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Behavior of Exposure Build-up Factor and Mass Attenuation Coefficients of Blast Furnace Slag and Steel Slag on Interaction with High Energy Radiation

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Abstract: ***The vitality boundaries of fractional communication cross area and all out Attenuation coefficients (µtot.) of Blast Furnaceslag (BFS) and steel slag (SS) are determined by utilizing the 'WinXcom' program over the vitality run 1 KeV to 100 GeV. Here watch regularities of cooperation of gamma radiation with Blast Furnaceslag (BFS) and steel slag (SS, for example, the exponential Attenuation law, the diminishing of the mass Attenuation coefficient with expanding vitality of gamma Ray, the expansion of the mass Attenuation coefficient with expanding nuclear number of the safeguard and the proportionality of the mass Attenuation coefficient comparing to Compton dissipating to the nuclear number of the safeguard. Geometric Progression (GP) strategy was utilized to compute gamma-beam vitality Exposure Buildup factors (EBF) of taken examples for the vitality extend 0.015–15 MeV, and penetration depth upto 40mfp.The outcome recommends that the communication measures are 'Z' subordinate. The charts and conditions portraying the above reliance as of now empower in deciding the thickness of different taking blast furnace slag and steel slag. The estimations of EBF were discovered to be littler in lower and higher photon vitality locales though exceptionally huge in middle vitality area where Compton dispersing rules. Here BFS has higher estimations of µ(total) in vitality extend when contrasted with SS, so BFS shows great protecting adequacy for gamma beams.***

Keywords: Partial interaction cross section, Total attenuation coefficients, Exposure Build up factor and Geometric Progression (GP)

1. Introduction

Atomic force age require assurance against unsafe effect of ionizing radiation. Radiation insurance depends on the straight, no-threshold model of wellbeing dangers at low portions and three crucial standards: legitimization, streamlining, and constraint. The useful utilization of radiation assurance is partitioned into three territories: arranged, crisis, and existing introduction circumstances.

The mass attenuation coefficient (μ/ρ) is a proportion of likelihood of collaboration that happens between occurrence photons and matter per unit mass per unit zone. Buildup factors are the protecting materials and math subordinate boundaries which right the straightforward attenuation estimations with the goal that they incorporate the commitment of the radiation field delivered by the impacted piece of shaft. The idea of Buildup factor was commonly presented by White [2] and Fano [3] who perceived its significance in attenuation studies. The Exposure buildup factor that is the buildup factor in which the amount of intrigueis the consumed or saved vitality in the interfacing material and the finder reaction work is that of ingestion in the associating material [4]. American National principles ANSI/ANS-6.4.3[5] has given buildup factor information to 23 components, one compound and two blends (for example air and water) and cement at energies in the range 0.015-15 MeV up to entrance profundities of 40 mfp by utilizing the G.P strategy. Harima has made the unreasonable verifiable survey and an appraisal for the status of buildup factor estimations and applications [4].Berger and Hubble [6,13] have created PC program, WINXCOM, which ascertains photon cross-segments and mass attenuation coefficients for unadulterated components and blends in the vitality scope of 1keV to 100 GeV.

Blast Furnace slag (BFS) concrete is the blend of normal Portland concrete and fine granulated blast furnace slag got as a result in the assembling of steel with percent under 70% to that of concrete.

The fundamental parts of blast furnace slag are CaO, SiO2, Al2O3, and MgO. As a rule expanding the CaO substance of the slag brings about raised slag basicity and an expansion in compressive quality.

When utilizing the Blast Furnace granulated slag (BFGS) as a free restricting medium or along with a portland concrete it is important to know its stage structure and action. The significant piece of BFGS, particularly in the Ural district, is spoken to meagerly by the principle and corrosive slags, wherein the amount of glass in these glasses varies somewhere in the range of 80 to 95% [7].

With the most recent pattern toward a reusing focused society, nonetheless, viable utilization of slag is standing out, and considering this, the Company has examined the utilization of blast furnace slag as solid total for more extensive assortments of uses. Here reports a model where the slag was preliminary utilized as the solid total for street clearing, just as the quality control during the work and follow-up review of the asphalt execution. The measures to tackle the issues in the utilization of fine slag total for concrete and its relevance to project solid items are additionally portrayed thus [8].

