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A Comparative Study Of Gamma Radiation Level Selected In Industries In Jos Plateau State, Nigeria

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Abstract

In this research work, a comparative study of the gamma radiation dose level in different industries in Jos and environs was carried out. A Digital radiation detector (gamma Scout of a standard version GS2 –model with a serial number A20) was used to carry out the measurement in the industries. The industries were categorized as communication, mining, Timber milling shades, Food processing, printing press and other industries. The gamma radiation dose levels in communication industries ranged from 0.561 – 2.435 mSv/yr, mining industries from 35.522 – 40.813 mSv/yr, Timber milling shade from 0.613 – 2.961 mSv/yr, Food processing industries from 0.823 – 1.901 mSv/yr, Printing industries from 0.821 – 1.524 mSv/yr and other industries ranged from 1.034 – 3.600 mSv/yr. The highest dose level of 40.813 mSv/yr was measured at Tin processing shade in Utan, Rock Haven and lowest dose of 0.613 mSv/hr at one of the communication masts.

Key words: Gamma radiation, industries, ionizing radiations, Background radiation.

1. Introduction

Radiation is a very general term, used to describe any process that transmits energy through space or a material away from a source. Light, sound, and radio waves are all examples of radiation. When most people think of radiation, however, they are thinking of ionizing radiation that is radiation that can disrupt the atoms and molecules within the body. While scientists think of these emissions in highly mathematical terms, they can be visualized either as subatomic particles or as rays. Radiation's effects on humans can best be understood by first examining the effect of radiation on atoms, the basic building blocks of matter. Atoms consist of comparatively large particles (protons and neutrons) sitting in a central nucleus, orbited by smaller particles (electrons): a miniature solar system. Normally, the number of protons in the center of the atom equals the number of electrons in orbit. An ion is any atom or molecule that does not have the normal number of electrons. Ionizing radiation is any form of radiation that has enough energy to knock electrons out of atoms or molecules, creating ions there by depositing its energy as it propagates through the atom or molecule. There are many types of ionizing radiation, but the most familiar are alpha, beta, and gamma/x-ray radiation. Neutrons, when expelled from atomic nuclei and traveling as a form of radiation, can also be a significant health concern.

2. Gamma radiation

Many industries around us are possible source of gamma radiation that can be detrimental to human health if it is not properly controlled. In timber industry, there is likelihood of elevated level of gamma radiation compare to the background radiation level in such environment where the industry is located. The possible source of radiation in timber industries can be from timber used for furniture, roofing and fiber for pulp and paper in which is usually procured from the forests (Akpabio et al 2004): The Timber business, which involves processing of logs into plywood, storage of processed products and sales of logs for roofing and carpentry, employs several people who earn their living on it. High levels of uranium and thorium have been observed in the soils of some of the forests where timber is sourced. It is one of the paths through which radioactivity and radiation get to man. (NCRP)

In food processing industries during the irradiation of food product, gamma radiations are used for this purpose and there can be likelihood of gamma radiation in such industry. The most common radio nuclides used are ^{60}Co or ^{137}Cs which are possible sources of gamma radiation in
food processing industries. Soap and cosmetic industries have a likelihood of gamma radiation source also. **Code of Practice For Radiation Processing of Food (Cac/Rcp 19-1979)**

In communication industries, radio transmitters, cellular phones based stations, power lines, communication antenna (mast) are possible sources of gamma radiation. The telecommunication industries available in the country presently have their communication antennas producing gamma radiation at varying quantities. (EPA, 1993). Apart from people living in the immediate neighborhood, the most critical group of exposed people consist of the construction and maintenance workers because during maintenance even though the power to the antenna under work may be switched off the workers may need to climb through energized antennas because the broadcasting companies try to minimize breaks in the transmissions. In broadcasting, high power radiofrequency is used since it is required to maximize the area of coverage so that very close to the antennas electric field strength can reach several hundred volts per meter (ICNIRP 16. 2009). Although cellular mobile

