MARBOLITE—A NEW SYNTHETIC MATERIAL

Part II.—Gamma Ray Shielding Measurements on Marbolite and Other Materials

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Gamma-ray shielding (absorption and scattering) properties of a new synthetic material "Marbolite," have been studied and compared with other shielding materials, especially lead and natural marble. For temporary shielding, Marbolite turns out to be much cheaper than lead and marble for the same percentage absorption. Ease of handling and fabrication in any desired size and shape coupled with acid and alkali resistant property, makes it an excellent shielding material for radiochemical laboratories.

Introduction

In Part I a brief account was given of the production of Marbolite, a synthetic material produced in these Laboratories from indigenous raw materials.[1] It has a density of about 4 g./cc. and is both acid and alkali resistant, and was expected to be a good radiation shielding material because of its high density and low cost.

Marshall Bruser[2] has compared the shielding capabilities of natural marble with lead and other shielding materials for gamma radiation. In a two-year use of lead and marble bricks interchangeably for temporary shielding, marble showed less distortion of edges and corners and was more easily decontaminated. For some types of radiation protection marble bricks were found to be six times cheaper than lead. Bruser has recommended marble bricks as radiation shield especially for teletherapy rooms. The present communication presents a study of the shielding properties of Marbolite in comparison with other shielding materials, especially lead and natural marble.

Gamma Ray Absorption

Experiments were first performed to study the absorption of gamma rays from a cobalt-60 source by various thicknesses of lead, Marbolite, Pakistani white marble, gypsum and plaster of Paris. The block diagram of the experimental set up is shown in Fig. 1, and is essentially a gamma ray spectrometer, which enabled us to increase the measuring accuracy by supressing most of the unwanted background radiations. The scintillation assembly consisted of a 6097B-EMI photomultiplier coupled with a $1\frac{1}{2}'' \times 1''$ thallium activated sodium iodide crystal, which was selected for its high detection efficiency for gamma radiations.

The gamma ray intensity received at the detector, from the Co^{60} source placed at a fixed distance from it, was first measured when there was no shielding material in between. The shielding material to be examined was then placed between the source and the detector in the form of slabs, and the intensity of radiation, after passing through various thicknesses of the material, was measured, from which the percentage transmission was calculated for each thickness. The experiments were repeated for each material.

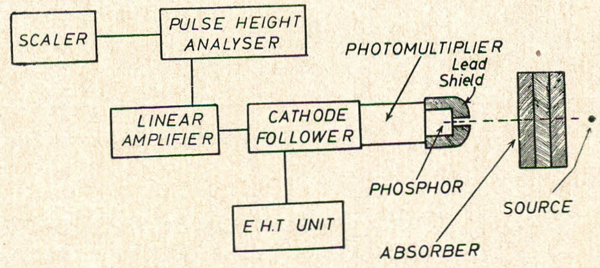

Fig. 1.—Block diagram of the scintillation counting assembly for gamma ray absorption measurements.

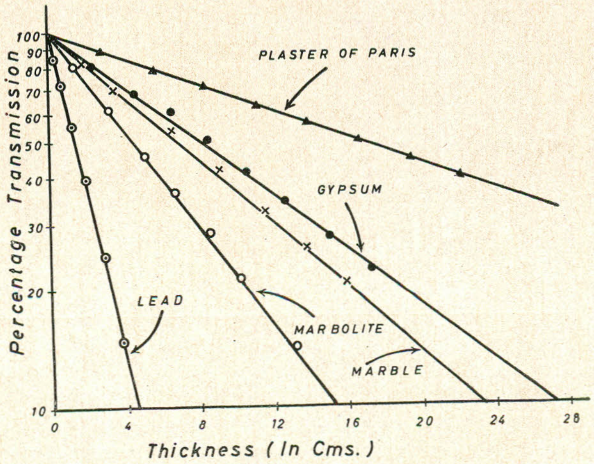

Fig. 2.—Transmission of gamma rays (cobalt 60) through lead, marble, Marbolite, gypsum and plaster of Paris.

The results were plotted in Fig. 2 as percentage transmission of gamma rays against thickness on a semi-log scale. The absorption coefficients and half-value thicknesses of the various materials can be read off from these graphs and are given in Table 1. The values of lead obtained in our experiments, agree well with the standard values[3,4] within 1%, and confirm the accuracy of our experimental set up. It can be seen from Fig. 1 and Table 1 that so far as absorption of gamma rays is concerned Marbolite ranks second only to lead in the list, being about one-third as effective as lead and about twice as good as natural white marble.

TABLE 1.

