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Survey on difference between the concentration of radon indoor air of black cement with decorative stones warehouses

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Abstract: *Radon 222 is a colorless and odorless radioactive gas with a half-life of 3.82 days which can be emitted from various building materials such as cement and decorative stones like granite. In the present study, the difference between the concentration of* radon 222 *indoor air of black cement and decorative stones warehouses has been analyzed. The results showed that the mean concentration of* radon 222*indoor air of cement warehouses is significantly greater than decorative stones warehouses (p value < 0.05). So corrective actions such as increasing ventilation and reducing staff work time in black cements warehouses are priority to decorative stones warehouses.*

Key words: radon 222*, black cement warehouses, decorative stones warehouses, indoor air*

I. Introduction

Colorless and odorless radon 222 gas is one of the most important global concerns about indoor air quality [3-1]. Radon 222produces by the decay of radium 226 in the chain of uranium 238 [4-5]. Based on the information presented by theNRPB[1] 85% of the effective dose received by humans is fromnaturalradiationand15 % of it is from synthetic (man-made) radiation [6]. Radon 222 allocates 1.4 mSv of annual effective does received by natural radiation (over 50%) [7-9]. The alpha radiation emitted by radon 222 in the long term can damage the DNA of lung cells and eventually cause lung cancer [10, 11]. After smoking, Radon is the second leading cause of death from lung cancer [11]. The WHO[2] has confirmed the significant direct relation lung cancer prevalence with indoor air Radon [12]. The EPA[3]has stated that the mortality rate caused by indoor air Radon is equal to approximately 21000 people annually which is 10 times higher than deaths from air pollution [13]. The global mean concentration of indoor and outdoor air Radon is 48 Bq/m^3 and 15 Bq/m^3 respectively [14]. Indoor air Radon concentration is mainly related to emissions from building materials, the surrounding soil and water resources [15]. All building materials have radioactive substances although in small amounts. Many studies have shown that cement (black and white powder, plasters, concrete, etc.) can emit more radioactive materials especially radium 226, radon 222, and Thoron compare to many other building materials [16-18]. Also many studies have shown that decorative stones such as granite, marble etc. can also emit radon 222 [19-22]. In many studies the concentration of radon 222 emitted from black cement was more than granite and in some studies the concentration of radon 222 emitted from granite was more than black cement [23-24]. Therefore, in the present review study, it has been tried to compare and evaluate the difference between concentrations of radon 222 indoor air of cement and decorative stones warehouses.

II. Material and Methods

Effective dose received in cement and decorative stones warehouses have been studied by Fakhri et al in Minab [25-26]. Fakhri et al. had selected 5 important and major Black Cement Warehouses (BCW) in Minab city to measure concentration radon 222 indoor air in cement warehouses. Three stages measurement was conducted from March2011to May 2012(one stage per month). At each stage, two 24-hour measurements and two 4-hour measurements were performed at each warehouse. In total of three stages of 5 warehouses, 30 concentration of

[1] International Radiation Protection Board
[2] World Health Organization
[3] Environmental Protection Agency of America

radon 222 and Thoron 24-hour indoor air and 30 concentration of radon 222 and Thoron 4hour of background air were measured [25]. Fakhri et al. had selected 4 major and important decorative stones warehouses (granite, marble etc.) in Minab to measure concentration of radon 222 indoor air in decorative stones warehouses (mainly granite). The measurement was performed in three stages from November to April
2012 (one stage per month). In each warehouse, the Radon meter was placed at a height of 1 meter and in the center of warehouse. At every stage in every warehouse, two 24-hour measurements and two 4-hour measurements were done. In total of three stages of 5 warehouses, 24 concentration of 24-hour indoor air and 24 concentrations of 4-hour radon 222 and Thoron of background air were measured [26].Since ventilation variable affects indoor air concentration of radon 222, hence to eliminate its effect it was attempted to select the same natural and artificial ventilation for black cement and decorative stones warehouses. The differences between the concentration of indoor air radon 222 in cement and decorative stones warehouses were compared using Pair sample test statistical analysis. P value<0.05 (α=5%) was as significant confidence.

III. Results

The mean concentration of indoor air Radon (M±SD) in black cement warehouses BCW1, BCW2, BCW3, BCW4 and BCW5 were 158.33±28, 183.67±32, 111.25±19, 199.67±35 and 123.33±22Bq/m3, respectively (Table 1). Total mean of indoor air concentration of radon 222 in 5 warehouses was equal to 154 Bq/m3. The concentration range of indoor air radon in BCW1, BCW2, BCW3, BCW4 and BCW5 were 211±37-103±18, 239±42-127±22, 158±28-50±9, 261±46-156±27 and 172±30-86±15 Bq/m3, respectively [25].