communication network causes an average low levels electromagnetic fields on the user, this magnitude also depends on the user's behavior especially concerning distance and time. (ICNIRP 16. 2009)
Mining industry is another possible source of gamma radiation in the environment which is likely to raise the gamma radiation level compare to the background value of the mining area. In Jos, Tin mining industries are possible source of gamma radiation.
In foam manufacturing industry, it has been observed that polymer is the major raw material used in the production of foam. Polyurethane is radiated so as to produce a more stronger, lasting and cost reduced mattresses and foam product. It is also known that additives used in the production of foams can as well be a major source of radiation. Addictives such as tin is also used in foam processing industry. Tolylene di-isocyanate (TDI) which is also a material in foam processing industry and is a confirmed carcinogen (Clough, 2001). All these can raise the radiation level in the environment.

3. Materials and method

Gamma scout is a general purpose survey meter that measures alpha, beta, gamma and x-ray radiation, it has proven to be useful in the medical, nuclear, mining, metal scrap and foundry industries, it is also used by first responders, police, customs and borders control, hobbyist's rock hunds and in personal or home survival kits. The gamma scout sets a new standard in portable Geiger counter performance and functionality.

In this research work, the Gamma Scout was used to survey the radiation dose level in industries in Jos, Plateau State ranging from: food processing industry, mining, milling, printing press, hospitals and communication industries. The background radiation values of those areas where the industries are located are taken some few meters away before getting to the industrial premises. This was done so as to be able to know the gamma radiation level coming out from such industries. Tables 1 shows the gamma radiation dose levels in the different industries in Jos.

Table 1. Gamma Radiation dose rates in industries in Jos

Location code	Background count(µSv/hr)	1st reading (µSv/hr)	2nd reading (µSv/hr)	3rd reading (µSv/hr)	Average value (µSv/hr)	Net reading (µSv/hr)	Net reading mSv/yr
CM 1	0.261	0.347	0.357	0.352	0.352	0.019	0.798
CM 2	0.196	0.258	0.266	0.258	0.260	0.064	0.561
CM 3	0.226	0.357	0.366	0.374	0.365	0.139	1.218
CM 4	0.165	0.465	0.446	0.419	0.443	0.278	2.437
CM 5	0.290	0.483	0.502	0.465	0.483	0.193	1.692
TS 1	0.195	4.803	4.940	4.836	4.854	4.659	40.841
TS 2	0.226	4.201	4.201	4.334	4.281	4.055	35.546
MI 1	0.203	0.493	0.521	0.541	0.541	0.338	2.963
MI 2	0.180	0.242	0.234	0.250	0.250	0.070	0.614
AL	0.211	0.471	0.471	0.428	0.456	0.245	2.148
ABF	0.136	0.446	0.428	0.430	0.376	0.240	2.108
VF	0.211	0.664	0.622	0.581	0.622	0.411	3.603
UTH	0.196	0.306	0.322	0.316	0.314	0.118	1.034
FP 1	0.258	0.428	0.465	0.437	0.443	0.185	1.622
FP 2	0.226	0.374	0.392	0.383	0.388	0.157	1.376
FP 3	0.226	0.419	0.446	0.465	0.443	0.217	1.902
FP 4	0.216	0.305	0.310	0.315	0.310	0.094	0.824
PP1	0.266	0.392	0.401	0.401	0.398	0.132	1.157
PP2	0.183	0.340	0.349	0.366	0.352	0.169	1.481
PP3	0.266	0.354	0.362	0.358	0.358	0.092	0.806
PP4	0.188	0.357	0.374	0.357	0.362	0.174	1.525
PP5	0.203	0.304	0.312	0.318	0.311	0.108	0.147

CM=Communication companies, TS= Tin processing shades, MI= Milling industries, AL= Air Liquid, ABF= Amo-Byng Feeds, VF= Vita Foam, UTH= University Teaching Hospital, FP= Food processing companies and PP= Printing Press.

