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Nano Technology Applications, Veritable Tools to Mitigating the Effects of Generator Exhaust Fumes on the Environment, the Onitsha Scenario, Anambra State, Nigeria

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Abstract: In this study, we considered the effect of generator exhaust fumes on air; a case study of Onitsha and the possible way of mitigating it using nano technology. 400 copies of questionnaire were randomly administered within Onitsha. The sample was chosen based on population. The issue of exhaust fume and the quantity of fuel products bought were discussed. The objective of this work was achieved through the following hypothesis: there is no significant difference in the effects of generator usage in Onitsha. This hypothesis was tested using Chi square. The result showed that there is significance difference in the effects of generator usage in Onitsha. Since, people resort to the use of generator because of the inadequate power supply by Power Holdings Corporation of Nigeria and generator usage affects environment, it was recommended that government should try to always ensure efficient and adequate supply of electric power from PHCN. To ensure proper protection of the environment and economic growth, the study also recommended that government should adopt better strategies like the use of less carbon fuel products, provision of alternative carbon sinks, encouragement of tree planting and replanting; promotion of the use of renewable and green energies and the promotion of grass root campaigns geared towards informing the masses on the implications of anthropogenic activities on the climate and the environment in general.

Keywords: Nano Science, Onitsha Scenario, Generator and Exhaust Fumes

1. Introduction

Under the sun, everything is energy demanding. The economy of any nation is a function of her energy mix, for an economy to emerge it must have steady energy supply. Energy is the hub around which the development and industrialization of any nation revolve. It is a fact that any distortion in energy supply chain at any point in time results into serious economic and social disorder/hardship. The significance of energy in the provision of goods, services; elevation of the standard of living of mankind and the role it plays in industries for sustainability of production is a well known fact (Sambo, 2005).

In Nigeria the problem of power supply from the national grid has greatly encouraged the use of generator which is powered by fossil fuel (Diesel or Premium Motor Spirit). Going by the recent natural disaster in Nigeria and the world at large, it is clear that the climate is changing. Therefore, the use of fossil energy which contributes to the warming of the globe and increase the temperature of the earth surface should be discouraged. Recently, the effect of global warming was highly felt in Nigeria through flooding which took place in the 36 states of Nigeria plus the federal capital territory (Guardian News p.1; 10th October, 2012). The government has diverted funds meant for other purposes to the provision of palliative measures and permanent solution to the problem.

The cost of energy for domestic, commercial, and industrial uses in Nigeria has risen astronomically in the past few years following the liberalization and reform of the oil industry and the energy sector as a whole. The cost of energy is now a very significant factor which determines the price paid by end-users of commodities (National Energy Policy (NEP), 2003). People have resorted to the use of generator

since conventional energy was not available. These generators through the exhaust emit gases that are not environmental friendly. The largest part of most combustion gas is nitrogen (N_2), water vapor (H_2O) and carbon dioxide (CO_2); these are not toxic or noxious, although carbon dioxide is generally recognized as a greenhouse gas that contributes to global warming. A relatively small part of combustion gas is undesirable noxious or toxic, such as carbon monoxide (CO) from incomplete combustion, hydrocarbons C_xH_y, from un burnt fuel, nitrogen oxides (NO_x) from excessive combustion temperatures, Ozone (O_3) and particulate matter (mostly soot). Water vapour, CO_2, NOx are greenhouse gases that contribute to warming of the globe. CO causes respiratory problem. Incomplete burnt hydrocarbon (HC) and particulate matter (mostly soot) contribute to acid rain and accumulation of ozone in the troposphere. Ozone (O_3) adds to the quantity of ozone in the troposphere which can cause respiratory problem.

1.1. The Environment

The environment consists of natural and manmade or built environment. The natural environment involves all living and non-living things existing naturally on the earth surface. It houses the interactions of all living things, climate, weather, natural activities that affect life and economic activities, Johnson et.al (1997). Manmade or built environment involves that area where man has greatly modified in the cause of development, industrialization and urbanization etc., Symons (1997). It is this environment that human activities affect through the use of fossil fuel and others.

1.2. Study Area

Onitsha founded in 1550 is one of the commercial nerve centres of Nigeria with a metropolitan population of 1,003,000 million, Minaham (2002) and with a growth rate of 3.5%. It is one of the fastest growing cities in Africa. Onitsha is the strategic trade way between the former eastern, western and northern States. It is made up two local governments; North and South. The housing stock is inadequate for the large population thereby adding pressure to the rent and facilities of the existing infrastructure. This indicates the need to take proactive measure in steps to monitor the current rate of GHG emission.

