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The Correlation Graph between Gamma Radiation and Radon Concentration in soil of oil Exploration Areas in Thenzawl Village of Mizoram

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Abstract: The Ground level Gamma Radiation and Radon gas concentration at different depth beneath the ground surface of oil exploration areas in Mizoram, India is studied and correlation graph is drawn. The oil exploration area at Thenzawl(TZ) site in Serchhip district, is studied. The main instrument utilized for the study was RnDuo machine devised to survey Radon 222 (^{222}Rn) connected to soil probe of 1mtr long to be baptized at different depth. Background gamma radiation survey at ground level is conducted with Russian base Gamma Survey Meter (PM 1405). The background gamma radiation at ground level varies from 168 nSv/hr at TZ-1 to 176 nSv/h at TZ-3 location with an average of 173.3 nSv/h. An in-situ measurement of soil gas was carried out at three different spots at four different depths each namely 10cm, 30cm, 50cm and 70cm. The radon gas concentration beneath the soil, within the study area ranges from 0.14 kBq/m^3 at TZ-3 to 1.37 kBq/m^3 at TZ-2 location. A correlation graph between ground level gamma radiation and the radon concentration in soil at different dept shows that the correlation coefficient is highest at 10cm with R^2=0.238 and lowest at 70cm with R^2=0.005. The Radon gas concentration obtained is below the worldwide average of 35-40 kBq/m^3 .(UNSCEAR 2000).
Keywords: Soil Probe, in-situ measurement, Gamma survey meter PM-1405, Thenzawl.

I. INTRODUCTION

Earth, not only consists of organic and inorganic compounds but also contains radionuclide namely Uranium, thorium, radium, potassium etc, which are a source of natural radioactivity and contribute to background radiation. The background radiation contribute a considerable percentage of the total radiation exposure to individuals (*Porstendorfer et al., 1994).* Natural radionuclide are broadly classified into two types as – Cosmogenic (which comes from cosmic ray particles undergoing nuclear reactions) and Primordial (which are in existence since the origin of Earth) *(Radenkovic et al., 2009; Tzortzis et al., 2003)*. The levels of natural background radiation dose rates vary from 1.4 to 2.4 mSv y^{-1} depending on the abundance of primordial radionuclides in the soil and the latitude and longitude of that place (*UNSCEAR 1993).*

Radon is a gas that comes from the naturally occurring radionuclide. The isotope ^{222}Rn is mostly the decay product of ^{238}U (approximately 55%) of the internal radiation exposed to human (ICPR 1993) and it is found in almost all types of soil. Despite porosity, the radon movement in rock depends upon various factors like compaction, fractural, tectonic features like earths thrust, earths faults and earths joints (Choubey *et al.* 1997). The radon concentration at different baptism depth is different (Bourai *et al.*2013). The concentration increases with depth. The deeper the baptism depth the greater the radon concentration (Duggal *et al.* 2013). Radon concentration at different baptism depth of oil exploration arease in Serchhip and Kolasib district are studied. In India and Pakistan, radon survey in soil gas was carried out at different parts and locations (Mujahid *et al.* 2008; Ali *et al.* 2010; Prasad *et al.* 2005, 2008; Bajwa *et al.* 2010; Singh *et al.* 2010; Mehra and Bala 2013). The aim of the present study is to find the radon concentration at different baptism dept and to draw the correlation graph with the background gamma radiation at ground level.

II. MATERIAL AND METHODS

Mizoram is located in the North Eastern part of India neighbouring the state of Assam in the north. The oil fields studied is situated at Thenzawl area in Serchhip district. The present study location Thenzawl area stretches from 23^{0}18’08.3”N to 23^{0}18’12.4”N and between 92’42’5.8”E to 92’47’11.9”E with an elevation range of 2454 ft and 2483 ft from sea level. The Fig.1. shows the location maps of oil exploration areas at different districts of Mizoram, India.

A. *Measurement of Background Gamma radiation using Gamma survey meter PM-1405*

At each location of soil sample collection a gamma radiation survey will be conducted with the help of Gamma Survey Meter (PM 1405). Detecting γ radiations is carried out with Survey Meter PM 1405 by detection bloc on the basis of Geiger-Muller counter by transformation of photon to electro-pulses. Detection bloc controlling, transfer of measured data to the main microprocessor controller are carried out by the embedded microprocessor controller as shown in Fig.2. The instrument's operating algorithm ensures continuity of the measurement process, static handling of measurement results, fast adaptation to radiation rate changes and effective output of the information obtained on the LCD. The measurement range for γ radiations is between the range of 0.1μSv/h – 100 mSv/h. The Gamma survey is conducted at the surface of the earth/ground.

