Journal of Multidisciplinary Engineering Science Studies (JMESS)
ISSN: 2458-925X
Vol. 3 Issue 5, May - 2017

Effect of Paints On Emanation of Alpha Particles from Natural Radionuclide in The Internal Walls

Ali Abdulwahab Ridha , Hawraa Khalaf Ayyed
Department of Physics, College of Science, Al-Mustansiriyah University, Baghdad, Iraq.
Corresponding author, E-mail: ahmed_naji_abd@yahoo.com

***Abstract*—Thirty-two samples of different paint types were used for painting the inner walls of buildings. A passive technique based on CR-39 nuclear track detector which is widely employed to measure alpha emitters concentration in indoor air. The purpose of this work is to measure the alpha particles shield percentage (ASP) were emitted to the atmosphere from building materials.Results showed that the alpha emitter concentrations of the examined samples ranging from (66.9±18.0 to 187.8±24.4) Bq.m^{-2} with an average of 125.5±23.8Bq.m^{-2}.**

Maximum percentage of alpha particle shields reached to +41% , which in turns leads to reducing the emanation of alpha particles, while the lowest was -66% that enhance alpha emanation from the samples which containing somewhat interior concentrations of natural radionuclides. The concentrations of alpha emitters in painted wall samples were below the worldwide average. Therefore, recommended using these paints as the covering or decorative materials which are safe for human uses.

Keywords—Paints, Alpha particles shield percentage (ASP), CR-39 detector.

Introduction

Natural radionuclides are present everywhere in the environment and they constitute the greatest percentage of human exposure to ionizing radiation [1]. Most of the materials found on the earth's surface contain a measurable amount of naturally occurring radioactive materials (NORM) due to the inherent presence of uranium, thorium and their decay products. However, the materials that contain a high concentration of NORM have the potential to be carcinogenic when exposed to them [2,3].It is well known that most natural substances such as sand, brick, cement, rock, plaster, etc., are used for constructing buildings. These materials are predominately rich in several radioactive elements such as U-238, U-235 and Th-232. Thereby, the study of alpha particle activity in constructing materials is very important since alpha ray is a thousand times more carcinogenic than gamma ray [4]. Radiation exposure that resulted from building materials can be classified into two types; external and internal exposures. The external exposure caused by the direct gamma rays from building materials inside the building. The internal exposure is caused by inhalation of radon gas, turn-on gas and their short-lived decay products [5]. The exposing to alpha emitters from the earth shell and constructing materials, forms the major source of alpha particles in an indoor environment**.** For that, some researchers focused on techniques at which, the walls and roofs are painted with different kind of paints and may affect the alpha emitters concentration and radon exhalation from these

construction materials. As a various brand of paints are available in the market and widely used as a cover for plastered bricks in order to increase the life and for the ornamental purpose, it is important to highlight the impact of the wall coverings on (α-emitters and radon gas) exhalation from the building materials [6].More, ionizing radiation can cause damage in the human tissues and can also produce chemical alters in deoxyribonucleic acid (DNA) which store genetic information and function of the human body to be not active and powerful. Hence this may lead to biological hazards [7]. So that lung cancer, skin cancer and kidney diseases are affected by this [8]. Recently, many detectors have been developed to detect the tiny doses of such hazards [9].

1. Experimental Procedure and Methodology

2.1. Sample Preparation

In this project, thirty-two samples of Iraqi paints were collected from different areas origins and companies, as shown in Table-1. The samples included two types of paints; water-based paints which comprise paints (marked pantilayt, plastic and decorative paints (Fabiano, glaze, etc.,)) and oil-based paints (marked Boya). After collection, the walls have been painted after diluting with liquids (water and thinner). Pantilyt, plastic and decorative paints mixed with water, while boya paints mixed with liquid thinner. Figure-1 shows the painted wall during the preparation stage for (BO2 and BO5) a typically painted wall sample.