1.3. Data Presentation

In this paper the effects of generator exhaust fumes on air is studied through interviewing male and female residents in Onitsha. The essence is to maintain gender equality and to compare the male reasoning with that of their female counterparts. The results of the response to the questionnaire survey were interpreted in tabular form for easy comprehension. The analysis of the data was done using chi-square (x^2) so as to test the hypotheses. This is simply because the chi-square measures the discrepancy that exists between the expected and observed frequencies. A confidence level of 95% and significance of 5% is assumed in the calculation. The chi-square statistical formula is stated thus $X^2=\Sigma(O-E)^2/E$

Where X^2= Chi-square

O= Observed frequency

E= Expected frequency

Σ= Summation

Moreover, two set of figures are relevant in decision making using the X^2, these are:

a. The calculated X^2 value and the critical value which is given in the X^2 table
b. If the calculated X^2 is greater than the critical X^2 value, the null hypothesis (Ho) is rejected. Conversely, if the calculated X^2 value is equal or less than the critical X^2 value, the null hypothesis is accepted i.e., if $X^2C>X^2$ reject Ho, otherwise accept H_1. The degree of freedom is calculated thus.

$$DF = (R-1)\ (C-1)$$

Where: DF = degree of freedom

R = row

C = column

From the contingency table, the df is given by: DF = (R-1)(C-1)

Where R is the number of rows, C is the number of columns

Therefore, DF = (2-1)(14-1) = 1 x 13 = 13.

Reading the value at the intersection of df 13 and 0.05 (5%) level of significance then we have 22.36.

Decision

The calculated value 26.89 is above the critical value 22.36 at df 13 and 0.05 alpha level, we therefore reject the null hypothesis that "There is no significant difference in the effects of generator usage in Onitsha" This implies that generator usage affects the environment. This has to be addressed by government and appropriate agencies to save our environment.

Table 1.1. *Administration and Collection of Questionnaire.*

Questionnaire	Responses	Percentage
Number Returned	385	96
Number not returned	15	4
Total	400	100

Source: Field survey, May, 2014.

Table 1.1 above, shows that out of 400 questionnaires used in data collection, 385 representing 96% were returned and 15 representing 4% of the population was not returned. The high rate of return (96%) was a function of the researcher's patience and regular visits to the respondents. Based on the number returned, 3 out of the 385 questionnaire is damaged therefore 382 will be used in this study to represent the 100%.

1.4. Sex Distribution of the Respondents

The sex distribution of the respondents were analyzed and presented on table 1.2.

Table 1.2. *Sex distribution of the respondents.*

Sex	No of Respondent	Percentage (%)
Male	298	78
Female	84	22
Total	382	100

Source: Author's Field work, 2014.

The table above shows that 298 respondents, representing 78% of the total population were male while the remaining 84 respondents representing 22% of the population were female. The dominance of male over the female is attributed to the fact that in African setting male is the head of families and is mainly the owner of houses. The 22% population of the female is scattered across the spinsters, divorcees and widows. With this in mind, let us look at the age distribution of the respondents.

1.5. Respondents that Use Generators as Sources of Power in Their Houses

The different number of respondents that use generators as source of power in their houses were analyzed and presented on the table below.

Table 1.3. *Distribution of the Respondents that use Generator as a Source of Power in their Houses.*

Response	Male	Female	Percentage of male	Percentage of female	Total
Yes	263	64	88	76	327
No	35	20	12	24	55
Total	298	84	100	100	382

Source: Author's field survey (2014).

Table 1.3 shows that out of the 382 respondents that use generator, 263 representing 88% of the male respondents said that the number of hours they use generator in their houses indicate that it is main source of power because when you need the conventional power it may not be there, 35 respondents representing 12% of the male said they do not use generator as source of power. 64 respondents representing 76% of the female respondents said they use generator as source of power in their houses and 20 respondents representing 24% of the female population said they do not use generator as source of power. Considering the high number of male and female respondents that use generator as source of power in their houses, it is clear that a reasonable amount of pollution is released in the environment through the use of generators.

1.6. Respondents Who Have Their Houses Within Onitsha

The number of respondents who have their houses within Onitsha were analyzed and represented on the table below.

