Analysis of Dose—Thickness Interaction with X-Rays Energy of 6 and 18 MeV for Beech Wooden Materials

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Abstract: In this study, dose and thickness interrelation is analyzed by using photon rays with an energy of 6 MeV and 18 MeV on wooden type materials made of beech trees with different surface area. We studied the dose measurements on the surface area of 5 cm × 5 cm, 8 cm × 8 cm, 10 cm × 10 cm, 12 cm × 12 cm with different thicknesses. X-ray with an energy of 6 MeV is applied at 0° gantry angle; and solid phantom is adjusted. Dose measurements are carried out on beech type of wooden materials with different thicknesses, and stopping power of these materials are compared.

Key words: Beech, dose, thickness-rays.

1. Introduction

Regulations and procedures have been developed and implemented to limit radiation dose by regulating the use, storage, transport, and disposal of radioactive material by controlling time, distance and shielding as follows:

- Time: The short the time spent around the source, the smaller the dose;
- Distance: The greater the distance the smaller the dose;
- Shielding: Use of materials to absorb the radiation dose.

Shielding is an important part of the design of radiotherapy centers [1]. Responsibility not only treats patients but protects the public from becoming exposed to radiation. By understanding why shielding is needed and what goes into a shielding design, one can develop an optimized design that both protects the public and keeps costs low. Therefore, there are a lot of studies which research shielding [2-4].

The radiation beam used for treatment beam does not necessarily stop when it reaches the tumor. It can

continue on through the patient, towards the wall/ceiling/floor and would continue out to the rest of the facility if it did not properly block. Radiation shielding is used to ensure that the radiation dose received by people outside the treatment room is lower than the regulated permissible levels. Any material can stop photon radiation, but dense materials are preferred for the purposes of radiation shielding—the denser the material, the less of it you need to reduce radiation to permissible levels.

Wood has been an essential material for human survival since the primitive state, for its wide abundance, relative ease of working it, and outstanding mechanical properties. With the development of technology, wood came to be used for shelter, fuel, tools, boats, vehicles, bridges, furniture, engineering materials, weapons, and even raw materials for energy [5]. X-rays are forms of radiant energy, like light or radio waves. Unlike light, x-rays can penetrate the body, which allows a radiologist to produce pictures of internal structures. The radiologist can view these on photographic film or on a TV or computer monitor. The scientific unit of measurement for radiation dose, commonly referred to as effective dose, is the mSv. Other radiation dose

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measurement units include rad, rem, roentgen and gray.

The measurement of absorbed dose is of fundamental importance in radiological protection for calculating radiation dose. However, absorbed dose is a physical quantity and used unmodified is not an adequate indicator of the likely health effects in humans. Also, dose-thickness relation has a great importance for the shielding using wooden materials in science. From this point, this study aims to show usability wooden materials such as beech trees in shielding and compare these results with literature. Siemens Oncor Impression Model linear accelerator, PTW model parallel ion chamber and water equivalent water phantom is used during the experimental measurements.

Absorbed dose is a measure of the energy deposited in a medium by ionizing radiation. It is equal to the energy deposited per unit mass of medium, and so has the unit J/kg or gray (Gy) where $1 \text{ Gy} = 1 \text{ J/kg}$. Our aim is to analyze dose-thickness relation of beech wooden material at 6 MeV and 18 MeV energy for different surface areas and thicknesses.

2. Results and Discussion

In this study, we measured dose and thickness interrelation using photon rays with an energy of 6 MeV and 18 MeV on different type of wooden materials made of beech trees with a different surface area and different thicknesses (such as 0.5 cm, 1 cm, 1.5 cm, 2 cm, 2.5 cm, 3 cm, 3.5 cm, 4 cm, 4.5 cm, 5 cm, 6 cm, 7 cm, 8 cm, 9 cm). X-rays with energy of 6 MeV and 18 MeV are applied at grant angle of 0° . In order to make the dose measurements, the solid phantom is also adjusted for $5 \text{ cm} \times 5 \text{ cm}$, $8 \text{ cm} \times 8 \text{ cm}$, $10 \text{ cm} \times 10 \text{ cm}$, $12 \text{ cm} \times 12 \text{ cm}$ surface area. Dose measurements are carried out on beech type of wooden materials with different thicknesses.

The stopping power of these materials is then compared with using beech materials (Figs. 1-4) and without using beech materials (Figs. 5-8) at 6 MeV and 18 MeV. From our measurements as seen from Figs. 1-8, we concluded that results from beech wooden materials were similar to that without any materials. In order to compare all the results, it is seen absorbed dose in all thickness at 6 and 18 MeV in Figs. 9-10.

Fig. 1 Dose measurement for $5 \times 5 \text{ cm}^2$ area versus thickness at 6 MeV.

Fig. 2 Dose measurement for $8 \times 8 \text{ cm}^2$ area versus thickness at 6 MeV.

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Fig. 3 Dose measurement for $10 \times 10 \text{ cm}^2$ area versus thickness at 6 MeV.

Fig. 4 Dose measurement for $12 \times 12 \text{ cm}^2$ area versus thickness at 6 MeV.

Fig. 5 Dose measurement for $5 \times 5 \text{ cm}^2$ area versus thickness at 18 MeV.

Fig. 6 Dose measurement for $8 \times 8 \text{ cm}^2$ area versus thickness at 18 MeV.

Fig. 7 Dose measurement for $10 \times 10 \text{ cm}^2$ area versus thickness at 18 MeV.

Fig. 8 Dose measurement for $12 \times 12 \text{ cm}^2$ area versus thickness at 18 MeV.

Fig. 9 Comparison of absorbed dose versus thickness at 6 MeV.

Fig. 10 Comparison of absorbed dose versus thickness at 18 MeV.

3. Conclusion

In this study, we realized the experimental analysis of the stopping power of beech type wooden materials used as a covering material in the laboratories where Medical Linac is used. Dose measurements were made for different thicknesses at 6 MeV and 18 MeV. These materials are possible to be used as a covering material on some parts of the devices (Linacs) and can be used as a shield (covering) material because of reachable and cheaper. In this context, we purpose that it is important to measure the stopping power of such wooden materials. Dose measurements of type wooden materials are also important for radiation shielding research.

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