RADIATION EXPOSURE FROM THE RAW MATERIAL AND RESIDUES OF WORKERS IN THE INDUSTRIAL COMPLEX " NEWCO FERRONIKELI COMPLEX L.L.C" – DRENAS

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ABSTRACT

In this study there are determined the levels of radiation doses to non enhanced materials (raw material) and the changing level of these doses of radiation after the technological enhances of the materials, respectively NORM (Naturally Occurring Radioactive Material) & TENORM (Technologically Enhanced Naturally Occurring Radioactive Material).

The directly field measurements are conducted by the detectors: Gamma spectrometer Gr-130; Inspector–EXP-Radiation Alert, TA-PUG-7A and Gama monitor- SGM-29-246. The field measurements indicate that the level of radiation dose of the natural background, raw material (ore, lignite and limestone) and residues (Converter slag, Electro filter dust, Slag from electric furnace and Sludge from electric converter gas scrubber) are from 75.00 nSv/h to 110.00 nSv/h.

Then samples from the field are treated in terms of physic-chemical aspect in the Centre of Applied Nuclear Physics in Tirana, where are determined the radionuclide's and also is determined the concentration of radiation, respectively in the laboratory of Gamma Spectrometry with Gamma instrument spectrometer - CANBERRA It is determined the Radionuclide and specific activity from Converter slag residues [Bq/kg] and the specific activity Gamma Total

Keywords: Radioactivity, Radiation, Activity, Norm, Tenorm

INTRODUCTION

The study of this research was to identify the level of potential exposure of workers in the Industrial Complex "NewCo. Ferronikeli Complex L.L.C" - Drenas. Meantime the goal was to inform and support the management of the company on their efforts to minimize radiation exposure to workers, which may occur as a source of raw materials and technological waste.

It is known that mining exploitation and technological processing minerals in the Republic of Kosovo are important industrial branches and within them are employed a large number of employees who may be subject of radiation exposure, however not only the employees but also the public near this complex and the environment in general.

Radionuclides that are in the nature are mainly classified: in primordial radioisotopes (40K, 226Ra, 87Rb, 238U, 232Th), secondary radioisotopes and cosmogenic radioisotope. The dimidiation time of primordial radioisotope is quiet a lot long and it is known that they survived since their creation, it means that their age is comparable to the age of the Universe. Secondary radioisotopes are as a product of decomposition of primordial radioisotopes while cosmogenic radioisotopes are the result of continuous bombarding of stable nucleus by cosmic rays (HOLMES-SIEDLE A., ADAMS L., 2006).

In recent decades it was a rapid technologic development and these technological products have resulted in the production of sub-products and waste so called TENORM (Technologically Enhanced Naturally Occurring Radioactive). The technical-technological

human activities have effected that with these activities to increase the level of radiation dose level to these radioactive materials, which are exposed not only to the employees directly involved in these activities, but also to the public near to these complex, and also the environment in general

Waste from TENORM are divided into four categories (EPA-ENVIRONMENTAL PROTECTION AGENCY, 1999):

1. Waste from Mining, mineral processing,
2. Waste from energy production - coal, oil, and natural gas,
3. Waste from water treatment – drinking water, industrial water, waste water,
4. Waste from consumed products.

MATERIAL AND METHOD

We performed two measurements during 2010 (April-October), direct measurements within the industrial complex. Then very carefully it has been taken the samples and their treatment in laboratories at the Center for the Nuclear Applied Physics in Tirana. In the first period we determined the level of basic radiation dose – Natural Background, then the radiation dose level of unprocessed materials and radiation dose levels after technological processes of materials, so we researched NORM - Naturally Occurring Radioactive Material / TENORM - Technologically Enhanced Naturally Occurring Radioactive Material.

Industrial Complex "New Co Ferronikeli Complex L.L.C" – Drenas

The Industrial Complex is located at a lower geographic region, namely in the Drenica region, about 30 km far away from Pristina, the capital of the Republic of Kosovo, (*Fig. 1*). It consists of two complexes, mining (1.5 km and 7.0 km the distance from the smelter) and the smelter. Currently the factory only works with one line because of the economic crisis, with a low export, but also it has not enough capacity for two lines. According to the operator's information, the main products are Ferronikel blocks weighing 25 kg, with approximately 35% Ni content.

