CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)

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Project Number

S1510

Project Title

Beta Busters and Gamma Grabbers: A Study of Radiation Shield Effectiveness

Abstract

Objectives/Goals

This project was to determine which material would be the best shield against beta and gamma radiation. Often times, radiation needs shielding because it causes harm to the environment. Radiation can be used in many important ways such as cancer treatment, sterilizing, and as a power source. Radiation can only be useful if it is controlled; shields are often used for this purpose.

Methods/Materials

This project was conducted at the Isotope Products Laboratory in Burbank,CA. A disk of Cesium-137 was placed on a crate in the center of a 2" high tape roll. The tape roll was used to hold the shield in place and to ensure that the distance between the radioactive source and the shield remained constant. A Geiger Mueller Counter was used to measure the background radiation. The bare source was also measured with the counter to ensure accuracy. The Geiger Mueller Counter was used to determine which of the tested materials stopped the most beta and gamma radiation from penetrating. 48 tests were completed, results were recorded and analyzed using the linear attenuation coefficient equation to eliminate the thickness variable in order to determine the most effective shields.

Results

Materials with high linear attenuation coefficient values are the best shields because they block the most beta/gamma particles. The materials with the highest μ values (above 200) included aluminum flashing (1-7 layers), plaskolite (1 layer), vinyl, aluminum foil (8 layers) and the Molybdenum. The next best shields, where μ=199-100, were aluminum flashing (8-10 layers), vinyl (2 layers), aluminum foil (4 and 16 layers), and plaskolite (2 layers). The shields with μ values below 100 included copper, aluminum tape, lexan, carbon, kapton, Tupperware, rubber, mirror, Plexiglas, cast iron, airflow baking sheet, fiberglass, marble, polyethyline, graphite, paraffin, foam insulation, and Styrofoam.

Conclusions/Discussion

Cast iron was among the worst shields with a μ=8. Three layers of aluminum flashing were the best with a μ=466. The aluminum products fell between 466 (3 layers of aluminum flashing) and 8(the air-flow baking sheet). Plaskolite was also very effective with a μ=219. The worst shields, with μ values below 1, were the foam insulation and Styrofoam; probably due to their porous compositions. The top 6 shields, were different combinations of aluminum flashing, this was interesting due to the lightness of the material.

Summary Statement

Forty-eight materials were tested for gamma and beta radiation shield effectiveness.

Help Received

Cary Renquist (Radiation Safety Officer/ Isotope Products Laboratory), Marissa Renyolds (Nuclear Physicist formerly at IPL, equation help), Michael Holmes (Nuclear Physicist / Air Force Research Lab, equation help), parents (drove), Mr. Mark Grubb (HS physics; supplied fiber glass, Lexan, & carbon).