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Uses of utilizing slags are to prepared blend solid plants. Utilized for structures implied for water holding, for example, holding divider, streams, ports, burrows for development in impermeability. Utilized in mass cementing works, for example, dams, establishments which require low warmth of hydration. Utilized in the spots helpless to chloride and sulfate assaults, for example, sub-structure, exhausted heaps, pre-case heaps and marine structures.

Directly, new wellsprings of vitality are required to satisfy different necessities and atomic vitality is by all accounts the main arrangement. Such huge numbers of numerous nations are intending to build atomic reactors, because of which numerous little girl items in the energized state are delivered by atomic reactors during the different cycles. Because of these radiations which are destructive, there is need of the day to get composite materials that can be utilized for the protecting, against gamma beam used in numerous logical, mechanical and clinical applications just as shield the earth and individuals from the danger of the radiation.

The attenuation coefficient is a significant portraying the entrance and dissemination of gamma beams in expanded medium. Study various boundaries identified with the section of gamma beams through materials and give data on the portion of gamma vitality dispersed or ingested.

The Research paper on mass attenuation coefficients and buildup factor estimated by scientists revealed [9-11] for various energies for different examples, for example, delicate tissue, amino corrosive and calming drugs.In the current investigation, an endeavor has been made to consider the absolute mass attenuation coefficients of BFS and SS. This work is additionally proposed to contemplate the radiation connections in the given examples. Considering significance and appropriateness of the investigation of gamma beam attenuation in different fields, we need to contemplate the assimilation properties of BFS and SS identified with protecting of radiation sources. In present investigation the compound synthesis of various sorts of blast furnace slag and steel slag taken from Ivanka Netinger et al 'Qualities and employments of steel slag in building development, Wood Head Publishing arrangement in common and basic designing(page no. 16 and 21) appeared in table (1). The produced EBF information have been concentrated as an element of entrance profundities .Also study the variety of mass attenuation coefficients of tests with episode photon vitality for in all out photon connection [with coherent]) in the vitality extend 1 KeV - 100 GeV.

Table 1: Chemical composition of chosen samples [12]

Sr. No	Compositions	% in (Wt.) (BFS)	% in (Wt.) (SS)
1	Lime (CaO)	32-45	35-45
2	Magnesia (MgO)	5-15	2-9
4	Alumina (Al_2O_3)	7-16	1-6
5	Sulphur(S)	1-2	≤ 0.2
6	Iron Oxide (Fe_2O_3)	0.1-1.5	0.9-38
7	ManganeseOxide (MnO)	0.2-1	2-6
8	Iron (II) Oxide (FeO)	≤ 1	16-26
9	Chromium (III) Oxide (Cr_2O_3)	≤ 1	0.5-2
10	P_2O_5	--------	Approx. 0.0
11	TiO_2	--------	0.4-3.0

2. Theory

2.1 Calculation of Mass Attenuation Coefficient

The linear attenuation coefficient is the entirety of the probabilities of communication per unit way length by every one of the three dispersing and assimilation measures - photoelectric effect, Compton Effect, and pair Production. Since linear attenuation coefficients are corresponding to the safeguard thickness, which as a rule doesn't have an exceptional worth however relies to some degree upon the physical condition of the material, it is standard to utilize the mass attenuation coefficient, which eliminates thickness reliance: The absorption coefficient of solutions of BFS and SS is subject to its substance and gamma - beam vitality. This work portrays an investigation of substance reliance on estimations of content of gamma - radiation at gamma-beam vitality of arrangements of BFS and SS. The attenuation of gamma rays expressed as:

$$I= I_o \exp (-\mu\ x) \qquad (1)$$

Where I_o is the number of particles of radiation counted during a certain time duration without any absorber, I is the number counted during the same time with a thickness xof absorber between the source of radiation and the detector, and μ is the linear absorption coefficient. This equation may be cast into the linear form,

$$\log I = \log I_o - \mu\ x$$
$$\text{i.e. } \mu\ x = \log (Io/ I)$$
$$\mu = (1/x) \log (I_o/I) \qquad (2)$$

The mass absorption coefficient of solutions of BFS and SS, μ_m defined as,

$$\mu_m = \mu/\rho \qquad (3)$$

Where, $\mu_m$is the mass attenuation coefficient and 'ρ' is the density of solutions of BFS and SS.
The unit of 'μ' is cm^{-1} and that of $\mu_m$is cm^2/gm.

