Evaluation of the External Radiation Effects of Fly Ash Added to Iraqi Concrete

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Abstract: Increased in treats in measuring radionuclides and radon concern tractions in fly ash, cement and other components of building products is due to concern of health hazard of naturally occurring radioactive materials. The current work focuses on studying the influence of fly ash (FA) on radon – exhalation rate (radon flux) from cementations material. The tests were carried out on cement past specimens with FA content. It is found that despite the (more than 3 times, compared with Portland cement). The radon – exhalation rate was found top significantly lower in concrete containing fly ash than in ordinary concrete.

Keywords: Radionuclide, Radon, Fly ash, cement, concert

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1. Introduction

The fly ash is waste product from coal – fired and gas power plants. In several countries [1] fly ash is used as a component of building materials [2].

Use of fly ash is advantageous from economical and resource points of view, and it has the advantages associated with using a waste product which may be regarded as a possible environmental pollutant.

The fly ash may contain enhanced levels of the natural radionuclides in the uranium and thorium series [3, 4], and by using the fly ash in building martials, the radiation levels in houses may thus be technologically enhanced.

Fly ash may be used as the major component of building blacks or just as a small fraction of the find building material and used fly ash as a partial replacement of sand. [2]

In Iraq, we have yet on coal –fired power plants, but it is imported from abroad, especially Turkey.

Although this topic has been studied globally in the eighties and according to research and studies published globally, it is new in Iraq and this study is the first in Iraq because the fly ash and foreign cement was prohibited to import until often the year 2003.

The future Iraq fly ash – cement is planned to contain fly ash increases the compressive strength of the concert and the geometrically tests have shown that the best ration 15% of fly ash in the red sand [2].

2. Materials and Methods

The Following materials were investigated:

1- Ordinary Portland cement (Type 1) product from Kufa cement factory and Kitchens to Iraq standard specification No.5 for the year (1984).
2- Ordinary Portland cement (Type 2) product from Bazian cement factory (Sulaymaniyah in Iraq).
3- Ordinary Portland cement (Type 3) product from Karkuk cement factory Iraq.
4- Ordinary concrete i.e. a mixture of 30% cement and 70% sand and gravel.
5- Fly ash (Type F) Turkish origin and classified according to standard specification ASTM C618.
6- FA-cement, i.e. a mixture of (85%) cement and (15%) fly ash (FA).
7- FA-concrete, i.e. a mixture of (40%) FA-cement and (60%) sand and gravel.
8- The natural sand of the Akheider quarries in the work of concrete mixtures.
9- The natural rounded gravel of the Nabai area quarries.

The following measurements were:

1- Activity concentrations of fly ash, cement FA-cement, sand and gravel.
2- The radon emanation coefficient, η, of some materials, the emanation coefficient is defined as the fraction of the radon activity produced that enters the interstitial air volume of the material.
3- Radon- exhalation rates from six 16000-cm3 of concerted three of which were made of ordinary concrete and three mad of FA-concrete. The producer was asked to use the same sand and gravel in all the samples.
4- Radon – exhalation rate per unit activity concentration of Ra for 16000-cm3 molds of ordinary concrete.

The following experimental methods were used:

1- Measurements of the activity concentrations measurements of the activity concentrations of Ra, Th, and K were performed by (a 209 cm3 HpGeLi) detector and a Canberra multi-channel analysis.

The samples were measured in 1kg (marinelli Berker) Plastic cans. The equipment was calibrated against standard samples with known concentrations of Ra, Th and K (directorate of radiation and nuclear safety Laboratory in Iraq).

The following ∂ - transitions were used:

(Ra) 182.2 kev, (Bi) 609.3 kev, (Th) 583kev, (K) 1461.5 kev.

2- Measurements of the radon- exhalation:

Exhalation rates for concrete molds were measured by enclosing the samples in closed containers. After a certain sampling time, the exhalation rate may be assessed by measuring the activity concentration of the air in the container. Under ideal conditions (no back diffusion or leakage from the container), the exhalation rate ,

E maybe calculated by :[5 , 6 , 7]

$E = V_d.\, C_{Rm}.\, \lambda_{Rn} / [\, 1-\exp(-\lambda_{Rn}\, .t)\,]$ ------------------(1)

Where

V_d = dead space or air volume of the container.

C_{Rn} = measured activity concentration of the air in the container.

λ_{Rn} = decay constant of Rn (0.00756hr-1)

t = sampling time.