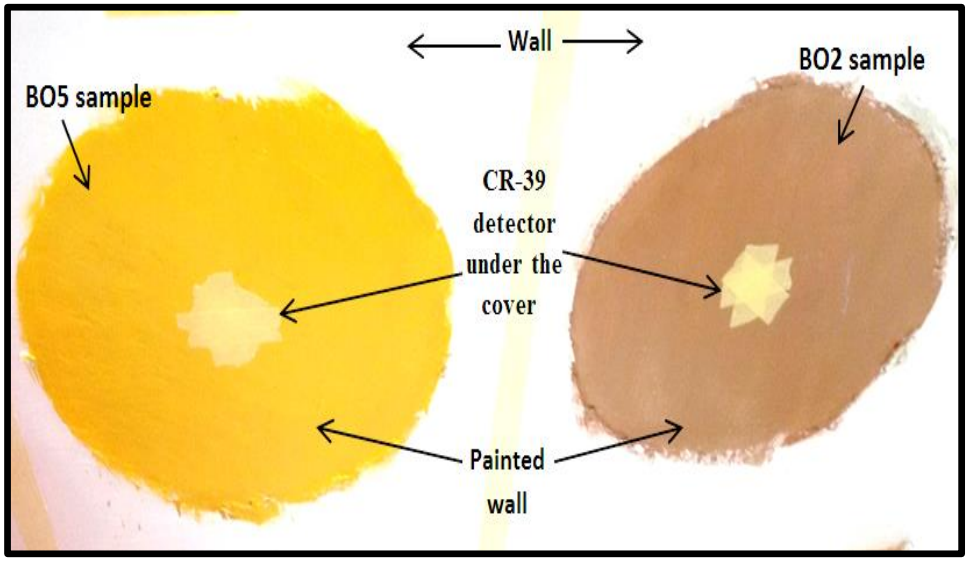

Figure 1. The painted wall during the preparation stage for (BO2 and BO5) samples.

2.2. Alpha Emitters Analysis

The activity concentration of alpha emitters has been measured in the painted wall samples, at which covering and decorative the walls ceiling in indoor buildings. A square pieces (5×5) cm^2 of (CR-39) track detectors was used for each painted wall sample. The CR-39 detector was placed attached to the painted wall sample for detection α-particles emitted from radionuclides in the building materials and paint samples itself in 30 days, this detector was covered tightly to

prevent the exposure to radon gas progeny, as shown in Figure-2. The chemical etching to the CR-39 detectors has been carried out in order to display the alpha tracks from alpha emitters.

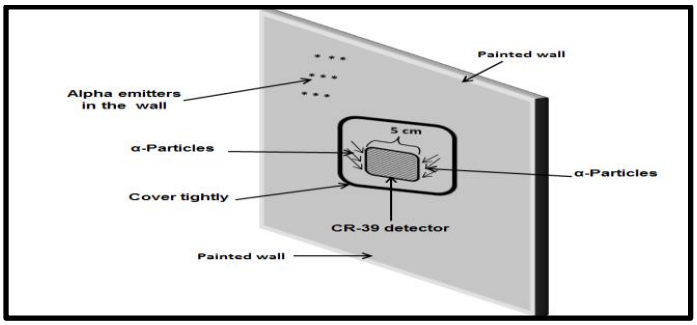

Figure 2. The mechanism of measurement of alpha emitters using CR-39 nuclear track detector.

A base solution of sodium hydroxide (NaOH) with normality (6 N) has been used for the chemical etching process in this research, water bath device used for heating the NaOH solution with the temperature of (70 ^{o}C) for 6.5 hours. These detectors were washed with distilled water the remains of NaOH solution, then dried for a microscopic viewing using an optical microscope at a magnification of 360 X. The calibration for experimental setup of alpha emitter concentrations using a point source of Am-241 with a calibration factor of 0.0025 (track.mm^{-2})/(Bq.sec.cm^{-2}) was done.

Results and Discussion

1.1. Estimation of Alpha Emitters Concentration

In this study, the concentration of alpha emitters (Bq.m^{-2}) for each painted wall sample was calculated using the formula as:

$$C_{\alpha} = \rho/KT \quad (1)$$

Where: C_{α} represents alpha emitters concentration (Bq.m^{-2}), ρ the track density (Track.mm^{-2}), K is the calibration factor for alpha emitters which is equal to 0.0025 (Track.mm^{-2}/Bq.sec.cm^{-2}), T is the exposure time which is equal to 30day=2592×10^{3}sec.