Table 1. Mean of total indoor air Radon concentration (Bq/m3) in 5 black cement warehouses during 24 hours.

Time (hr)	BCW1	BCW2	BCW3	BCW4	BCW5
10:30 AM	123±22	146±26	80±14	165±29	96±17
12	103±18	127±22	69±12	156±27	86±15
14	134±23	154±27	76±13	167±29	96±17
16	138±24	134±23	50±9	183±32	104±18
18	160±28	181±32	110±19	195±34	122±21
20	166±29	200±35	114±20	199±35	118±21
22	182±32	217±38	140±25	197±34	139±24
24	190±33	225±39	140±25	227±40	134±23
2 PM	196±34	233±41	156±27	240±42	152±27
4	211±37	239±42	158±28	248±43	172±30
6	163±29	190±33	143±25	261±46	157±27
8:30	134±23	158±28	99±17	158±28	104±18
M±SD[4]	158.33[5]±28	183.67±32	111.25±19	199.67±35	123.33±22

The mean concentration of Radon in the decorative stones warehouses DSW1, DSW2, DSW3 and DSW4 was 72.50±34, 98.25±43, 34.42±18 and 88.92±51 Bq/m^3, respectively. Total mean of indoor air concentration of radon 222 in the 4 decorative stones warehouses was equal to 73 Bq/m^3. The concentration range of indoor air Radon 222 in DSW1, DSW2, DSW3 and DSW4 warehouses was 16±3-124±22,33±6157±27, 11±4-64±11and 31±5-184±32 Bq/m^3, respectively (Table 2) [26].

Table 2. Mean concentrations of indoor air Radon in 4 decorative stones warehouses during 24 hours (Bq/m^3).

Time (hr)	DSW1[6]	DSW2	DSW3	DSW4
9	[7]29±5	52±9	11±4	54±9
11	16±3	33±6	16±3	45±8
13	40±7	60±11	26±5	31±5
15	44±8	40±7	28±5	89±16
17	66±12	87±15	16±3	57±10
19	72±13	106±19	20±4	47±8
21	88±15	123±22	46±8	76±13
23	96±18	131±23	46±8	126±22
1	102±18	139±24	62±11	121±21
3	117±21	145±25	64±11	173±30

[4] Mean ± Standard Deviation
[5] Mean of 6 Concentration 24 hours radon222 and thoron 220
[6] Mean ± Standard Error
[7] Mean of 3 level

5	124±22	157±27	49±9	184±32
7	76±13	106±19	29±5	64±11
M±SD (Day)	44.5±8	63±11	19.5±4	53.83±9
M±SD (Night)	100.5±18	133.5±23	49.33±9	124±22
M±SD[8]	72.50±34	98.25±43	34.42±18	88.92±51

IV. Discussion

Since p value < 0.05 was obtained between radon 222 indoor air concentration in cement and decorative warehouses so it can be said that there is a significant difference between concentration of radon 222 in cement and decorative stones warehouses (Table 3). The ratio of mean concentration of indoor air radon 222 in cement warehouses (154 Bq/m^3) to decorative stones warehouses (73 Bq/m^3) is equal to 2.1. However to perform properly statistical analysis of samples in two warehouses, the data of no.5 black cement warehouse was not analyzed.

Table 3. Paired Samples Test analysis between concentration of radon 222 of indoor air in black cement and decorative stones warehouses

Paired Samples Test									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Cement - Granite	8.9	24.5	2.0	85.6	93.7	43.8	143	.000

In the study conducted by Sathish et al., the amount of radium 226 emitted from granite (54.5 ± 2.73 Bq/kg) was almost 2.1 times more than its emission from black cement (25.6 ± 1.30 Bq/kg)]27[. Also in the study conducted by Dabayneh in the Hong Kong the amount of radium 226 emitted from granite (220 Bq/kg) was almost 10.5 times more than its emission from black cement (19.2 Bq/kg)]23[. In study conducted by Taher in Arabia, the amount of radium 226 emitted from granite (23 Bq/kg) was almost 2.1 times more than its emission from black cement (34.8 Bq/kg) [28]. Despite radium 226 is different from radon 222, but due to that radon 222 is a decay product of radium 226, so it can be said that this amount of emission is also true for radon 222]24[. In some studies radioactive emission from black cement is more than granite and vice versa. This difference in emission could be caused by the difference in the concentration of radioactive elements particularly uranium 238 in bed rock]29[.

V. Conclusion

The mean indoor air concentration of radon 222 in cement warehouses was significantly more than decorative stones warehouses. Therefore corrective actions (increasing ventilation and reducing staff work time) in black cement warehouses are priority to decorative stone warehouses.

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