Measuring the NORM in the Oil Fields & Oil Ports in Libya (2)

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Abstract

This paper is the second part of the research its aim is to draw attention to the need for configuration of database about the existence of NORM (Naturally Occurring Radioactive Material) in the oil fields, ports, and terminals of exporting gas across Libya; whereas the NORM is measured in two oil ports (ALHRIKA Ports- Tobrok in the East and AL-ZAWIA Port in the West) where the petroleum exporting there from as coming from oilfields registered therein relatively high radioactivity concentration in the Scales samplesas an attempt to track the spread of the pollution coming from the NORM and to confirm or not the arrival of pollution to the ports. Furthermore, the NORM was measured in some commercial ports so for comparison of NORM levels in each of the Oil & Commercial Ports

The results were as follows:

The Port	Port Classification	Activity Concentration (Bq/L)		
		^{238}U	^{232}Th	^{40}K
Zawia Port	Oil Port	3.0±1.73	6.6±2.56	10.3±3.2
Tobrok Port	Oil Port	1.2±1.09	2.09 ±4.4	21±4.58
Misrata Port	Commercial Port	2.64 ±7.0	B.D.L	26±5.09
Tripoli Port	Commercial Port	6.0±2.44	B.D.L.	2±1.41
Khoms Port	Commercial Port	B.D.L	B.D.L.	15.9±3.98

Table 1- Activity Concentration registered in Tobrok &Zawia Ports and Commercial Ports

(B.D.L= Below Detection Limit).

It is clear from thetable 1 that the Activity Concentration Levels in the Oil & Commercial Ports are in the permissible limits. Samples were 1.5 liters of water taken from the port basins where oil tankers loaded in the oil ports, loading basins and unloading in commercial ports. Gamma rays issued by the samples are measured by High Pure Germanium Detector HGPe in Radiation Prevention Department at Nuclear Research Center/TajuraTripoli, Libya.

Key Words: NORM, Activity Concentration, Scales, Germanium Detector.

Introduction

Natural radioactivity

It is a nuclear activity in which the nuclei of unstable elements transferred to new nuclei of elements. Such transitions automatically occur without any external influences .

The natural radioactivity occurs only when the nucleus launched the alpha particles, beta particles, gamma rays until the nucleus reached to the state of stability (1).

Radioactive isotopes are spread in the earth's crust and their presence ratio varies from one place to another, like any component of the material formed the land. Most of the natural radioactive isotopes belongs to three radioactive families, i.e. 238 uranium (^{238}U) series,232 thorium (^{232}Th) series and 235 uranium (^{235}U) series. In each series, the heavy isotopes dissolved to various isotopes with low launching radiation until reached to the state of stability. In addition to the natural radioactive series, there is in nature some other radioactiveisotopes that are not belong to those chains such as potassium, all of which are characterized by large half ages**(1)**.

Figure 1- uranium 238 (^{238}U) series ,thorium 232 (^{232}Th) series and uranium 235 (^{235}U) series.(2)

NORM (Naturally Occurring Radioactive Materials) used in the Oil & Gas Industry concerns the Naturally Originated Radioactive Materials, while TE-NORM (Technical Enhanced Naturally Occurring Radioactive Materials) concerns the Industrially Enhanced Radioactive Materials (3) .

Oil and Gas Industry is considered as an industry whose employees were exposed to the risk of natural radioactive materials that are concentrated by the industry .The natural radioactive materials accompanied the oil extracted from the ground, to position on the inner walls of pipes and oil separation or stored depots. Such localizations took the form of scales.. The Sludge is also full of radioactive isotopes, which are precipitated in the pipes and tanks in the form of scales; for that reason, this water when posited in the surrounding environment it is polluted the soil (4).The most import risk of the NORM in the Oil & Gas Industry, the workers, during their work closed to the equipment contained the NORM trashes, receive an external radiation dose caused by gamma radiation; such dose is considered the less dangerous than that workers can be received when direct touch with scales during equipment, pipes and reservoirs maintenance operations due to the possibility of entry of molecules carrying radioactive materials to their bodies through inhalation or ingestion (1).