The concentration of alpha emitters has been listed in Table-1, the maximum concentration of α-emitters emitted from the surface of painted wall sample was 187.8±24.4 Bq.m^{-2} in the lumbar varnish sample (LV) from Arteco company, Turkey origin, while the minimum value was (66.9±18.0 Bq.m^{-2}) in the pantilayt sample (PN9) from Top Primer company (Belgian origin) and the average value of C_{α} was 125.5±23.8 Bq.m^{-2}. Figure-3 represents alpha emitter concentration for each painted wall sample.

3.2. Estimation of Alpha Particles Shield Percentage (ASP)

Paints and covering the walls, roofs, etc., can be shielded of alpha emitters, coating or painting effect on the emanation of α-emitters can be expressed in alpha emitter shield percentages (ASP), this percentage is very important to identify the amount of blocking or shielding by the paints for emanation of alpha emitters emitted from building materials of the walls. ASP (%) of alpha emitters were computed for the first time for each sample by applying the following equation:

$$\text{ASP}\ (\%) = 100 - \left(\frac{C_{\alpha}}{C_{\alpha(B.G)}} * 100\right) \quad (2)$$

Where: C_{α} ($Bq.m^{-2}$) represents the concentration of alpha emitters after painting the wall, $C_{\alpha(B.G)}$ is the average concentration of alpha emitters of the background was to the wall without paint and equal to 113.2 $Bq.m^{-2}$. The sign (+) of (ASP) denoted to the increasing in the paint shielding for the emanation of alpha emitters and *vice versa* for a sign (-).

From the Table-1, the maximum value of ASP (%) was +40.9 % in the pantilayt sample (PN9), while the minimum value of ASP was -65.9 % in the decorative lumbar varnish sample (LV). However, the mean value of ASP was -10.8 %. Figure-3 shows the relation between the shield percentage of alpha particles and the concentration. The high concentrations of α-emitters have low values of shield percentage, but lwer concentrations of α-emitters have high values of shield percentage. Therefore, some paints have the highest values of ASP (%) as in pantilyt paint samples (Belgian PN9 and Jordanian PN6) and plastic paint samples (Norwegian PL3, United State PL5 and Jordanian PL6), whereas, the samples which have the lowest values of alpha particles shield percentage as in decorative paints (Turkish LV, German ST and Jordanian FA1), these samples have high values of alpha emitters concentration ($Bq.m^{-2}$).

The results showed that the pantilyt samples have low values of shield percentage (ASP) less than zero except the samples (PN6 and PN9), all boya samples support a little bit the emanation of alpha particles, plastic samples have a high values of percentage of α-particles especially in paint samples (PL3, PL5 and PL6) but the decorative samples were supported significantly the exhalation of alpha particles especially in sample (ST, LV and FA1), as shown in Figure-5 which represents alpha particles shield percentage for each sample.

Table 1. Alpha emitters concentration (C_α) and the shield percentage (ASP) for each painted wall sample.