Material	Density (g./cc.)	Half-value thickness (in cm.)	Absorption coefficient
Lead	11.1	1.3	0.51
Marbolite	3.9	4.5	0.15
White marble	2.7	7.7	0.09
Gypsum	2.3	8.7	0.08
Plaster of Paris	1.2	17.0	0.04

Gamma Ray Scattering

The experimetal arrangement for the measurement of scattering was based on that of R. R. Wilson,[5] and is shown in Fig. 3. The arrangement for the measurement of gamma ray intensity was similar to that shown in Fig. 1. Gamma rays from a Co^{60} source are collimated by the conical opening in lead blocks and then fall on the scattering material. The scattering of gamma rays in passing through the same thicknesses, each equal to 7 mm. of Marbolite, marble and lead, was measured. The results of scattering are shown in Fig. 4, where the curve with broken line shows the background, i.e., fraction of incidental beam scattered in the absence of the scatterer 'A'. The lower part of Fig. 4 shows the corrected curves obtained after substraction of this background. After eorrecting for density, the scattering of gamma rays through Marbolite, for the same percentage absorption, is less than for either lead or natural marble.

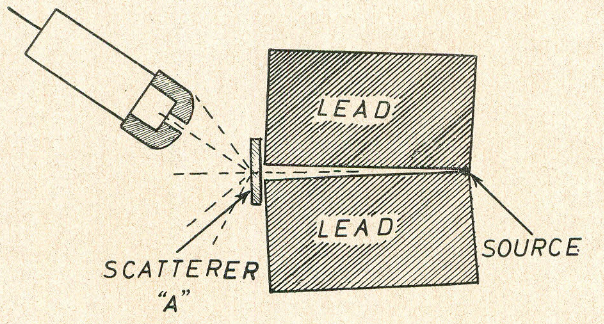

Fig. 3.—Experimental arrangement for scattering measurements.

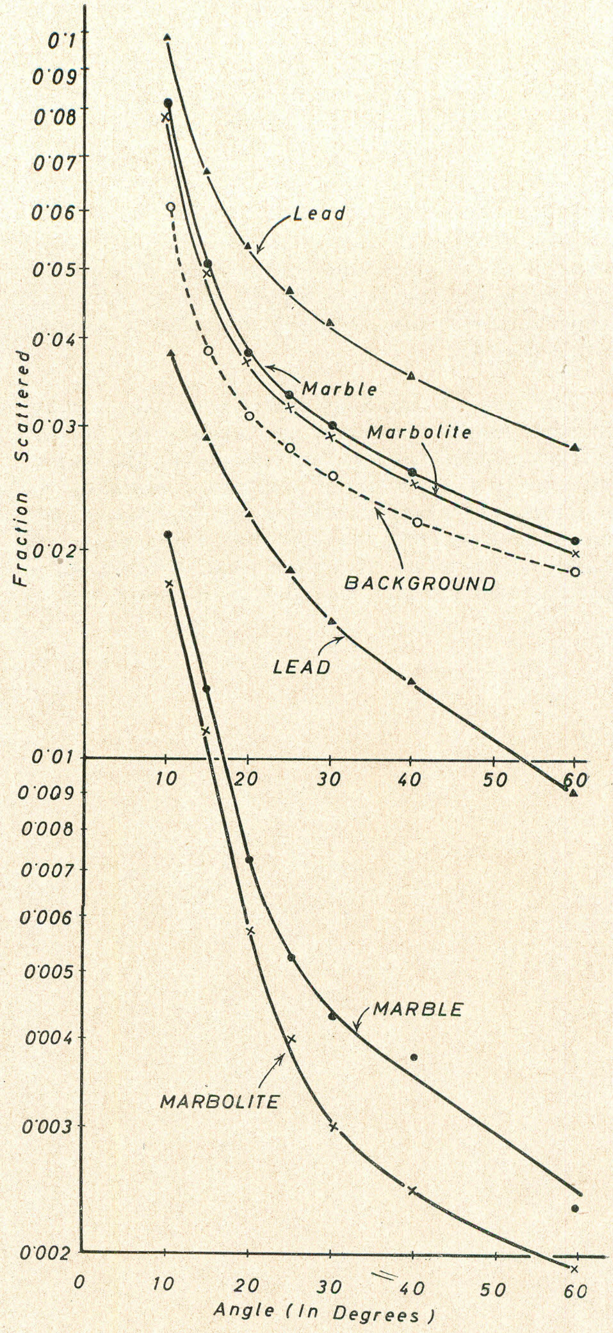

Fig. 4.—Scattering of Co60 gamma radiations in passing through equivalent absorption thicknesses of lead, Marbolite and marble measured as fraction of normal beam.

Conclusion

Results obtained for both absorption and scattering show that Marbolite is a considerably better shielding material than natural white marble. As compared to lead, Marbolite is about one third as effective in absorption but has the advantage of producing less scattering. Calculations based on the cost of these materials[1] show that for the same percentage absorption, Marbolite is about eight times cheaper than lead and about four times cheaper than that of natural white marble.

The ease of handling and fabrication in any desired shape (especially to make interlocking bricks) coupled with its low cost makes Marbolite, an excellent material for temporary shielding in laboratories where shielding arrangements are changed frequently to suit the experiments in hand. Due to its acid and alkali resistant properties, and the fact that it can be easily decontaminated due to its polished surface, Marbolite appears especially suitable for radiochemical or other similar laboratories where chemical reactions with radioactive isotopes are performed.

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