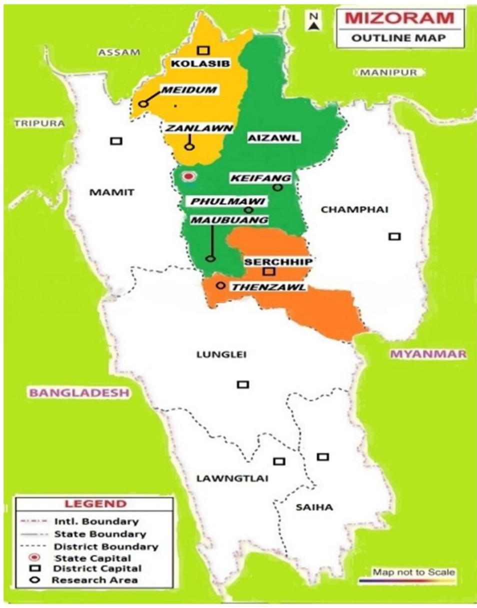


Fig.1. Map of Mizoram showing different Oil Exploration areas (2021)

Fig.2. Gamma survey meter PM-1405

B. *In-situ measurement of Radon concentration at different baptism depth*

The Radon concentration in soil gas was carried out in the oil exploration area. Three different spots were chosen to cover the entire areas. The radon concentration was determined at four different depths namely 10cm, 30cm, 50cm and 70cm. An *in-situ* measurement was done with Smart RnDuo, an instrument specially designed for the purpose. Fig.3. shows the set up for measuring radon concentration in soil gas at different depth which is fitted with a stainless steel probe that could be baptized at different depths. After the probe has been baptised at a particular depth, four reading at 15mins cycle was taken. The mean of the three readings gives the final reading for that depth. Fig.2 shows the block diagram of the mentioned smart RnDuo.