No.	Types		Sample code	Origin	Company	Cα ($Bq.m^{-2}$)	ASP (%)
1	Pantilayt		PN1	Iraq	Al-Marjan	128.6±27.1	-13.6
2			PN2	Iraq	Asia	118.3±18.0	-4.5
3			PN3	Iraq	Almas	126.0±28.3	-11.3
4			PN4	Jordan	Dorsal	133.7±10.8	-18.1
5			PN5	Jordan	Arabco	136.3±17.4	-20.4
6			PN6	Jordan	Cryola	87.4±13.3	+22.7
7			PN7	Lebanon	Omega	105.5±19.0	+6.8
8			PN8	Turkey	Betek	154.3±21.0	-36.3
9			PN9	Belgium/Greece	Top Primer	66.9±18.0	+40.9
10			PN10	Norway/ UAE	Jotun	146.6±29.8	-29.5
11	Boya		BO1	Iraq	Al-Marjan	131.2±19.0	-15.9
12			BO2	Jordan	Riva	120.9±21.2	-6.8
13			BO3	Jordan	Fixtone	126.0±28.3	-11.3
14			BO4	Egypt	Nova	136.3±17.4	-20.4
15			BO5	Turkey	Betek	133.7±23.6	-18.1
16	Plastic		PL1	Iraq	Al-Marjan	156.9±41.0	-38.6
17			PL2	Jordan	Dylon	123.5±20.3	-9.1
18			PL3	Norway/UAE	Jotun	87.4±24.8	+22.7
19			PL4	Germany/Greece	Smart Plast	123.5±26.6	-9.1
20			PL5	USA	Colorplace	87.4±13.3	+22.7
21			PL6	Jordan	Mado	90.0±18.2	+20.5
22	Decorative	**Fabiano**	FA1	Jordan	Global	162.0±32.2	-43.1
23		**Fabiano**	FA2	UAE	Mas	110.6±24.4	+2.3
24		**Glaze**	GL	Jordan	Meraco	133.7±26.6	-18.1
25		**Mas Crystal**	MC	UAE	Mas	92.6±32.5	+18.2
26		**CrackleVarnish**	CV	Turkey	Fira Color	123.5±23.6	-9.1
27		**Lumbar Varnish**	LV	Turkey	Arteco	187.8±24.4	-65.9
28		**Gypsum Filler**	GF1	Jordan	Meraco	136.3±12.4	-20.4
29		**Gypsum Filler**	GF2	Jordan	Fixtone	108.0±20.3	+4.6
30		**Stucco**	ST	Germany/Turkey	Sandeco	180.0±27.1	-59.0
31		**Oteshinto**	OT	Turkey	Fira color	141.5±54.6	-25.0
32		**Acrylic**	AC	Jordan	Meraco	118.3±27.6	-4.5
					Maximum	**187.8±24.4**	**+40.9**
					Minimum	**66.9±18.0**	**-65.9**
					Average	**125.5±23.8**	**-10.8**