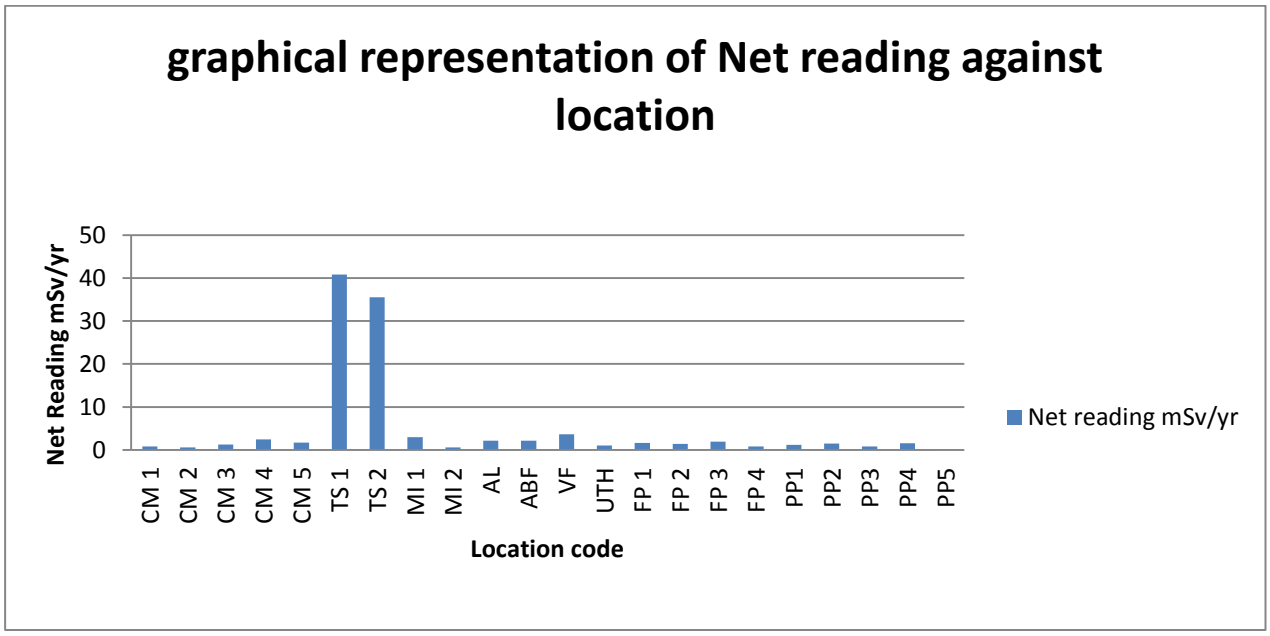

Fig. 1 graphical representation of Net reading against location

4. Discussion

From Table 1 and fig 1, it was observed that the gamma radiation level in the communication masts were within the acceptable limit except company CM4 with 2.437mSv/yr which is relatively high compare to other communication masts. The possible reason for this is that, the communication mast was located on top of a rock. This might have contributed to the increase in the radiation level. Since Jos is known to be of high gamma radiation levels compare to other states in Nigeria because of the rock types (younger granites) present in the state. These rocks are rich in Naturally Occurring Radionuclides (NOR) which are the primary terrestrial sources of radiation in the environment. This suggests that communication masts sited or located close to or on rocky area tends to have high level of radiation. The radiation produced by these communication masts is within the accepted value of 1mSv/yr for the public according to the ICRP regulation.

Foam processing industries also has a relatively high gamma radiation dose level 0f 3.608 mSv/yr. Polyurethane foam is the most widely used flexible foam plastic. It is used to produce a wide variety of items including thermal insulation, packaging materials, comfort cushions, bed mattresses, carpet backings and resilient floor coverings. Tolylene di-isocyanate (TDI) and polyalcohol are the basic ingredients used for the production of polyurethane foam. With the commercial use of radiation for industrial purposes, these polymers are irradiated to establish a cross-linked in the polymer. Polymers that are cross-linked can maintained their shape and useful properties at a higher temperature that is they do not flow. Generally, cross-linking materials have better strength, better resistance to impact and stress cracking. They have improved creep resistance and in many case improved chemical. Some of the advantages of radiation cross-linking compared to conventional cross-linking with chemical additives are cost, speed, the ability to cross-link performed parts at or near room temperature, reduction in chemical ingredients and chemical residue for environmental or toxicological reasons, and, in many cases superior material properties in the final product. (Clough, 2001).
A range of additives are blended with the raw materials. A tin based additive is used to stabilize the foam while a few amine based additives are added to control the extent of cross linkage and the rate of reaction. This additive is another possible source of the increase in radiation observed from foam processing industry apart from the radiated polymer. TDI is a confirmed carcinogen.