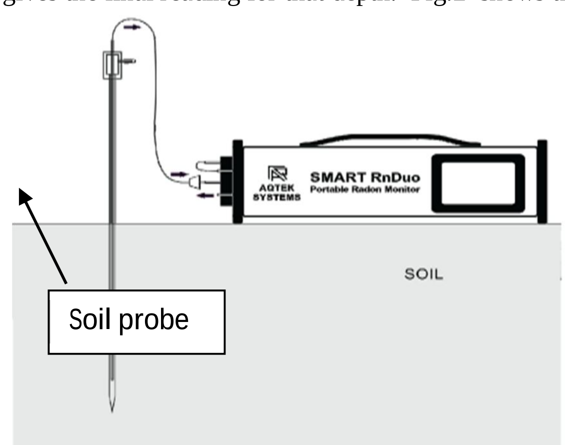


Fig.3. Set up for measurement of radon in soil

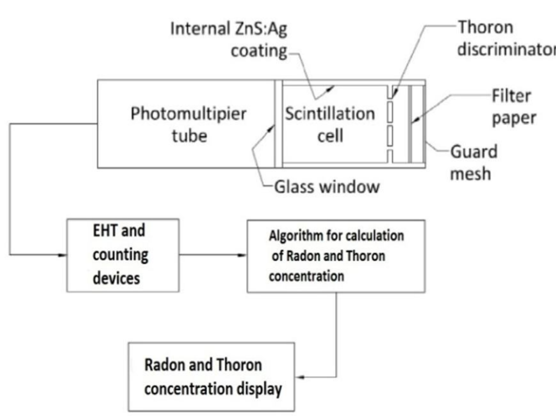


Fig.4. Block diagram of Smart RnDuo

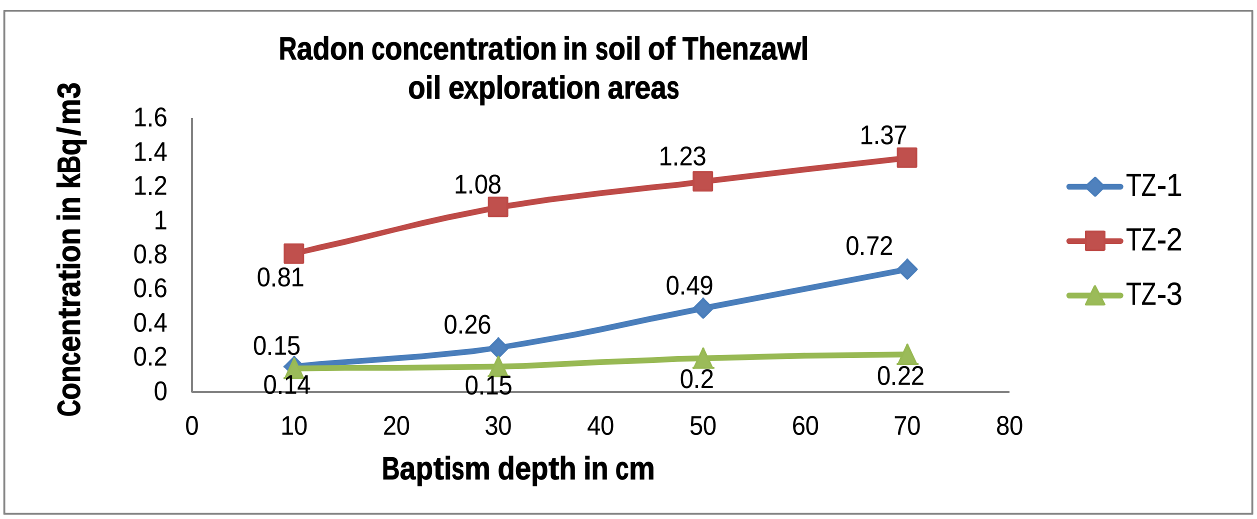
III. RESULTS AND DISCUSSION

The background gamma radiation at the study location is given in Table-1. The same table shows radon concentration at 10cm, 30cm, 50cm and 70cm deep. The radon concentration in Thenzawl location varies from 0.14 kBq/m^3 at 10cm depth to 1.37 kBq/m^3 at 70cm depth. The readings are taken in the month of January 2020. During this month the weather is dry and there are no rainfall for the last 30 days. The soil in the study area is free from moisture.

Table-1. Gamma Radiation at ground level and Radon Concentration in soil gas at various baptism depth of oil exploration areas in Serchhip district of Mizoram, India

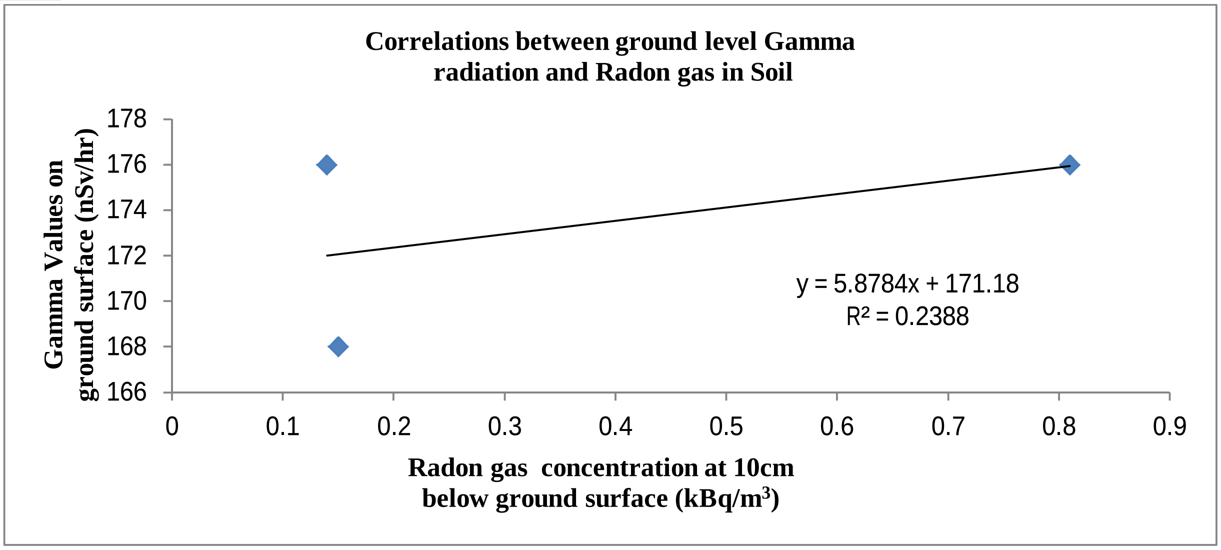
Sl. No	Sampling Location	Sampling ID	Gamma ground level (nSv/hr)	Baptism Depth	Radon Concentration kBq/m^3
1	Thenzawl	TZ-1	168	10cm	0.15
				30cm	0.26
				50cm	0.49
				70cm	0.72
2	Thenzawl	TZ-2	175	10cm	0.81
				30cm	1.08
				50cm	1.23
				70cm	1.37
3	Thenzawl	TZ-3	176	10cm	0.14
				30cm	0.15
				50cm	0.20
				70cm	0.22