The production Ferronikel in Drenas includes preparing pre-metallurgical raw materials and the melting process. Therein, the material passes two ovens (rotary ovens), each with a length of 100 m and a width of 5.0 m, and then putted into the melting process in electric ovens. The capacity of the rotary oven and electric oven is around 12,000 t Ni / per year (NEWCO FERRONIKELI COMPLEX L.L.C, 2010).

Direct measurement and chemical-physical treatment of samples in Laboratories

During the measurements we performed 20-25 measurement within a short time, on a point of a material and it is calculated the average radiation dose of Gama Total of that material. At the same time, were taken the samples of waste from converter. Doses of radiation levels are measured in a height of 5 cm above the ground surface, and for the natural background in the height of 1 m above the ground surface. For this research are used the following radiation detectors: Gamma-spectrometer Gr-130; Inspector-EXP-Radiation Alert, The samples for laboratory analysis are carefully taken in the surface of 1 m^2 and in the depth surface of 5 cm.

The Center for Nuclear Applied Physics in Tirana, is well equipped with laboratories in

this field, starting for the laboratory of Radio-chemistry to the laboratories with spectrometric measurements. Sample has gone through the following preparations: The preparation of sample for analysis has passed through several procedures, so as they are broken in very small pieces, homogenized, dried, measured, etc. For Gamma Spectrometric measurement it is used the device gamma-spectrometer CANBERRA. Gamma-spectrometer can handle a wide range, ranging from large samples to smaller ones, in dishes from Marinelli, in bottles, filters, Petri dishes, etc. (CANBERRA- GAMMA SPECTROMETER - DETECTOR 2000).

With gamma spectrometric analysis it is determined the specific activity (Bq / kg) of the converter waste. There are identified radioisotopes and their activities.

Fig.1. Location of measurement and sampling in NewCo Ferronikeli Complex L.L.C (FADIL 2010)

RESULTS

In the Republic of Kosovo the field of study from NORM / TENORM has not been researched a lot, unfortunately from the responsible institution - Kosovo Agency for Radiation Protection and Nuclear Safety we don't have yet any regulation which handles this field. Our researches used to deal with direct measurements that are performed near the surface of materials and treatment of sample in laboratory. The results of direct measurements are presented in *table 1*

Table 1. Data of ambient gamma dose rate measurement of natural background, raw material and residues, at the NewCo Ferronikeli Complex L.L.C (Fadil, 2010)

Location	Sample ID	Distance [m]	[nSv/h]
Natural background dose rate	**FN-1**	**1.0**	**70**
Ore (black and brown)	**FN-2**	**0.05**	**86**
Hard coal	**FN-3**	**0.05**	**75**
Converter slag	**FN-4**	**0.05**	**110**
Electro filter dust	**FN-5**	**0.05**	**107**