In the First Part of this Research, the NORM levels have been measured in some oilfields, and the results were as follows:

Activity Concentration (Bq/L) of Radioactive Series						The shape of Sample
^{223}Ra	^{226}Ra	^{235}U	^{40}K	^{232}Th	^{238}U	
	80.1±8.94		302.33±17.3	31.8±5.63	37.42±6.11	Sludge
	26.39±5.13		123.54±11.1	3.5±1.87	15.31±3.91	Sludge
	14.5±3.8		107.21±10.3	16.6±4.07	5.47±2.33	Sludge
			11.17±3.34	0.54±0.73	3.8±1.94	Crude oil
		441.31 ±21	612.74±24.7	33±5.74	3630±60.2	Scales
4411.32± 66.4			553.32±23.5	8785.25±93.7	6823.51±82.6	Scales

Table 2 - NORM level registered in some oilfields

From these results, it is clear that the scales samples contain a relatively high concentration of radioactivty. And the next step was to try to follow up the NORM extension path in Export Ports of Oil coming from the fields registered therein a high relatively NORM level. Such ports are AL-HRIGA Port at the City of TOBROK in the East and Port of AL-ZAWIA in the West as indicated in the map in the figure 2. It is noted that there is no previous researches registered the NORM in the ports in the face of large quantity of the research about the NORM in the fields; furthermore, the name of the fields is not mentioned upon the requestfromthemanagers of these fieldsbecause this registered level is not limited to these fields but maybe generalized in all fields produced the oil.

Figure2 - Map of Oil Fields & Ports in Libya (5)

Materials and methods

After routine preparation of the samples in terms of cleaning and filtering as well as detector calibration, which is a High Germanium Detector of the purity and efficiency 90% in vertical position and resolution 1.89 kev the samples has been detected

Tables 3&4 indicated the necessary information about the samples taken from ports and fields:

Date of Detect	Date of Collect	Time of the detect (hr)	The Port	Sample Volume	The shape of sample
July 2015	Mars 2015	15	Al Zawia oil Port	1.5L	Water
July 2015	Mars 2015	15	Tobrok oil Port	1.5L	Water
July 2015	Mars 2015	15	Misrata Commercial Port	1.5L	Water
July 2015	Mars 2015	15	Tripoli Commercial Port	1.5L	Water
July2015	Mars 2015	15	Khoms Commercial Port	1.5L	Water

Table-3- indicated the necessary information about samples taken from the ports.

Date of Detect	Date of Collect	Time of the detect (hr)	Weight of the Sample (Kg)	The shape of samples
Mars 2014	October 2013	14	1.35	(Sludge)
Mars 2014	October 2013	14	1.35	(Sludge)
Mars 2014	October 2013	13	1	(Sludge)
Mars 2014	2013	15	0.7	(Crude Oil)
Mars 2014	Desamber2013	12	0.7	(Scales)
Mars 2014	2013	12	1.35	(Scales)

Table-4- indicated the necessary information about samples taken from the fields.

Figure 3-Samples of the water ports

Figure 4-Scales inside the pipes (6)

Figure (6) the position of the samples inside the detector which isaround by the leads

Figure (5) Investigation system inside the protection building

Results & Discussion

Theradioactivity carbe calculated shortly as follows:

$$A = \frac{net(Cps)}{Eff.W.I\gamma} \quad Bq/kg$$

A radioactivity within the sample, which is required to be found,**Eff** the devise efficiency at specific energy,**Net (Cps)**net count rate per second for specific energy, **I**γ rate of gamma rays emitted at Gamma Yield,**W** sample weight ((kg) "W= Volume/Density".