For chrushed samples, the emanation coefficient may be calculated by: [1 , 7 , 8]

$$\eta = \frac{E}{C_{Rn}.M.\lambda_{Rn}} \text{ -------------------- } (\ 2\ )$$

Where:
C_{Rn} = activity concentration of Ra in the ample.
M = mass of the sample.
For our measurements of the emanation rate of ordinary concrete molds, sampling times of between 15 and 20 hr were used, and exhalation rate was calculated according to equation (1). The activity concentration of Rn was measured by the scintillation flask method.

3. Experimental Results

Table 1, Table 2, Table 3, Table 4, and Table 5 summarize the results. In Table (1), the measured activity concentration is listed. The results of the emanation coefficient measurements are given in Table (2). In Table (3), we have listed the total exhalation rate per unit activity concentration of Ra for (3) ordinary concrete molds. In Table (4) comparison measurements of concrete molds with and without fly ash are shown. In Table (5) the measured activity concentrations in word are listed.

Table 1: Activity concentrations of natural radionuclides in samples of fly ash and cement (Bq/Kg)

Material	No of Samples	Activity concentration (Bq / Kg)			
		Ra226	Bi214	Th232	K40
ordinary cement	3	14-36	28-15	30-28	250-245
FA-cement (*)	3	97-39	72-65	70-64	299-301
Turkis FA	1	121	89	101	650
Gravel	1	19	8	13	95
Sand	1	32	15	23	135

(*) FA-Cement containing (15%) fly ash (FA)

Table 2: Measurements of emanation coefficient η , of fly ash and cement

Material	No of samples	Emanation coefficient, η%
Fly ash	1	2
Cement	3	3-6
FA-Cement	3	3-4

Table 3: Exhalation rate per unit radium activity concentration of 16000 cm^3 concrete molds (1 Bq hr-1 per Bq Kg-1)

No of samples	Exhalation rate per unit activity concentration 1 Bq hr-1 per Bq Kg-1		
	Min	**Mean**	**Max**
6	0.0034	0.0045	0.0063

Table 4: Exhalation rate from 16000 cm^3 ordinary concrete and of concrete containing fly ash (FA)

Pair	Exhalation rat (Bq/h)	
	with FA	**without FA**
1	0.053	0.086
2	0.068	0.096
3	0.075	0.101

Table 5: Activity concentrations of building materials

Country	Material	Concentration (Bq/Kg-1)		
		226Ra	232Th	40K
Germany	Portland Cement	26	19	315
	Fly ash	111	130	550
	Building sand and gravel	15	19	129
Poland	Cement	26	67	259
	Fly ash	610	320	493
United Kingdom	sand and gravel	4	7	115
	cement	22	18	210
	fly ash	301	216	430
Denmark	Concrete	24	17	285
	cement	30	21	290
	Fly ash	210	160	383
Hungary	Concrete	13	11	279

4. Discussion

Table (1) shows radioactivity of radionuclide concentrations in cement and fly ash models as well as red sand and gravel. Through the table it is shown that the concentration Ra226 in fly ash more than three times than ordinary cement.
In table (4) we see that the subtract ratio of the radon in the concrete containing fly ash is lower than of the non-concerts.

Thus, there is a very important benefit to fly ash as it reduces the addition of concrete to the introduction of radon inside houses built with concrete, and thus reduces the exposure of people through inhalation. With the increase in the use of concrete in the construction of house in Iraq it is preferable to add fly ash cement.

5. Conclusions

1- After reviewing the results, it is better to reduce the addition of dark sand and compensate for it by adding fly ash to increase the hardness of the concrete and reduce the emission of radon

2- After experimenting with adding different amounts of fly ash, it was found that the best percentage is 15 percent to reduce radon emissions inside homes. Side homes.

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تقييم تأثيرات الإشعاع الخارجي للرماد المتطاير المضاف إلى الخرسانة العراقية

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المستخلص: زيادة المعالجات في قياس النويدات المشعة وجرار الرادون في الرماد المتطاير والأسمنت والمكونات الأخرى لمنتجات البناء ترجع إلى القلق من المخاطر الصحية للمواد المشعة التي تحدث بشكل طبيعي. يركز العمل الحالي على دراسة تأثير الرماد المتطاير (FA) على غاز الرادون - معدل الزفير (تدفق الرادون) من مواد التدعيم. تم إجراء الاختبارات على عينات الأسمنت السابقة مع محتوى FA. وتبين أنه بالرغم من (أكثر من 3 مرات مقارنة مع الأسمنت البورتلاندي). تم العثور على معدل غاز الرادون - الزفير أعلى بشكل ملحوظ في الخرسانة المحتوية على الرماد المتطاير مما هو عليه في الخرسانة العادية.

الكلمات المفتاحية: النويدات المشعة، الرادون، الرماد المتطاير، الأسمنت، الخرسانة

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