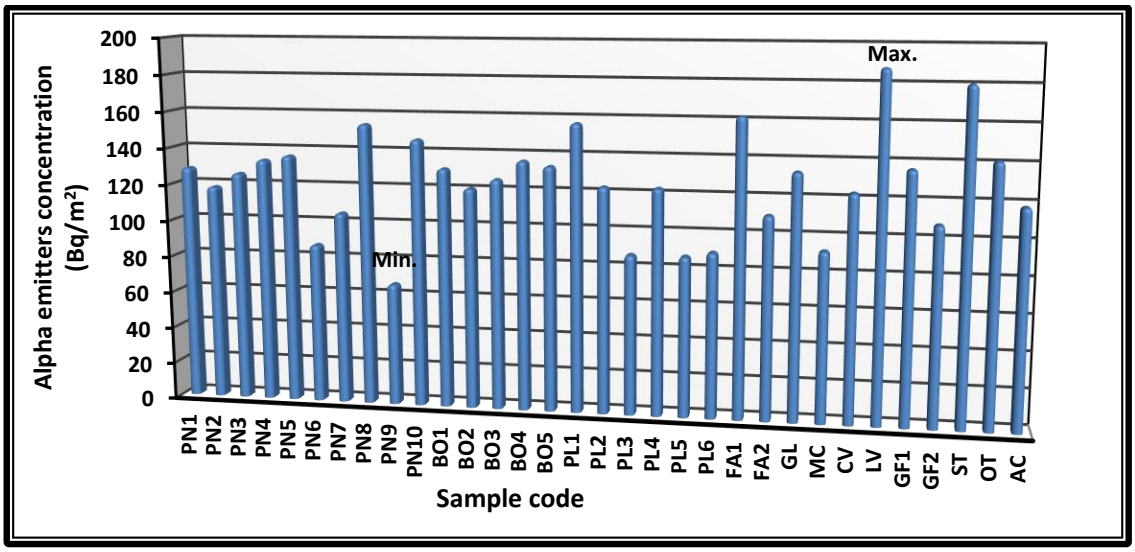

Figure 3. Shows alpha emitter concentration for each painted wall sample

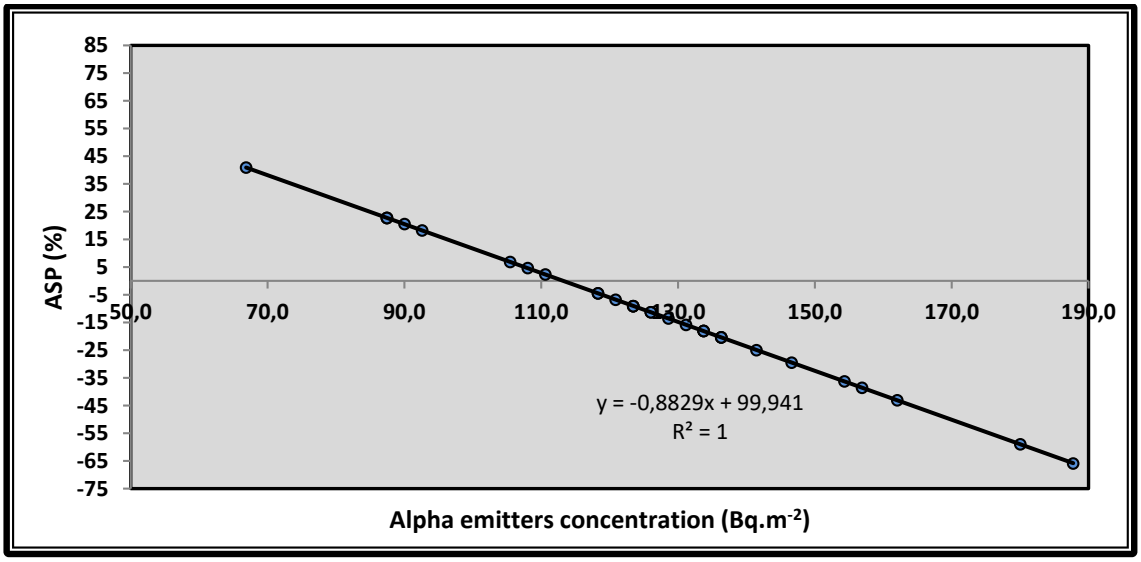

Figure 4. The relation between α-particles shield percentage and its concentration for each painted wall sample

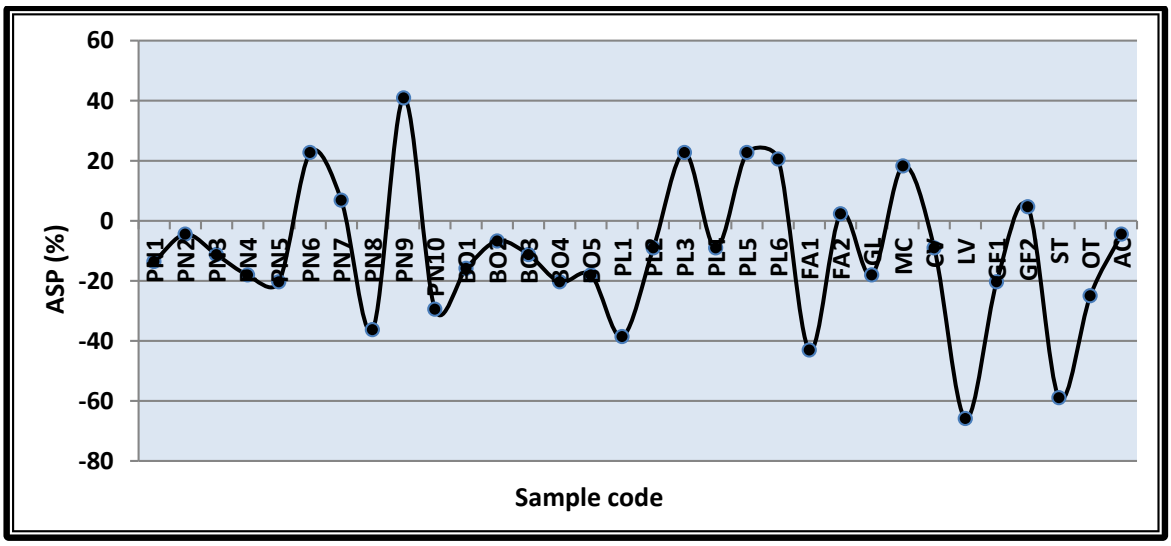

Figure 5. Shows the percentage of alpha particles shield for each sample.

