DATABASE OF CO_2 EMISSION IN NIGERIA: A PRELIMINARY REPORT†

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Abstract

The issue of global warming has become one of the hottest topics in our world today and the reason is because of the increasing fear of its adverse effects. There is a growing consensus today that the increased emission of green house gases especially carbon dioxides (CO_2) which is believed to have increased by about 30% since the Industrial Revolution, are responsible for the overall warming of our planet. The emission of CO_2 is attributed to the high rate of energy consumption from burning of fossil fuel such as coal, oil and gas by the major industrialized nations. By global indices of classification, Nigeria is not an industrialized country. However, owing to its large population and the proliferation of alternative means of energy from fuel combustion machines, Nigeria is feared to be a major contributor to global warming. However, there are no reliable data to ascertain the amount of CO_2 that is emitted in the country. The purpose of our study is to accumulate a database of CO_2 emission in Nigeria especially as there is already a report by scientists at the Lawrence Livermore National Laboratory in the U.S that the effects of global warming are for the first time, visible on a regional scale. In this preliminary report, we demonstrated the theoretical and the experiment approaches of estimating the amount of CO_2 that is emitted in a place (or town) and the prospect of using this methodology to obtain a database CO_2 emission in Nigeria.

Keywords: Nigeria, Environment, global warming, Carbon dioxide emissions, database

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†***African Journal of Physics Vol. 2,pp.267-279, (2009)***

ISSN: PRINT: 1948-0229 CD ROM:1948-0245 ONLINE: 1948-0237

1. INTRODUCTION

Increase in the concentration of greenhouse gases has become one of the most harzardous impacts on our environment it has resulted into an increase in the temperature of the earth [1-5]. It is predicted that the global average temperature will rise by about 1.6^0C - 6^0C by the year 2100 if current trends of green house gases emission continue [1]. This increase in the average temperature of the earth is termed global warming: it occurs when certain gases commonly known as greenhouse gases trap the sun's heat. When sunlight reaches the surface of the earth, some of it will be absorbed by the earth's surface and this warms the earth. It is a case of heat transfer since the earth's surface is much cooler than the sun and radiate energy at much larger wavelengths than the sun. Some of the longer wavelengths are absorbed by greenhouse gases in the atmosphere before it can be lost to space. The absorption of this long wave radiant energy warms the atmosphere. Greenhouse gases also emit long wave radiation both upward to space and downward to the surface. The downward part of this long wave radiation emitted by the atmosphere is the greenhouse effect [6].

The major greenhouse gas responsible for global warming is Carbon dioxide (CO_2). Atmospheric CO_2 is derived from multiple natural sources such as volcanic out gassing, the combination of organic matter and the respiration processes of living anaerobic organisms. Apart from these natural phenomena, man-made sources include the burning of various fossil fuels for power generation in the industry, transportation. Agriculture, etc [7]. The growing belief is that increase in the man-made sources of CO_2 emission are responsible for the global warming hence it is also known as anthropogenic climate change. These man-made sources depend on the economies of the various countries. which in turn depends on their developmental levels. This corroborate the report that the concentration of CO_2 has increased substantially since the industrial revolution and is expected to continue to be so [2,3].

The adverse effects of our warming planet are also global such as precipitation, depreciation of slow cover, glacier extent, etc, all of which are believed to be responsible for the present drying up of some lakes, rise in the sea levels leading to flooding, etc [8]. This flooding is expected to affect African countries on the coastline such as the southern part of

Nigeria [9]. There also the fears of health related problems and uncertain effects on the Agriculture [10]. Thus in general, the geological location of a country will determine the level of the consequences of global warming on it. This supports the report by scientists at the Lawrence Livermore National Laboratory in the U.S that the effects of global warming are for the first time visible on a local scale [3].

It is surprising to note that in Nigeria, there is still no clear leadership in tackling the issue of climate change and the predicted consequences. While it has been a national agenda in many countries even with relatively high CO_2 emission, it is only in June 2009 that a desk office under the auspices of the Nigeria Climate Action Network (Nigeria CAN) was inaugurated in the Fededal Ministry of Science and Technology, Abuja.

