

ABSTRACT

Radiotherapy using a linear accelerator (LINAC) requires an effective shielding system to protect radiation workers, patients, and the public from scattered and leakage radiation exposure. Conventional concrete is commonly used as a shielding material; however, high-energy radiation requires large shielding thicknesses, leading to the development of high-density alternative materials such as magnetite concrete and tungsten heavy alloy (WHA). This study aims to compare the effectiveness of conventional concrete, magnetite concrete, and WHA as shielding materials in a 6 MV LINAC radiotherapy facility using Monte Carlo simulation. The simulation was performed using MCNP version 6.2 with an Elekta SL-25 LINAC radiation source model. Evaluation was conducted using tally F6 to obtain radiation dose distribution in units of Sv/hour. Material thickness variations were based on the Tenth Value Layer (TVL) approach at 0.5 TVL, 1 TVL, 1.5 TVL, and 2 TVL. The analysis included dose rate reduction, attenuation coefficient, thickness efficiency, and simulation relative error. The results showed that increasing material thickness significantly reduced the radiation dose rate following an exponential attenuation pattern. Conventional concrete required a thickness of up to 68 cm to achieve 2 TVL, magnetite concrete required 52 cm, while WHA required only 8 cm. Magnetite concrete demonstrated better shielding performance than conventional concrete due to its higher density and electron density. WHA exhibited the highest attenuation coefficient and the best thickness efficiency, although secondary radiation and build-up effects appeared in several detector configurations. Overall, the effectiveness order of the shielding materials in this study was WHA > magnetite concrete > conventional concrete.

Keywords: radiation shielding, 6 MV LINAC, Monte Carlo, MCNP, magnetite concrete, tungsten heavy alloy.