Table 5 indicated to radioactivity Concentration of Radiation Series being in the sample.

effective dose (µSv/y)	absorbed dose (nGy/h)	Activity Concentration (Bq/L)	Port Classification	The port
6.782±2.60	5.526±2.35	^{40}K(10.3),^{238}U(3), ^{232}Th(6.6)	Oil Port	Al Zawia
5.1082±26	4.162±2.04	^{40}K(21),^{238}U(1.2), ^{232}Th(4.4)	Oil Port	Tobrok
0.813±0.9	0.663±0.81	^{40}K(15.9),^{238}U (B.D.L), ^{232}Th(B.D.L)	Commercial Port	Al-komus
5.299±2.3	4.318±2.07	^{40}K(26),^{238}U(7), ^{232}Th(B.D.L)	Commercial Port	Misrata
3.504±1.87	2.855±1.68	^{40}K(2),^{238}U(6), ^{232}Th(B.D.L)	Commercial Port	Tripoli

Table-5- Radioactivity Concentration, Effective absorbed dose of samples and radiation series in the samples

(B.D.L= Below Detection Limit, less of system sensation) .

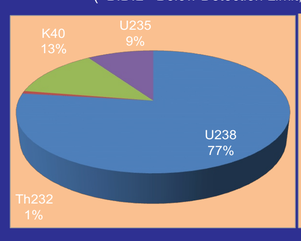

Figure 8 percentage of radiation series in scales sample for field arriving to Tobrok port

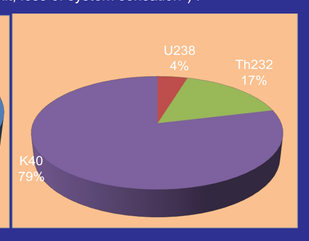

Figure 7 - Percentage of radiation series in Tobrok Port sample.

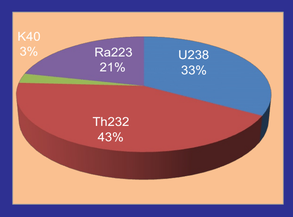

Figure 10 -Percentage of Radiation Series of scales sample for field arriving to AlZawia port

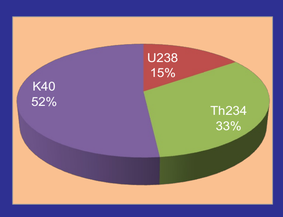

Figure 9- Percentage of Radiation Series in Al Zawia port sample

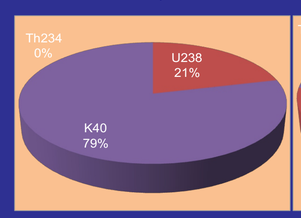

Figure 12 - Percentage of Radiation Series in Misrata port sample

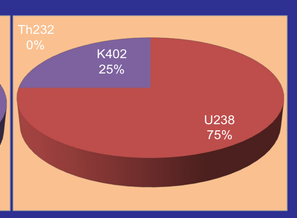

Figure 11- Percentage of Radiation Series Tripoli port sample .

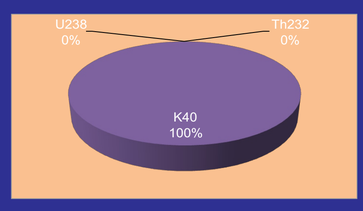

Figure 13 - Percentage of Radiation Series in Khoms Port Sample

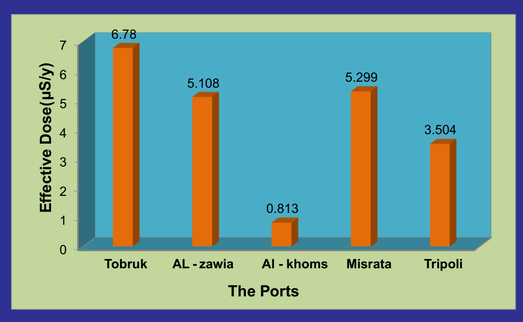

Figure 14- Effective Dose registered in Oil and Commercial Ports.