Table 1.4. *Respondents who have their houses within Onitsha.*

Response	Male	Female	Percentage of male	Percentage of female	Total
Yes	272	75	91	89	347
No	26	09	9	11	35
Total	298	84	100	100	382

Source: Author's field survey, May, 2014.

Table 1.4 shows that 272 representing 91% of the male respondents have their houses within Onitsha, 26 representing 9% do not have their houses within Onitsha, while 75 representing 89% of the female said that they have their offices within Onitsha and 9 representing 11% do not have their houses within Onitsha.

1.7. Respondents that Use Generator as Sources of Power in Their Offices

The numbers of respondents who use generator as a source of power in their offices were analyzed and represented on the table below.

Table 1.5. *Distribution of the respondents that use generator as a source of power in their offices.*

Response	Male	Female	Percentage of male	Percentage of female	Total
Yes	252	64	85	76	316
No	44	20	15	24	64
Total	296	84	100	100	382

Source: Author's field survey (2014).

On table 1.5, out of the 382 respondents, 252 representing 85% of the male population use generator as a source of power in their offices, 44 representing 15% of the male population said they do not use generator as a source of power in their offices, while 64 representing 17% of the female population said they use generator as a source of power in their offices and 20 representing 24% do not use generator as a source of power in their offices.

1.8. Respondents Who Have Their Offices Within Onitsha

The number of respondents who have their offices within Onitsha were analyzed and represented on the table below.

Table 1.6. *Distribution of the respondents who have their offices within Onitsha.*

Response	Male	Female	Percentage of male	Percentage of female	Total
Yes	276	77	93	92	353
No	22	07	7	8	29
Total	298	84	100	100	382

Source: Author's field survey (2014).

On table 1.6, 276 representing 93% of the respondents have their offices within Onitsha and 22 respondents

representing 7% of the male population said they do not have their offices within Onitsha, while 77 representing 92% of the female said that they have their offices within Onitsha and 7 respondents representing 8% of the female population said they do not have their offices within Onitsha.

1.9. Respondents Who Use PMS Powered Generator

The number of respondents who use PMS powered generator were analyzed and represented on the table below.

Table 1.7. *Distribution of the respondents who use Premium Motor Spirit powered generator.*

Response	Male	Female	Percentage of male	Percentage of female	Total
Yes	297	84	100	100	381
No	0	0	0	0	0
Total	297	84	100	100	381

Source: Author's field survey (2014).

On table 1.7, out of 381 respondents, 297 representing 100% of the male population said that their generators use petrol and 84 representing 100% of the female population said that their generator use petrol. Nobody said that he or she do not use PMS powered generator.

1.10. Respondents Who Said That Their Generators Use Diesel

The respondents who said their generator use diesel are analyzed and represented on the table below.

Table 1.8. *Distribution of the respondents whose generators use diesel.*

Response	Male	Female	Percentage of male	Percentage of female	Total
Yes	87	29	29	35	145
No	210	55	71	65	265
Total	297	84	100	100	381

Source: Author's field survey (2014).

Table 1.8 shows that 87 respondents representing 29% of the male population said that their generator use diesel and 210 respondents representing 71% of the male population said that their generators do not use diesel while 29 representing 35% of the female population said that their generator use diesel and 55 representing 65% of female population said that their generator do not use diesel.

2. Mitigation and Adaptation

Mitigating climate change involves a multitude of options; immediate reduction of all greenhouse gas emissions in all countries around the globe over time by a set dateline, set an emission ceiling that countries cannot go over, provide incentives to companies that reduce emissions, research into the methods to remove carbon dioxide from the atmosphere and research into alternatives to emission reductions. In this work, we are interested in the application of nano technology in the mitigation of climate change.