The Graph-1, show radon concentrations at 10cm, 30cm, 50cm and 70cm baptism depth at Thenzawl oil exploration area.

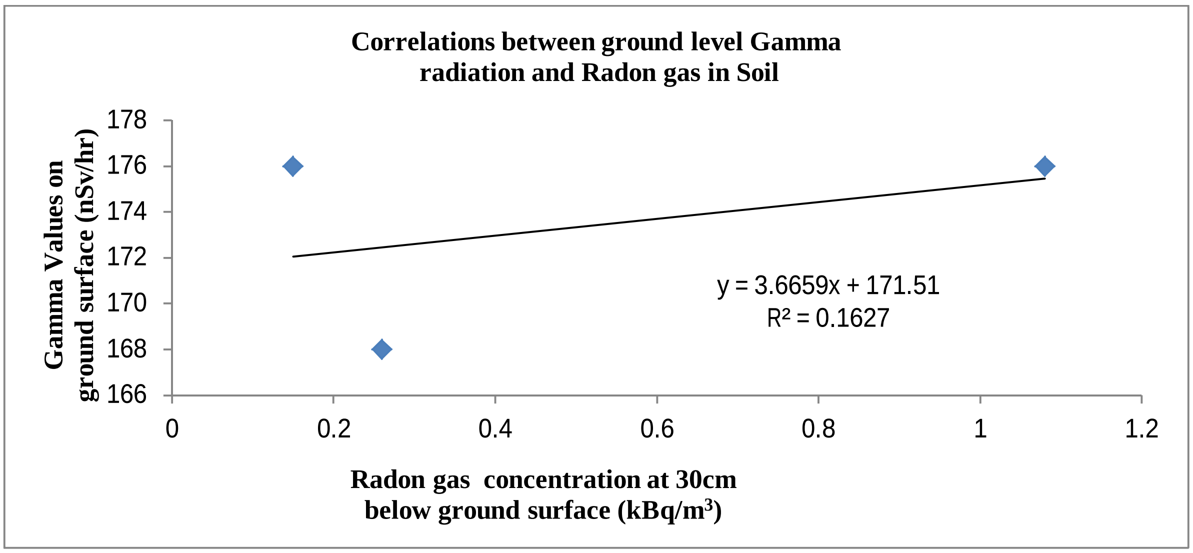


Graph-1. Radon concentration at different dept in soil of Thenzawl oil exploration area

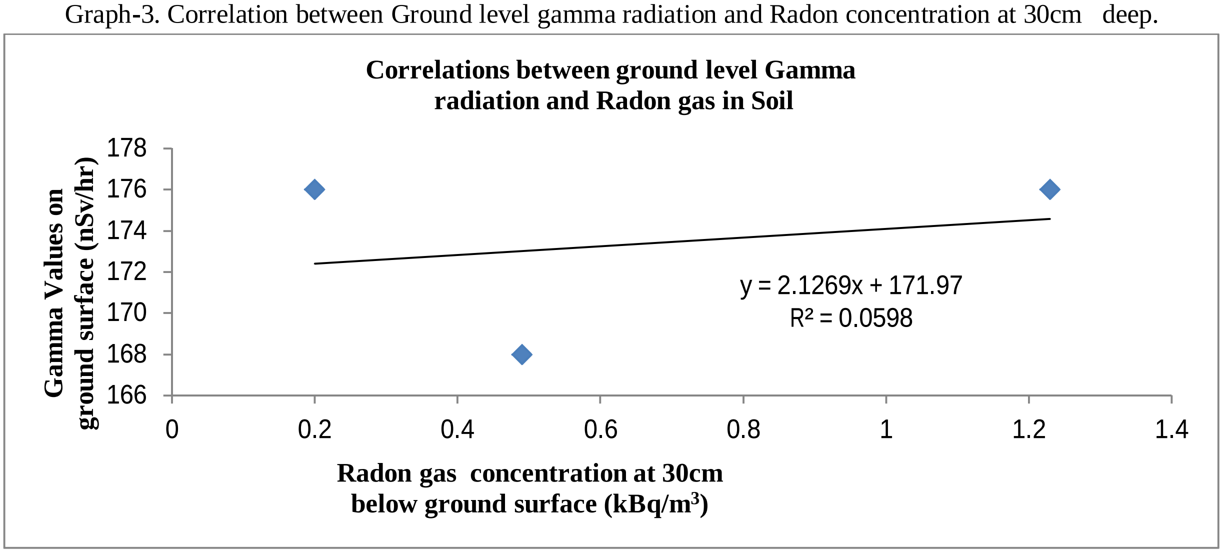
The graph-2, graph-3, graph-4 and graph-5 shows the correlation between Ground level gamma radiation and average radon concentration at different baptism depth such as 10cm, 30cm, 50cm and 70cm.



