A comparative study of dose transmission factor of ADDIBOND 65 based material used for Am-Be neutron source shielding

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Abstract

- ***This article introduces present neutron shielding materials with ADDIBOND 65 based materials. The method has a lot of advantage such as The success these materials low density and have better and low neutrons transmission trends, increases the strength properties, Improves the impermeability of cement mortar and increases resistance to chemicals and salts when The most important of the proposed method can be used successfully in the neutron therapy systems. Neutron can be prodused by many processes which include nuclear reactions induced by alpha particles , nuclear reaction induced by accelerated beams of light ions, fission and spallation reaction. The article has a lot of advantages, it improves the impermeability of cement mortar and increases resistance to chemicals and salts, increases the strength properties has no harmful effect.***

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Keywords: transmission factor , Dose, Neutron Source, addibond-65.

Introduction

Neutrons are used in many fields, industrial medical researches, and can be produced by many processes which include nuclear reactions induced by alpha particles, nuclear reaction induced by accelerated beams of light ions, fission and spallation, radioisotopes, and particle accelerators. In this work we used the ADDIBOND 65 (Density: 1.01 kg/l) compound which is a e adhesive with a wide range of applications. It is latex dispersion admixture based on styrene butadiene rubber and is used for improving the properties of cement mortar and concrete, specifically with regards to bond strength to different building materials, and impermeability to water[1].

Am-Be is one of the commonly used indirect radioisotope neutron source in laboratory measurements. The .alpha particle emitted by Americium-241 with decay energy of approximately 5.7 MeV and half-life of 433 years impinges on the Beryllium-9 target to produce neutrons with wide range of energies. The neutrons emitted are mostly high energy neutrons (fast neutrons) and thus needs to be thermalized by an appropriate material before being captured. Being an uncharged particle, the basis of neutron shielding is first reducing its energy through moderation (thermalization) and then placing shielding material with high neutron absorption cross section between the object and the source [7]. Therefore, the effectiveness of any given material in shielding against neutron source depends on the material density, material thickness and the geometry of the neutron source being shielded.

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Advantages

- *Increases the bond strength of concrete and mortar to different building materials.*
- *Increases the strength properties, especially tensile and bending strength.*
- *Increases the elasticity and reduces shrinkage cracking.*
- *Improves the workability and decreases the mixing water.*
- *Improves the impermeability of cement mortar and increases resistance to chemicals and salts when*
- *Added in high dosage to get a water proofing mortar.*
- *Has no harmful effect.*

Technical Data : (at 25 °C)

Colour	White
Soild content	25%± 0.02%
Density	1.04 ± 0.01 kg/ l
PH - Value	8 ± 0.5
Minimum application temperature	4°C

DOSE TRANSMISSION FACTOR

The rate at which each of these materials reduces neutron doses can be determined by the absorption cross section which is related to the transmission factor of the materials. Thus, according to Sorenson and Phelps [2,3], dose transmission factor is considered to be the ratio of the shielded neutron dose to the unshielded neutron dose:

$$Dose\,Transmission\,Factor = \frac{Dose\ with\ shield}{Dose\ without\ shield}$$

It represents the fraction of neutron dose transmitted by normal concrete or ADDIBOND 65 based compound i.e., it represent the ratio of the shielded neutron dose to the unshielded neutron dose.. This shows that the transmission factor of small dose is better off than the transmission factor of large dose values. The In foils were used for measured the activity measured after and before each samples. The net area of the 416 KeV gamma line was used for this calculation. The irradiation time was 9240 Sec the cooling time was 120 sec for each and the measuring time was 300 Sec. for each gamma spectrum.

Irradiation Facility and Experimental Setup:

In the present analysis, two ^{241}Am-Be isotopic neutron sources were used. The system full activity is 5 Ci/source. The neutron irradiation setup is presented in figure (1)
[4-6]. Irradiation assembly chamber consists of aluminum tube located between two ^{241}Am-Be neutron sources, inside a cylinder of paraffin wax of 58 cm diameter. High purity Indium foils were used for relative flux monitoring. The samples were located from the bottom of the irradiation chamber by 10 cm paraffin wax this is to reach good neutron homogeneity. The spectra of the activated, in foils were measured using a high resolution ORTEC hyper-pure germanium (HPGe) gamma-x detector of volume 100 cc , efficiency of 70 % and 2 KeV energy resolution at 1332 KeV. A cylindrical lead-shield of 5 cm

thickness, which contains inner concentric thin cylinders of Cu with a thickness of 5 mm, was used to shield the detector and to reduce the effect of background radiation. Standard ^{226}Ra gamma source were used for both energy and efficiency calibrations of the system.

