Optimizing the Cooling System of a Cyclotron Krypton Target by Simulating the Heat Transfer Process

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The demand for Krypton-81m (Kr-81m), a medical radioisotope used for diagnosing lung perfusions, is increasing in the Kingdom of Saudi Arabia. Kr-81m is generated using the Medical cyclotron machine that currently exists only in King Faisal Specialist Hospital (KFSHRC) in Riyadh and then transported to different parts of the Kingdom. The half-life of Kr-81m is short, which requires producing larger amounts to be able to ship to distant hospitals. This project focuses on an optimization research for the cyclotron to increase the outcome of the nuclear reaction that produces the Kr-81m. This can be accomplished by working with the water based unit that cools the target. "COMSOL Multiphysics" software was used to perform efficiency studies on an existing cooling system of the Krypton target. "Solidworks" was used to develop the Krypton model, and then exported into COMSOL Multiphysics software. "SRIM" software was used to model the Proton beam in which stopping power was used to deposit as the beam penetrates the target. Two variables were altered 6 times each during the simulations; the flow rate and water temperature. Results showed that the water temperature played a significant role in reducing the heat generated during production, whereas, flow rate did not alter the heat. Therefore, optimizing the existing cooling system by reducing the flow rate results in saving water consumption without affecting the cooling system. This study may lead to higher yield of Kr-81m to support the demand of Saudi Arabia’s hospitals for accurate lung disease diagnosis.