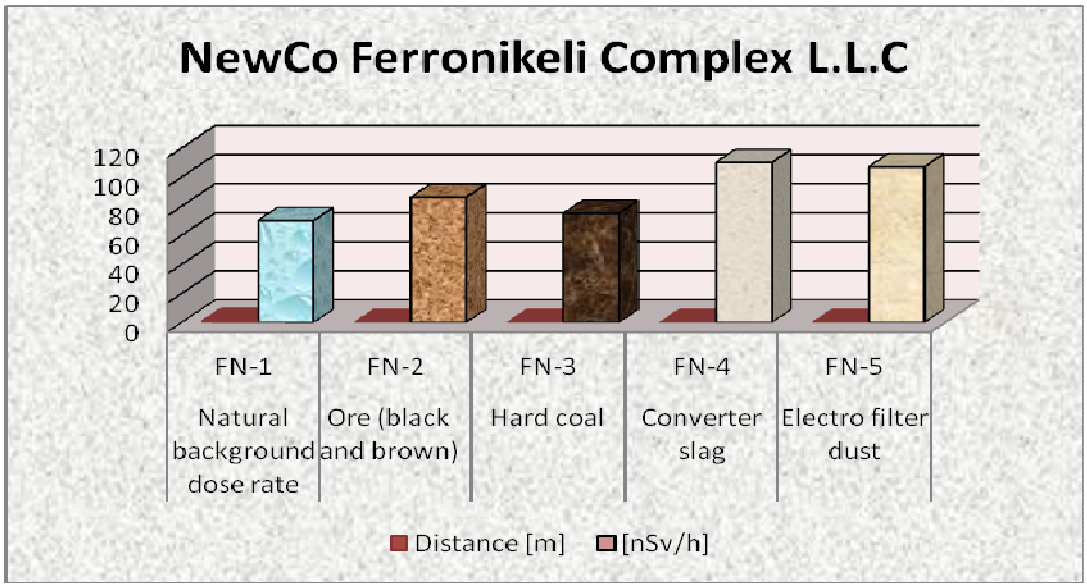

Fig.2 Data of ambient gamma dose rate measurement of natural background, raw material and residues, at the NewCo Ferronikeli Complex L.L.C - Drenas

From the obtained results it is shown that raw materials and waste are characterized by a low natural radioactivity. The results of direct measurements of levels radiation doses NORM/TENORM are within the interval of 75 nSv/h - 110 nSv/h. The worldwide average of natural background dose is about 2.4mSv/per year (UNSCEAR, 2008).

Relying on worldwide average of natural background we can assume that in a year an employee performs an average of 2000 working hours, then based on the calculations it is shown that he/she can receive a radiation dose of 0.189 mSv/year, only by the radiation of above mentioned materials (minerals, coal, waste from converter and dust from electro-filters). Based on the standards provided by the Euroatom Regulation (EURATOM 96/29, 1996), the equivalent allowed dose for professional workers exposed to radiation during an year on the average is 20 mSv/year. The maximum dose in any single year: 50mSv/year. For the public is: 1mSv/year. The measured and calculated doses on the basis of the above mentioned limits are on natural background level.

Therefore, these materials may be considered to pose no radiological concern for employees within the industrial complex and for the public that lives near the industrial complex. The sample from the field is treated in the laboratories of the Nuclear Applied Physics in Tirana, respectively in the laboratory of Gamma spectrometry (Gamma Spectrometry - CANBERRA). The determined results are presented in *table. 2.*

Table 2 Radionukleidet dhe aktiviteti specifik nga mbetjet e Konvertorit [Bq/kg] at the NewCo Ferronikeli Complex L.L.C – Drenas (FADIL, 2010)

Location	Radionuclide	^{40}K	^{226}Ra	^{228}Ra	^{228}Th	^{232}Th	^{238}U
Industrial Complex **"Ferronikeli"** Drenas Waste (scoria) from Converter	Concentration Bq/kg	37 ±7	17 ±4	6 ± 1	5 ± 1	5 ± 1	10 ± 3

Based on the obtained results it is shown that the values of the concentrations of all these radionuclide on the waste from converter are characterized by a very low radioactivity and can be classified as **NORM** (Naturally Occurring Radioactive Material). From the results we can see that we have increased levels of concentration since the natural background is in the interval 100 - 1000Bq/kg.

CONCLUSIONS

The overall purpose of this research, in this above mentioned industrial complex was: Determination of the level of radiation doses, detection of the presence of radioactive elements (radionuclide), their specific activity expressed in Bq/kg, analysis, review, information and assessment of potential risks. Researches in "NewCo Ferronikeli Complex L.L.C" - Drenas, in particular the radiological impacts of Technologically Enhanced Naturally Occurring Radioactive Material, especially the processing minerals and their waste, are of great interest.

Based on the results of the research we can conclude that the industrial complex "NewCo Ferronikeli Complex L.L.C" - Drenas including minerals and their waste from technologic processing in terms of radioactivity are low radiation sources. On the basis of the allowed maximum activity we come to a conclusion that these minerals and their waste can be used as construction materials or construction products.

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