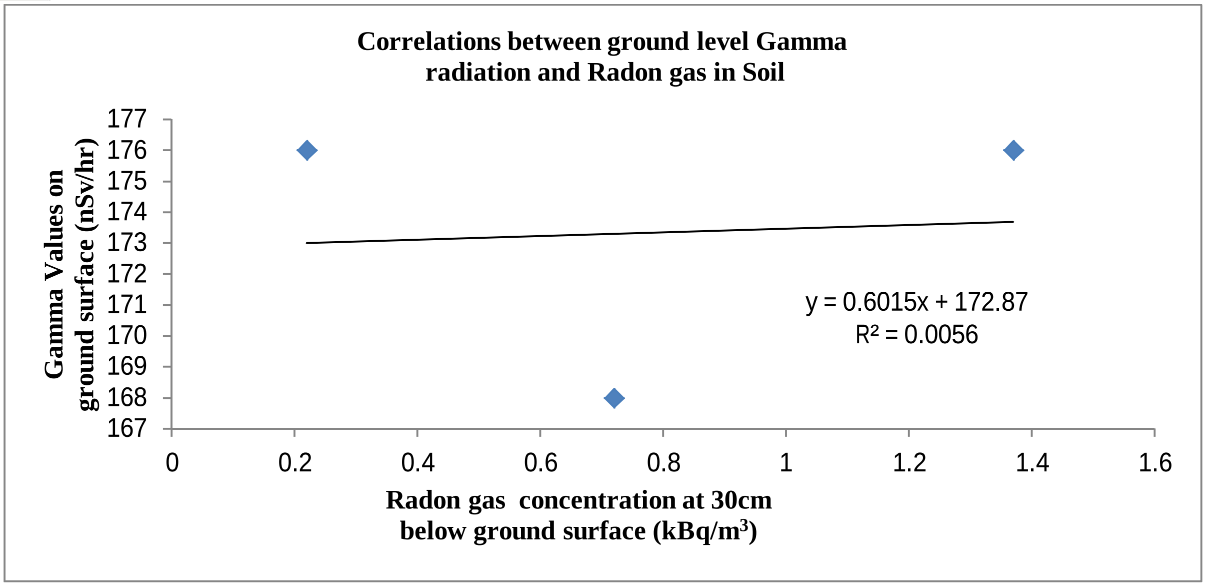
Graph-2. Correlation between Ground level gamma radiation and Radon concentration at 10cm deep.



Graph-3. Correlation between Ground level gamma radiation and Radon concentration at 30cm deep.



Graph-4. Correlation between Ground level gamma radiation and Radon concentration at 50cm deep.



Graph-5. Correlation between Ground level gamma radiation and Radon concentration at 70cm deep.

IV. CONCLUSION

The Radon concentration in soil gas of oil exploration area in Serchhip district of Mizoram is studied. An *in situ* measurement was taken at four different depth such as 10cm, 30cm, 50cm and 70cm with the help of a Smart RnDuo and a stainless steel probe. The study was carried out during winter season in the month of January 2020. The soil has no moisture content. It has been observed that the concentration of radon gas increases as we baptize the soil probe deeper and deeper. This means that for every spot chosen, the radon gas concentration at 10cm deep is lowest and the radon gas concentration at 70cm is highest and the concentration at 30cm and 50 cm lie in between. But, the correlation coefficient (R^2) obtained from the graph was best at 10cm with $R^2 = 0.238$ while it is least at 70cm deep with R^2 = 0.0.005. This indicates that the gamma radiation had a better correlation close to the ground surface. The correlations observed are not that good. The possible reason for this poor correlation may be due to the contributing factor. Whereas the radon concentration at different baptism depth is contributed by Uranium 238, on the other hand, the background gamma radiation at ground level is contributed by many cosmic and terrestrial sources like Uranium, potassium, thorium etc. The radon gas concentration obtained in these locations are far below the world average of 35-40 kBq/m^3 (UNSCEAR 2000).

