The Calorimetric Measurement of Low Energy Brachytherapy Sources

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Historically, the dose rate to tissue from ^{125}I and ^{103}Pd sources was abased on a source's apparent activity in free space. The American Association of Physicists in Medicine Task Group 43 (TG43) established a protocol that clarified this formalism for the dose rate determination that was universally accepted in the Medical Physics community. The TG43 protocol is based on air kerma strength and a different set of conversion factors for determining the dose rate. However, there are still many uncertainties associated with this methodology. These uncertainties are predominately the result of the unknown effects of variations in the source encapsulation and internal source structure on the dose distribution surrounding a source. Currently, there is no method of nondestructively determining the contained radioactivity of brachytherapy sources. Without the knowledge of the contained activity, the effects of source construction variations cannot be evaluated accurately.

The goal of this work was to develop a calorimeter that measures the total power generated by a source. This information could then be used to nondestructively determine the contained radioactivity activity of a source. The power generated by three different, well characterized source design of \I\ brachytherapy seeds to measured with the calorimeter. A theoretical model of the calorimeter was also developed to demonstrate that the calorimeter operated as expected. The measured and theoretical temperature results for the three different source models were consistent within the uncertainty of the measurements. The consistency between the calorimetric measurements and the theoretical expected results demonstrates proof of principle of the calorimeter. The information determined from the model can also be useful for future calorimetric research by identifying required calorimeter design features, potential design improvements and potential difficulties.