Returning to the table-2 we found that scales samples registered a high relatively radioactive concentration between 150-5200 Bq/kg and sometimes more than 5200 Bq/kg, which is the level approved in some Arab countries considering that the soil has a low level waste (4) to reach around 8700Bq/kg in the sample of field arriving to Al-Zawia port. From this point, it was important to follow up the extension and impact this high relatively level on the ports exporting where oil coming from these fields. The table 5 indicated the radioactive concentration level in all ports whether oil or commercial ports within the internationally levels of background radioactivity, which is 30 ,35 Bq/kg;^{232}Th, ^{226}Ra, ^{238}U, ^{40}K, respectively (7) .

Figures 7 &8 indicated the percentage of radiation series for AL-HRIGA(Tobrok) Port Water Sample, where it is registered the existence of ^{40}K, ^{232}Th, ^{238}U, and in scales sample of the field arriving to ALHRIGA port it is registered the existence of ^{40}K, ^{232}Th, ^{238}U and ^{235}U,with large difference in the radioactive concentration. That means that NORM resulted in the field has mostly no influence on the port, especially when taken into consideration that the distance between them is more than 550 km. this also applies on the figures 9 and 10, which are the samples of Al-Zawia port and field arriving to the port where the distance between them is about 800 km.

Figures 11 ,12 and 13 indicated the percentage of existence ^{40}K, ^{232}Th, ^{238}U in samples of commercialports water,Tripoli, Misrata andAL-Khoms It is noted that the radioactive concentration level is equally matched in all samples of oil and commercial ports, but there is a difference between the samples of oil ports and samples of commercial ports, which is non- system sensation to^{232}Th in all samples of commercial ports and non-system sensation to^{232}Th and^{238}U in KHOMS Commercial Port with system sensation to ^{40}K, ^{232}Th and^{238}U in the samples of oil ports; this gives impression that NORM impact on Oil ports is not completely non_existent.

Figure 14 indicated the effective dose registered in oil and commercial ports which is calculated according to the following equations:

Absorbed dose= (0.621CTh+ 0.462CU+0.0417CK) nGy/h)

where CTh, CUand CK are theradioactive concentration of^{232}Th, ^{238}U and ^{40}K, respectively (9). This equation gives the absorbed dose and its unit is nGy/h, then this dose may transferred to the annually equivalent dose by applying the equation:

Effective dose (H) (ySv/y)= absorbed dose (D) (24).(365.25)(0.2).(0.7Sv/Gy).10^{-3}

where 0.7Sv/Gy is transfer coefficient and 0.2 for the outdoor occupancy ,factor the unit of this dose is mSv/year (9). This transfer is correct in case of Gamma radiation only, which is applied to the radiation registered in the samples of this research. The effective dose in all ports were in the permitted limits, not exceeding 70ySv/y (7). It is noted that the level of this dose in Misrata commercial port is approximately equal to Oil Ports and higher than the other commercial ports. The reason may be returned that this port is the most active commercial ports in the last years.

Conclusions & Recommendations:

Even if we still need more researches including-non water samples(algae, mud, etc.) and important oil ports in the central region (ALSADRA, ALBREGA, RASLANUF, ALZWEITINA), and despite the absence of any similar research (NORM in ports) in Arabic or English for comparison and measurement, we can say in principle that the NORM levelin the oil and commercial ports does not pose a risk to workers and the public in contrary of the NORM recorded in the fields, which requires a serious position from officials of the oil and gas sector in Libya.

This research serves as the second part of the research consists of three parts: the first part (the results presented at a scientific conference in the State of Hungary RANC2016 in April 2016) where NORM measured in some oil fields for various samples, provided the third step will be to measure and register^{222}Ra in Mellitah gas station(70 km West of Tripoli).

The purpose of this research is to bring attention to this important topic, which is the radioactive contamination in the oil and gas industry and to form a preliminary initial idea of the extent of its spread and not to obtain a confirmed data and information to be a database. This subject needs to hundreds and thousands of samples, labs, equipment and a number of researchers and technicians. This work needs effort of the State not just a personal effort .

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