4. Conclusions

- At first, it was possible to calculate alpha particles shielding percentage (ASP), which is useful to select for paints and it is proportional inversely with alpha emitter concentrations.
- Some type of paints were containing different ratios of natural radionuclides (U-238, U-235 and Th-232) which support the increase of alpha emitters concentration inside buildings. This was shown by a comparison of alpha emitter concentrations before and after painting the wall.
- The highest value of α-emitters shield percentage exists in best for use pantilyt sample (PN9), on the other hand, the sample of decorative lumber varnish (LV) has the lowest values of ASP because it has the highest value of C_α ($Bq.m^{-2}$).

1. In general, the plastic paint samples have the higher percentage of the alpha particle shield also samples (PN6 and PN9) from pantilyt paints and decorative paints have a worst shield percentage to alpha particles except sample (MC), as shown in Figure-5.

- All samples were safe for construction, this means that the recorded values of alpha emitter concentrations in this study were less than the global permissible limit 400 $Bq.m^{-2}$ [10].

5. Recommendations

The best type of paints that we recommend to use for painting the inner surface walls of buildings is (PN6, PN9, PL3, PL5 and PL6 samples) which may reduce the emanation of alpha particles to reach about +41%. Here, the study showed to exclude the use (FA1, ST and LV types) because they contain the internal concentrations that support increasing of alpha particles exhalation to about -66%.

6. Acknowledgements

The authors wish to thank the assistant prof. Dr. Asma H. Mohammed AL-waeli from the optics laboratory in science college, Al-Mustansiriyah university for her providing language help, writing assistance and proofreading the article.

7. References

1. Bavarnegin E., Vahabi M., Babakhani A., Fathabadi N., (2012). Analytical study of radionuclide concentration and radon exhalation rate in market available building materials of Ramsar. Journal of Theoretical and Applied Physics. 6(5), 1-6.
2. Hassan N.M., Ishikawa T., Hosoda M., Sorimachi A., Tokonami S., Fukushi M., Sahoo S.K., (2010). Assessment of the natural radioactivity using two techniques for the measurement of radionuclide concentration in building materials used in Japan. J Radioanal Nucl Chem. 283, 15-21.
3. Arabi A.S., Futua I.I., Dewu B.B.M., Kwaya M.Y., Kurowska E., Muhammad A.M., Garba M.L., (2016). NORM, radon emanation kinetics and analysis of rocks-associated radiological hazards. Environ Earth Sci. 75(689), 1-9.

4. Amin R.M., (2015). A study of radon emitted from building materials using solid state nuclear track detectors. Journal of Radiation Research and Applied Sciences. 8,516-522.

5. Abdallah A.M., Mohery M., Yaghmour S.J., Alddin S.H., (2012). Radon exhalation and natural radiation exposure in low ventilated rooms. Radiation Physics and Chemistry.81, 1710-1714.

6. Sharma A., Mahur A.K., Sonkawade R.G., Sharma A.C., (2014). Radon exhalation in some building construction materials and effect of plastering and paints on the radon exhalation rate using fired bricks. Advances in Applied Science Research. Pelagia Research Library. 5(2), 382-386.

7. Appleton D., (2004). Natural Radioactivity and Health: The risks posed by exposure to ionizing radiation. Earthwise issue. British Geological Survey. 21,16-17.

8. Shoeib M.Y., Thabayneh K.M., (2014). Assessment of natural radiation exposure and radon exhalation rate in various samples of Egyptian building materials. Journal of Radiation Research and Applied Sciences. Science Direct. xxx, 1-8.

9. Nidal D., Ghassan S., Mousa El-H., Toshiyuki I., (2007). CR-39 detector compared with Kodalphafilm type (LR-115) in terms of radon concentration. Nuclear Instruments and Methods in Physics Research Section A. Elsevier. 574(2), 289-191.

10. Daniel A.G., (2010). Basic Radiation Protection Technology 6th edition Publisher: Pacific Radiation Corporation, ISBN: 978-0916339142.