

Desenvolvimento de corpo de prova para obter fatores de transmissão para atenuar fótons de 0.511 MeV

Development of test specimens to obtain the transmission factors to attenuate photons of 0.511 MeV

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Resumo: Para o projeto de uma blindagem necessita-se, principalmente, determinar ou ter acesso aos seguintes parâmetros: fatores de transmissão do material utilizado e tipo da radiação a ser blindada. Desenvolveram-se corpos de prova com diferentes espessuras, para obtenção experimental do fator de transmissão do material, para cálculo de blindagem. Os corpos de prova foram confeccionados considerando as características geométricas do detector, a facilidade de produção e a energia de 0.511 MeV proveniente do decaimento do ¹⁸F-FDG. Utilizou-se na confecção dos corpos de prova um tipo de concreto muito utilizado no Brasil.

Palavras-chave: fator de transmissão, blindagem e corpo de prova.

Abstract: For designing a shielding, it is necessary, mainly, to determine or have access to the following parameters: transmission factors of the material used and type of radiation to be shielded. Cylindrical test specimens with different thicknesses were developed for experimentally obtaining the material transmission factor for shielding calculation. The cylindrical test specimens were made considering the geometric characteristics of the detector, the ease of production and the energy of 0.511 MeV from the ¹⁸F-FDG decay. A type of concrete widely used in Brazil was used in the preparation of the cylindrical test specimens.

Keywords: transmission factor, shielding and test specimens.

1. INTRODUCTION

The breakthrough of nuclear medicine in the last 20 years has caused a singular increase in examinations and treatments. Technologies such

as PET and PET/CT were implemented and their use optimized the diagnosis and minimized disease detection time.

This type of technology performs use the radiopharmaceutical ¹⁸F-FDG [1,2] that in its

decay releases a positron, this positron after a time ends up going through the process of annihilation, thus releasing two photons of 0.511 MeV, a type of highly penetrating radiation.

In order to guarantee the physical protection of the public and worker in these installations, a shielding must be designed for electromagnetic radiation with energy of 0.511 MeV.

In this way the determination of parameters, such as the transmission factor, will contribute to the process of calculating the shielding for this type of facility.

The materials normally used to shield this type of radiation are lead, iron and concrete. For economic and practical reasons, concrete is commonly used in various facilities.

In this work, cylindrical test specimens of different thicknesses were developed to obtain the concrete transmission factor, irradiated with 0.511 MeV electromagnetic radiation [1], and thus, to obtain a fundamental parameter for the calculation of the shield.

Parallel to obtainment this experimental data, it is developed through a computational modeling in the Monte Carlo N-Particle software, a simulation of the experimental context to generate computational data.

Then, a comparison between the computational data and the experimental data was created, also creating another comparison between data generated and data of consecrated literatures, guaranteeing a greater reliability in the parameters for the project of the shield and protection of the general public and workers.

2. MATERIALS AND METHODS

2.1. Trace of concrete

The trace of concrete is defined as the expression of the relative amounts of the concrete components.

The components used in this work are:

- Portland 2 Cement
- Fine, Medium e Coarse Sand
- Crushed Stone number 0
- Water

2.2. Quantities of the material used

From the calculates for the trace of the concrete elaborated according to the reference [3], the quantities expressed in spread sheet 1 was obtained:

Spread Sheet 1. Quantities of the material used.

Materials	Quantities
Portland 2 Cement	2,2 Kg
Sand Fine	3,4 Kg
Sand Medium	1,75 Kg
Sand Coarse	1,75 Kg
Crushed Stone N:0	7,6 Kg
Water	2 L

The crushed stone type 0 has been sieved to obtain the smallest stones, which will fit into the cylindrical test specimens.

2.3. Cylindrical test specimen

The Cylindrical test specimens were designed considering the ease of production and the geometric characteristics of the experimental apparatus used.

Cylindrical test specimens were made from a PVC tube 10 centimeters in diameter and 2 meter in length. 7 cylindrical test specimens of this tube were cut into the lathe, cuts of 2 to 8 centimeters in length, varying 1 centimeter. Were also cut, three cylindrical test specimens of this tube, each 20 centimeters in length.

2.4. Equipments

The equipment used to make the concrete are:

- Concrete-mixer CSM 145 Litros
- Trowel
- 4" knitted sieve
- 3/8" knitted sieve
- Plastic Sheet
- Sideboard for concrete
- 1 Litre beaker

2.5. Procedures

The procedures were performed according to reference [3], as following:

- The concrete mixer was prepared by wetting its interior to receive the materials;
- Crushed stone, cement, fine sand, medium sand, coarse sand and water were introduced;
- The concrete mixer was activated, and waited 30 minutes until the mixture was homogeneous;
- The concrete mixer was turned off, and the concrete mix was poured into the Sideboard. The interior of the concrete mixer was checked to see if there were no traces of the mixture, if it still had, a trowel was used to remove traces of the mixture;
- The homogeneity of the mixture in the Sideboard for concrete was observed with the naked eye. If the mixture was not homogeneous, turn the mixture with the trowel until it remained;
- The vibrating machine was prepared by lining the workbench with a plastic sheet.
- The cylindrical test specimens were placed on top of the vibrating machine bed, then the cylindrical test specimens were filled with the concrete;

- The vibrating machine was turned on, so that the concrete was level in each cylindrical test specimens, after leveling the machine was turned off;
- It was waited 24 hours for the concrete to dry;
- After 24 hours, cylindrical test specimens were placed underwater to cure (increase the strength of the concrete);
- After 28 days of cure, according to the literature [3], the cylindrical test specimens are ready for use.

3. RESULTS

The purpose of this work was to demonstrate the care at the moment of designing and manufacturing the cylindrical test specimens, guaranteeing an experimental apparatus according to the context.

And in order to reproduce the ideal conditions for the design of a shield, in which the material to be shielded has its specific characteristics. The results of the cylindrical test specimens according to previously defined criteria, were as shown in figures 1 and 2:



Figure 1. Cylindrical test specimens 2 to 8 centimeters in height and 10 centimeters in diameter.



Figure 2. Cylindrical test specimens 10 centimeters in diameter and 20 centimeters in height.

4. CONCLUSION

The cylindrical test specimens were made, and the experimental data for the experimental transmission factor for the 0.511 MeV energy is now being used. The Monte Carlo simulation is in the final stage of elaboration, spread sheet 2 shows the preliminary results of the simulation, where “Length” is the length of the wall, “Buildup 1” is the buildup in the finite medium, “Buildup 2” is the buildup in the infinite medium, and “Correction Factor” is the factor to correct the buildup, so that compare the computational data with those of consecrated literatures.

Spread Sheet 2. Results of the simulation.

Length (cm)	Buildup 1	Buildup 2	Correction Factor
2	1.3161	1.4606	0.6862
4	1.7018	2.0015	0.7007
6	2.1762	2.6219	0.7252
8	2.6668	3.3118	0.7210
10	3.2570	4.0938	0.7295
14	4.5961	5.9126	0.7320
18	6.2105	7.7893	0.7674

Tests will also be done to analyze the composition of the concrete, below presents the two tests that will be done:

- With the scanning electron microscope will be done the EDS.
- X-ray Fluorescence.

Relevant points to emphasize:

- This made concrete has different specifications of those proposed in the literature.
- Data will be created in the literature for the energy of 0.511 MeV, because currently there has to be interpolation between the energies of 0.5 MeV and 0.6 MeV.

5. REFERENCES

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