In milling industry, the highest radiation level was 2.963 mSv/yr obtained at Building Material Timber shade was due to the effect of some rocks present around the area. Comparing the value obtained in Jos with milling industries in Calabar, the Cross River State capital (where their timber is derived from forests in the Northern part of the State), high levels of uranium and thorium have been observed in the soils of some of the forests where timber is sourced to Calabar. The average gamma radiation value obtained in Calabar is a little bit lower than 1.027 mSv/yr.(Uwah and Akpan, 2005).The effective doses obtained within the investigated timber

industries, although higher than the environmental background, are not sufficiently high to warrant regulatory control (Radiation safety regulations, 2006) and may not cause any radiological health hazard in workers within the industries. However, further investigation is necessary to establish the types and concentrations of the radionuclide present in the timber, and relate same to the values obtained from soil of the forest of which the timbers were sourced. (Uwah and Akpan, 2005)

Tin mining activities in Jos has led to the high value of radiation observed in Jos and its environ. The average value obtained from two different Tin shades in Jos are 40.841mSv/yr and 35.546mSv/yr. The measured radiation levels are several orders of magnitude higher than UNSCEAR reference values, revealing the pollution potential of the tin mining and process activities on the surrounding areas, vis-à-vis heavy particulate matter load, leaching into various water channels and direct exposure to gamma rays emitted from the houses and facilities built from the generated wastes. The observed activity levels reflects possible worst scenario situation and the data would not only be of use to the government in its remediation plan for the study area but will also serve as important information for the nuclear science and technology programme in Nigeria.

Printing press industry has a relatively low radiation level with lowest and highest values of 0.806mSv/yr and 1.525mSv/yr respectively from the four printing press locations visited. It is important to note that the possible sources of radiation in printing industries is due to the new technology that has suggested radiation of wood for its preservation. There is another radiation degradation project in progress which concerns the electron irradiation of wood chips prior to storage and subsequent conversion to pulp (for making paper used in printing press) **(**Silverman, 2012). It is well known that ionizing radiation kills insects, fungi and bacteria. (NSRRRT, 2011). Thus irradiation of wood chips should delay their spoilage and decrease the energy required to convert them into pulp. Another possible source of radiation from printing press may be from the chemicals use in printing.

5. Conclusion

The radiation detection meter used is environmental friendly i.e. it can be operated in any environment which enable the readings to be taken without any difficulties in all the industries visited. In the course of taking the readings, it was clearly seen that some industries have high radiation level than others, which is as result of some radioactive processes in such industry.

The highest radiation level was observed in the Tin shade locations visited in Utan Rock Heaven with a value of 40.841mSv/yr. This is relatively high compare to the accepted international standard of 1 mSv/year for the members of the public. This predisposes the people living around that area to high gamma radiation making it not safe for dweller around the area. The radiation level observed in the foam processing industry which was about 3.608mSv/yr. This is as a result of the new technology incorporated in the industry i.e. the use of radiated polymers. This does not raise much concern except for the TDI used in the production process which is a confirmed carcinogen making the workers vulnerable to cancer. Its emission should be closely monitored by the local council. The lowest radiation gamma radiation dose level was observed in a communication industry the milling industry with values of about 0.561mSv/yr and 0.614mSv/yr respectively showing that the communication masts and wood source from forest does not contain a reasonable amount of radionuclides making them safe without any serious biological effects on the members of the public. The food processing industries in Jos is quite safe with the radiation level between 0.824 – 1.902mSv/yr. This shows that there is no food irradiation process taking place in the industries in Jos. The communication masts and the printing press industries are below the required standard. Hence making it safe for the public in areas where the mast and printing press are located.

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