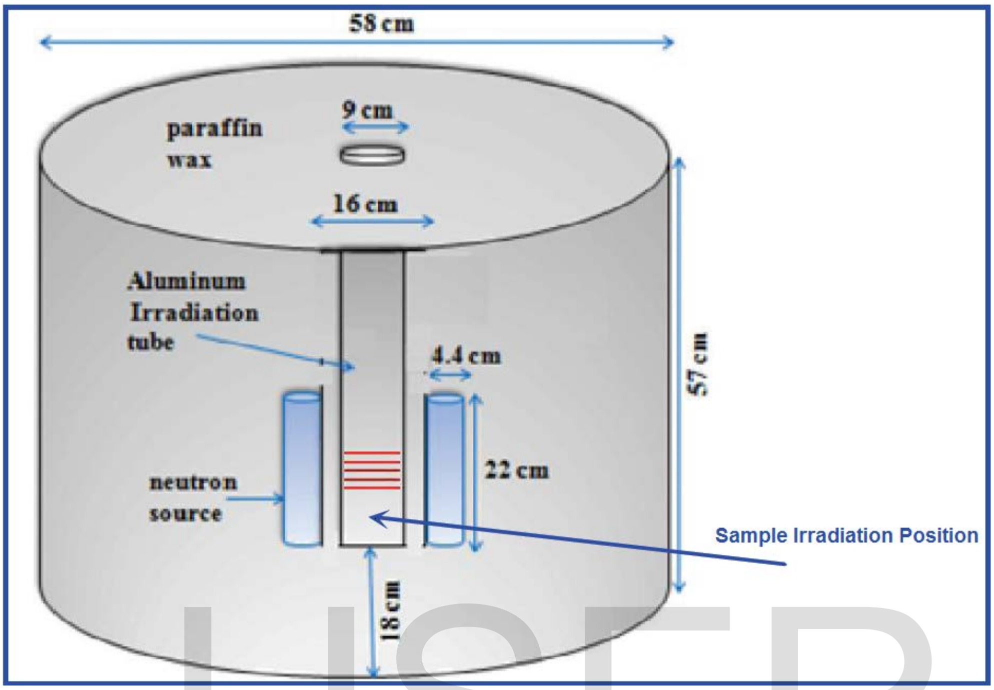

Fig. (1) Represents the Am-Be neutron irradiation facility used in this study[1-3]

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Sampling:

A mixture of 1kg cement: 0.2 l water, 0.2 l addibond & 0.55 Kgm sand was mad and the shielding disks were made with 8 cm diameter and 1.2 cm thickness. Figure (2) represents the shape of the used disks. In foil was used in between these samples for neutron monitoring.

Fig.(2) Represents the shape of the prepared disks using ADDIBOND 65.

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Result and discussion:

The presented method was compared with normal concrete and heavy concrete table (1). Disks were made with the same thickness 8cm for the aim of comparison.

Table (1) the used percentage of the heavy and normal concrete

Normal Concrete
sand =75 %
cement =15 %
water =10 %
Heavy Concrete
sand =30 %
cement =15 %
gravel =40 %
water =15 %

Experiment shows that the dose transmission factors were measured at 8 cm thickness. It was 0.2 and 1.6 for normal concrete and heavy concrete respectively.

As shown from figure (3) the introduced material has 1.1 dose transmission factor values at 8cm which is better compared than the normal and old material.

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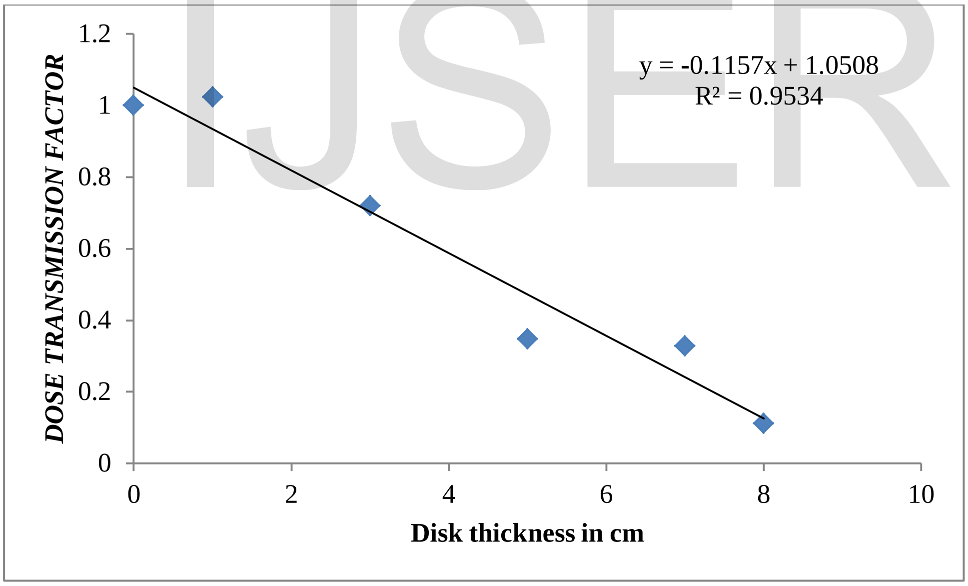

Fig.(3) Represents the measured dose transmission factor against the *thickness of the produced ADDIBOND 65 disk in cm.*

Conclusion

This article introduces present neutron shielding materials with ADDIBOND 65 based materials. The success these materials low density and have better and low neutrons transmission trends. The proposed method can be used successfully in the neutron therapy systems.

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الملخص العربي

في هذا البحث نتشرف بتقديم طريقة حديثة للتدريع الاشعاعي ضد النيوترونات. في هذه الطريقة تم استخدام أحد مواد البناء الحديثة وهو الاديبوند 65 و خلطه مع الاسمنت و الرمل للوصول لأعلي قدرة للتدريع و شدة صلابة جيدة مقارنة بالطرق التقليدية الاخري التي تستخدم الخرسانة عالية الكثافة. تم بالتعاون مع مركز البحوث النووية .. هيئة الطاقة الذرية .. استخدام نظام تشعيع نيوتروني من نوع عدد 2 Am-Be بشدة أشعاعية 5Ci لكل مصدر. أوضحت القياسات و النتائج انه من الافضل تطوير خلطات الخرسانة باضافة مثل هذا المركب لما له من نتائج مرضية ممزوجة بمميزات شدة الصلابة و حسن الصب و التشكيل و الجفاف. لذلك نوصي باستخدامة بالاخص في الاستخدامات السلمية للاشعاعات النيوترونية في حقول التجارب و كذلك في اماكن العلاج الاشعاعي.