2.2 Computational Work

To compute the buildup factors, the G-P fitting boundaries were acquired by the technique for interjections from the equivalent atomic number (Zeq). That calculation is partitioned into three stages as follows:

2.2.1. Calculation of the equivalent atomic number (Z_{eq})

The equal atomic number Zeq for specific material has been determined by coordinating the proportion, (μ/ρ) compton/(μ/ρ)Total, of that material at a particular vitality with the comparing proportion of a component at a similar vitality. Along these lines, initially the Compton partial mass attenuation coefficient, (μ/ρ)Compton, and the complete mass attenuation coefficients, (μ/ρ)Total, were acquired for the components of Z= 4-40 and for the geo polymers in the vitality locale 0.015-15 MeV, utilizing the WINXCOM [6,13] PC program. For the interjection of Zeq for which the proportion (μ/ρ) compton/ (μ/ρ)Total lies between two progressive proportions of components, the accompanying equation has been utilized:

$$Z_{eq} = \frac{Z_1(\log R_2 - \log R) + Z_2(\log R - \log R_1)}{\log R_2 - \log R_1} \qquad (1)$$

Where Z_1 and Z_2 is the elemental atomic numbers corresponding to the ratios (μ/ρ) Compton / (μ/ρ) Tot, R_1

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and R_2 respectively and R are the ratio for given geo polymers at a particular energy. The value of $Z_{eq}$for the selected BFS and SSso obtained.

2.2.2. Calculation of geometric progression (G-P fitting parameters)

Ascertain the G-P fitting boundary a comparable insertion system was embraced as on account of the equal nuclear number. The G-P fitting boundary for components were taken from the ANSI/ANS-6.4.3 [5] standard reference information base which gives the G-P fitting boundaries for components from beryllium to press in the vitality locale 0.015-15 MeV up to 40 mfp. Equation given underneath is utilized in interjection of G-P fitting buildup coefficient of the pre-owned materials

$$C = \frac{C_1\left(\log Z_2 - \log Z_{eq}\right) + C_2\left(\log Z_{eq} - \log Z_1\right)}{\log Z_2 - \log Z_1} \quad (2)$$

Where C_1 and C_2 are the values of coefficients (G-P fitting parameters) corresponding to the atomic numbers of Z_1 and Z_2 respectively, at a given energy and Z_{eq} is the equivalent atomic number of the given material.

2.2.3. Calculation of exposure buildup factors

The G.P fitting parameters were then used to generate exposure buildup factor data for these materials using the following G.P fitting formula given by Harima et al. [4]

$$B(E,x) = 1 + \frac{(b-1)(K^{x}-1)}{K-1} \quad \text{for } K \neq 1 \quad (3)$$

$$B(E,x) = 1 + (b-1)x \quad \text{for } K=1 \quad (4)$$

Where

$$K(E,x) = cx^{a} + d\,\frac{\tanh(x/X_k - 2) - \tanh(-2)}{1-\tanh(-2)}$$

$$\text{for } x \leq 40mfp \quad (5)$$

Where E is the incident photon energy, x is the penetration depth in mean free path, a,b,c,d and $X_k$are the G-P fitting parameters and b is the value of buildup factor at 1 mfp. The parameter K (E,x) is the photon dose multiplication factor and change in the shape of the spectrum.

3. Result and Discussion

3.1 Mass attenuation coefficient of selected materials as a function of chemical composition and incident photon energy

The consequences of the current examination are demonstrated graphically in fig.1, where µtotal is given as an element of episode photon vitality in all photon association measures. In the current work, the impact of concoction organizations of picked BFS and SS, µm and the varieties of µ total with occurrence photon vitality for all connections are examined in the accompanying sections.

Variation of total mass attenuation coefficients of slags with occurrence photon vitality (MeV) for a wide range of association measure is concentrated from fig. 1. Mass attenuation coefficient (µtotal) for the complete photon association measures is at first high and diminishes pointedly with increment in occurrence photon vitality up to 100 KeV. Over 100 KeV the pace of diminishing of µ (absolute) with episode photon vitality is less or more 30 MeV µ(total) increments somewhat with further increment in occurrence photon vitality. This conduct is because of predominance of various collaboration measures in various episode photon energies for example under 100 KeV photograph electric cycle is predominant, from 100 KeV to 30 MeV Compton dissipating or more 30 MeV pair-production measure is prevailing. It is additionally clear in fig. 1 that BFS has higher estimations of µ(total) in all vitality district when contrasted with SS.