2.1. Reduced Energy Consumption and Improving Efficiency

The major impact of nanotechnology on the energy sector is to improve the efficiency of present day technologies in minimizing the usage of fossil fuels. This is achieved through the following methods; (i) Reduction in the sizes and weights of engine and vehicle parts contribute to the decrease in fuel consumption which can have significant global impact because reduction in fuel consumption leads to reduced emissions. It is estimated that a 10% reduction in weight of the engine and vehicle parts corresponds to a 10% reduction in fuel consumption, leading to a proportionate fall in emissions, Cientifica (2007). Going by this development, there is worldwide growing interest in exploring means of achieving weight reduction in automobiles and stationary sources through the use of nano materials. Polymers like thermosets, thermoplastics, elastometer reinforced with colloidal silica, nanoclay and nanotubes are promising materials. Nanocatatalysts are used to improve the efficiency of fuel products used in combustion engines. Enercat, a third generation nanocatalist developed by Energenics, uses oxygen storing cerium oxide nanoparticles to promote complete fuel combustion, which helps in reducing fuel consumption, Cientifica (2007). (ii) Reducing friction can lower the fuel consumption by about 2% and result in cutting down carbon dioxide emissions by 500 million tons per year from trucks and other heavy vehicles in Sweden alone, based on the estimate made by a Swedish company, Applied Nano Surfaces. Nano based lubricants and nanocoatings can significantly reduce coefficient of friction and are being introduced in the market, Cientifica (2007).

2.2. Carbon Capture and Storage /Sequestration

Carbon sequestration is the process involved in carbon capture and long term storage of atmospheric carbon dioxide (CO_2), Sedjo R. et.al., (2012). This carbon is always captured from CO_2 produced from stationary and non-stationary sources. Carbon sequestration describes long-term storage of CO_2 or other forms of carbon to either mitigate global warming or avoid dangerous climate change. It has been proposed as a way to slow the atmospheric and marine accumulation of greenhouse gases which are released by burning fossil fuels, Hodrien C., (2008). When captured and buried under ground we have geosequestration. The concept of geosequestration involves liquifying carbon dioxide and depositing it into mineral zones below the earth's surface where chemical reactions of the liquid CO_2 with minerals stabilize it in solid form as defined by Professor Frost.

One proposed reaction is that of the olivine-rich rock dunite, or its hydrated equivalent, serpentinite with carbon dioxide to form the carbonate mineral magnesite, plus silica and iron oxide (magnetite). The olivine is a mineral of magnesium iron silicate with formula $(Mg^{+2}, Fe^{+2})_2SiO_4$. It is

a type of nesosilicate or orthosilicate and a common mineral in the Earth's surface. It is in nano scale and is used to sequester CO_2 through serpentinite reaction. When olivine is crushed, it weathers completely within a few years, depending on the grain size. All the CO_2 that is produced by burning 1 litre of oil can be less than 1 litre of olivine. The heat produced can be used to generate electricity, (Goldberg 2000, Schuiling 2006). Serpentinite sequestration is favored because of the non-toxic and stable nature of magnesium carbonate. The ideal reactions involve the magnesium end-member components of the olivine (reaction i) or serpentine (reaction ii), the latter derived from earlier olivine by hydration and silicification (reaction iii). The presence of iron in the olivine or serpentine reduces the efficiency of sequestration, since the iron components of these minerals break down to iron oxide and silica (reaction iv).

2.3. Serpentinite Reactions

Reaction i

Mg-olivine + carbon dioxide → magnesite + silica + water

$$Mg_2SiO_4 + 2CO_2 \rightarrow 2MgCO_3 + SiO_2 + H_2O$$

Reaction ii

Serpentine + carbon dioxide → magnesite + silica + water

$$Mg_3[Si_2O_5(OH)_4] + 3CO_2 \rightarrow 3MgCO_3 + 2SiO_2 + 2H_2O$$

Reaction iii

Mg-olivine + water + silica → serpentine

$$3Mg_2SiO_4 + 2SiO_2 + 4H_2O \rightarrow 2Mg_3[Si_2O_5(OH)_4]$$

Reaction iv

Fe-olivine + water → magnetite + silica + hydrogen

$$3Fe_2SiO_4 + 2H_2O \rightarrow 2Fe_3O_4 + 3SiO_2 + 2H_2$$

3. Conclusion

The pattern of electricity supply analyzed above using Onitsha as a model shows the poor state of conventional energy supply in Nigeria. It is however clear that though Africa at the moment is the least contributor of GHG in the globe; the continent stands the risk of being a major contributor due to her various activities especially as it has to do with the built environment. The people of the continent do not have adequate orientation and sensitization as to what climate change is and the dangers of various energy sources. This shows that environmental disaster more than what is happening now in Nigeria is looming if business continues as usual in the face of global warming. The level of urbanization in Onitsha has made trees that can absorb CO_2 to disappear. If the practice of tree planting, replanting and other methods of capturing carbon are not encouraged the earth surface may suffer. Government should encourage the use of alternative energy resources (Bio- fuel and solar energy etc.) There is every need for environmental managers to come up with the best energy for efficient use of the environmental resources.

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