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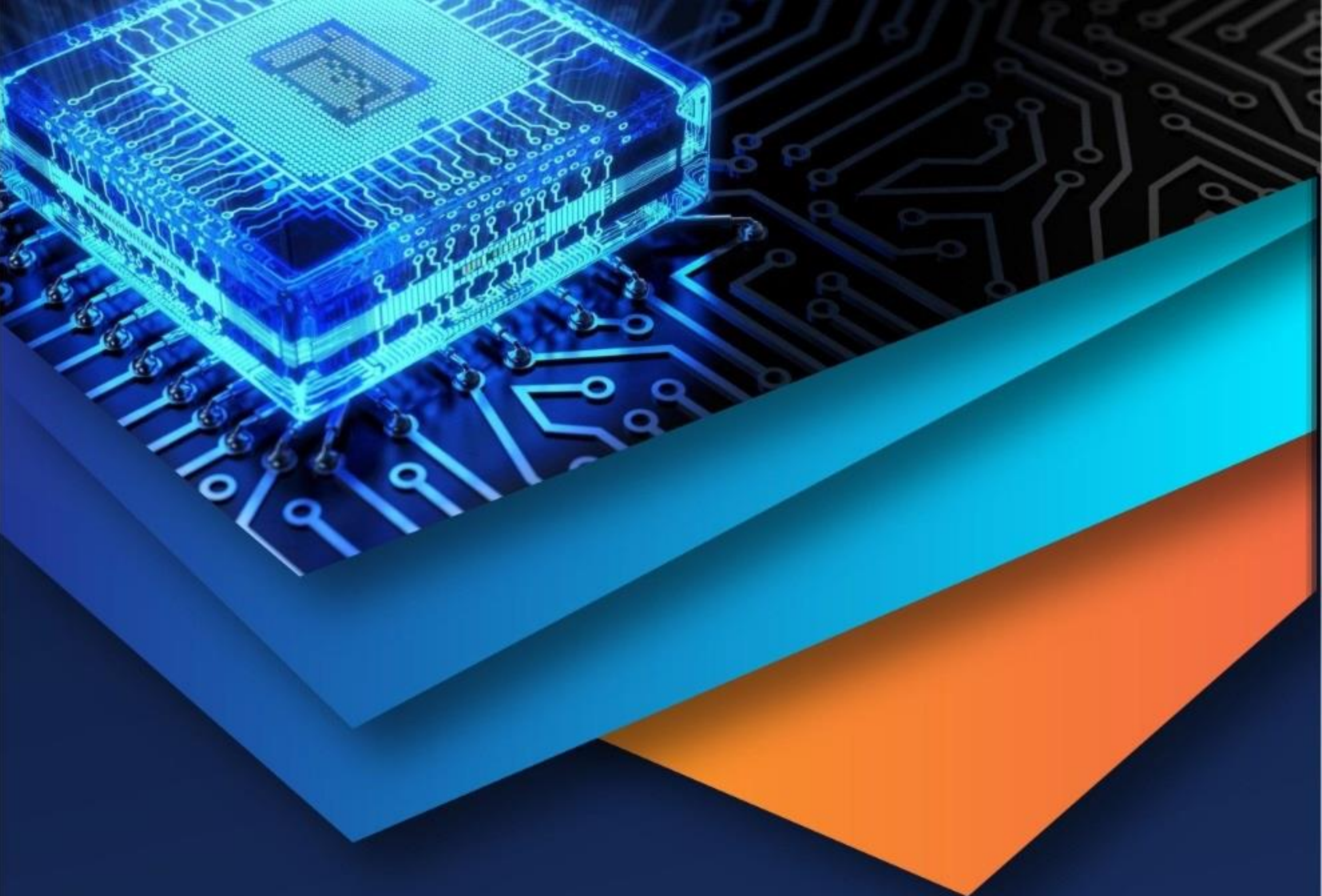

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