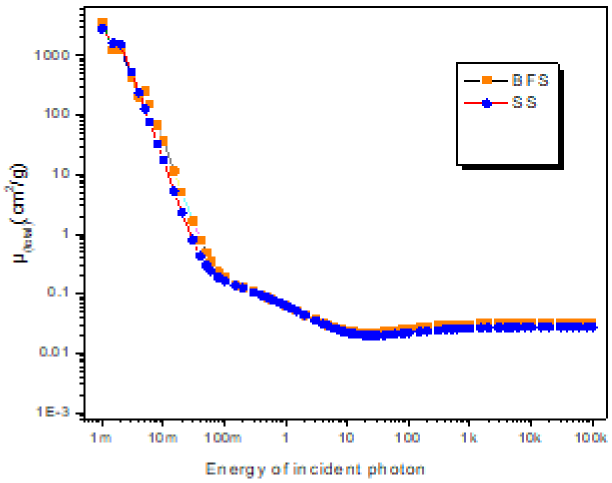

Figure 1: Variation of total mass attenuation coefficients of blast furnace slag(BFS) and steel slag(SS), with incident photon energy (MeV) for all types of interaction process

3.2 Buildup factors of Slags

The computed energy absorption GP fitting parameters were used to generate exposure buildup factors. In the following paragraphs, we discuss how the exposure buildup factors vary with penetration depths.

3.3 EAF as a Function of Penetration Depth

Figs. 2-3 shows the variety of EBF as a function of Penetration depth for some chose photon energies in the vitality run 0.015-15 MeV. The estimations of EBF pretty much stay consistent (solidarity) and low for all Penetration depth at the most minimal vitality 0.015 MeV because of predominance of photoelectric effect. However, at energies for example 0.20 MeV and 0.50 MeV the estimations of EABF are a lot higher and increments with increment in Penetration depth for all slags, because of more numerous dissipated photons are created everywhere Penetration depth for example expanding the buildup factor, additionally it tends to be seen that at higher energies for example 3 to 15 MeV, EBF values are in the middle of lower and higher qualities because of power of pair-production.

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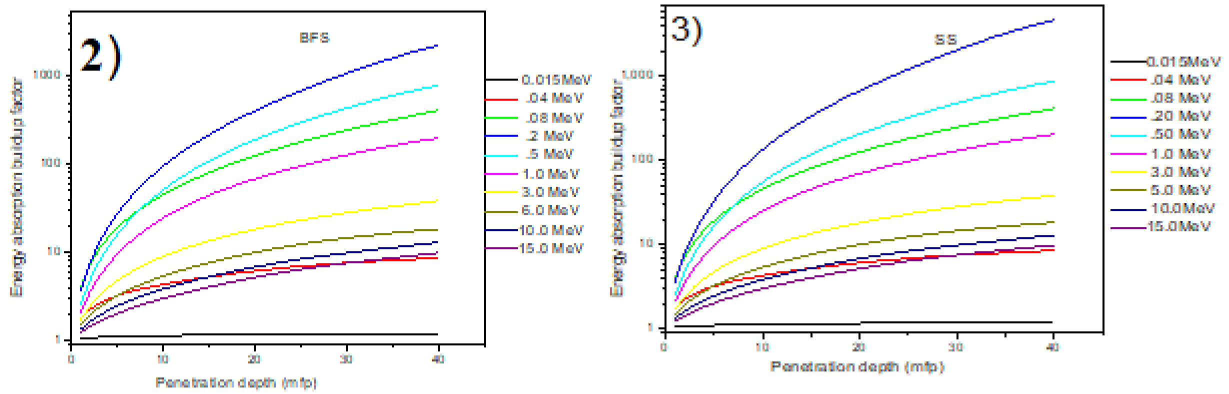

Figures 2-3: Variation of the EBF with penetration depth (in units of mfp) for some selected photon energies (in MeV): (2) BFS (3) SS

4. Conclusion

- Mass attenuation coefficient is useful for detail concentrate in protecting viability of various kinds of materials/ mediums.
- BFS has higher estimations of μ(total) in all vitality locale when contrasted with SS. So BFS shows great protecting adequacy for gamma beams.
- The estimations of EBF stays low for chosen infiltration profundities at 0.015 MeV, however at energies for example 100 KeV EBF values are increments with higher rate with increment in penetration depth. Anyway at higher energies EBF values are show expanding pattern turns out to be increasingly slow.

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