As we pointed out in 2005 [5], though Nigeria is not considered by global indices of classification an industrialised nation, the amount of CO_2 pumped into the atmosphere in the country can be relatively alarming when compared to that released in some many developing countries. The reason being that the over 140 million population based on the 1991 census which makes her the most populous country in Africa and the 8th most populous country in the world, means a large transport potential which may translate into a remarkable emission of CO_2. This has been aggravated by the epileptic power supply from the national grid and deforestation in the tropical parts of the country [3,11].

It is worthy of note that from World Environment Statistics [12], Nigeria is ranked. 51st among 178 countries in CO_2 emission with 48,145.7 thousand metric tonnes, as against the United States with a CO_2 emission of 5,762,050 thousand metric tonnes which makes her the first. This total emission of CO_2 does not indicate the variation in emission level from one place (or town) to another in the country. Therefore, it cannot be used for proper environmental planning and policy making. The purpose of our study here is to have a database of CO_2 emission in Nigeria. In this preliminary report, we have demonstrated how to obtain the total amount of CO_2 emission in any given place. The plan of our study is as follows. In sec. II, we will show how to obtain the total emitted CO_2 in any arbitrary number of litres of petroleum products. Thereafter, we will show how to

obtain the total amount of litres of petroleum products consumed in one place in sec. III. The results will be presented and discussed in sec. IV and this will be followed by a conclusion.

2. AMOUNT OF CO_2 EMISSION FROM N LITRES OF PETROLEUM PRODUCTS

The first step in developing a database of the amount of emitted CO_2 is to determine the amount of CO_2 in a litre of the petroleum products. Each of these various petroleum products, however, has various ratings depending on the quality of the parent crude oil and the refining technology. This variation in rating is not unconnected with the increase in importation of petroleum products in recent years owing to the inability of the four under producing refineries in the country to meet national consumption. As reported by Nwachukwu and Bala-gbogbo [13], the refineries in 2008 were only able to supply the market with 37,156 metric tonnes (mt) of petrol which is far below the 8,909 million mt for the national consumption of petrol and 169.088 mt of diesel lower than the national consumption of 3,215 million mt. Therefore, more than 90 % of the national consumption of petroleum products is imported. Since these importations are from various refineries around the world, the CO_2 emission from more than 90 % of the petroleum products varies from one importation source to another. Thus for the purpose of the database estimation here, we will show how to determine the amount of CO_2 in a litre of the various petroleum products. This will be done from theoretical analysis using the stoichiometric equations and then by experiment.

Theoretical Analysis

Taking into account their stoichiometric equations and molecular weights, it is easy to obtain the amount of CO_2 in a litre of petrol, diesel and kerosene:

For Petrol (C_8H_{18} = 114)

Amount of CO_2 in 1 litre of petrol = 1 x 0.74 x 0.84 x 3.6667

= 2.27kg of CO_2 = 2270g of CO_2

For Diesel (C_6H_{34} = 226)

Amount of CO_2 in 1 litre of diesel = 1 x 0.85 x 0.85 x 3.667

= 2.65kg = 2650g.

For Kerosene ($C_{12}H_{24}$ = 168)

Amount of CO_2 in 1litre of kerosine = 1 x 0.817 x 0.85 x 3.6667

= 2.55kg = 2550g.

Thus for n litres of petrol, diesel and kerosine, the amount of CO_2 is given as 2.270n Kg, 2.650n Kg and 2.550n Kg respectively. It is worthy to note that these values can also be written in terms of their specific gravities [14]

$n\Sigma\emptyset(3.6667)$.

where n = no. of litres consumed

Σ = specific gravity (petrol = 0.74, Diesel = 0.85, Kerosene = 0.87)

$\emptyset$ = Proportionality of carbon.

Experiment approach using an Eudiometer

The eudiometer looks like an autoclave built of thick glassy material that is heat resistant. It contains two bowls, one containing the materials to be combusted with the lighter (a resistor like device), which becomes hot when the equipment is switched on, igniting the sample. The other bowl contains a solution of calcium oxide which absorbs carbon (iv) oxide and turns milky. It absorbs better if the solution is acidified.

The base of the equipment is bent to enable the steam generated by combustion to be collected as water in a graduated container, when the equipment cools down.

