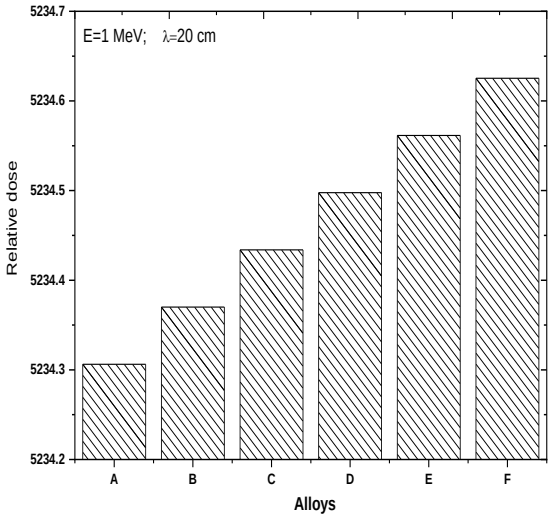

Fig 2. Comparison of RD for the studied alloys at a particular energy

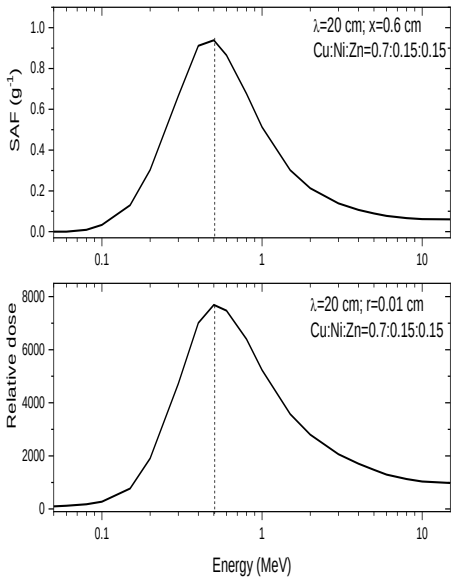

Fig 3. Variation of SAF and RD with energy for the studied alloy of composition (Cu 70 %, Ni 15 %, Zn 15%)

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