50ml of the sample is ignited inside the endiometer in the presence of excess air, CO_2 formed is absorbed by an acidified solution of calcium hydroxide to form a milky solution of calcium trioxocarbonate (iv). The

amount of carbondioxide formed is estimated by standardising the calcium trioxocarbonate (iv) solution using standard hydrochloric acid solution by titrametic method.

Alternatively, the pressure within the eudiometer before and after the spark can be determined by using gas equations, the volume of carbondioxide can be calculated.

The result of combustion analysis using an eudiometer gives:

Sample A: Petrol:

Colour: Reddish

Specific gravity 0.737

50ml (36.856g) of sample A (Petrol) on combustion in the presence of excess air yielded 113.65g of CO_2 and 53g of H_2O. The implication is that 1 litre (1000ml) (737g) of petrol on combustion yielded 2,274g of CO_2 and 1,040g of H_2O.

Sample B: Diesel:

Colour: Brownish

Specific gravity 0.882

50m/ (44.10g) of diesel on combustion in the presence of excess air yielded 161.70g of CO_2 and 69g of H_2O. The implication is that 1 litre (1000ml) of diesel on combustion yielded 3234g of CO_2 and 1,380g of H_2O.

Sample C: Kerosine:

Colour: Light Bluish

Specific gravity 0.817

50ml (40.85g) of kerosene in combustion in the presence of excess air yielded 126.81g of CO_2 and 56g of H_2O. The implication in that 1 litre (1000ml) of kerosene on combustion yielded 2.536g of CO_2 and 1,127g of H_2O.

Therefore, from the practical approach, the amount of CO_2 emission from 1 litre of petrol, diesel and kerosene.

Observe that the amount of CO_2 emitted from the petroleum products samples used in the experiment are the same except for the slight variation in that of diesel.

3. OBTAINING THE TOTAL AMOUNT OF CONSUMED PETROLEUM PRODUCTS

It is now straightforward to develop the database of any given place once we can obtain the total amount of petroleum products consumed over a period of time there. Doing so for Nigeria would have been straightforward if all the petroleum products consumed in the country are from our refineries because the Petroleum Pricing and Marketing Company (PPMC) of Nigeria will then be able to provide the amount of the petroleum products supplied to various parts of the country. But as stated earlier, more than 90% of the petroleum products consumed in the country are imported and the importers sell their products to the oil marketers from various parts of the country. The implication is that this arrangement makes it impossible to get the total amount of the petroleum products consumed in most towns from PPMC.

An alternative means to obtain estimate of the total amount of the petroleum products consumed in any town is to get this information directly from the fuel filling stations in that town. To demonstrate this approach, we have used Abraka which is the host community to the Delta State University, as a case study. Here we considered the possible relationship of the sales of petroleum products and the possible amount of consumption of energy resulting to the emission of CO_2 to the environment. The sampling was carried out in all the prominent filling stations in Abraka community; Emole Nig. Limited, Texaco, Total, Buovo, Blue Point, SpringBeds, Acod and Pellucid.

The samples were stratified to correspond to the amount of petroleum products (Petrol, Diesel and Kerosine) consumed in the year 2008 by individuals, organizations, corporate firms, government parastatals

and transport workers in Abraka. In general, the random sample covers the diversity of the environmental effect of the energy supply systems, since 95% of the sale of the product is utilised and consumed in Abraka. Therefore, the amount of CO_2 released from this 95% of petroleum products gives a good estimates of the CO_2 emission in Abraka.

Table 1 shows the sales of Petrol in thousand litres for 2008 in Abraka.

S/N	Filling stations	Sales of Petrol (in thousand litres) for 2008											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Emole Nig Ltd	180	180	210	210	180	210	240	240	240	270	270	180
2	Texaco	150	120	150	120	180	150	150	180	120	180	210	150
3	Total	150	150	180	120	150	120	120	180	150	120	150	120
4	Buovo	60	90	120	90	60	60	80	60	90	60	60	90
5	Blue Point	180	210	210	210	150	180	150	210	280	240	180	210
6	SpringBeds	210	240	240	210	240	180	240	270	230	240	230	250
7	Acod	120	150	150	90	120	120	60	90	150	150	150	150
8	Pellucid	60	30	60	30	40	50	60	30	45	60	70	60
	TOTAL	**1110**	**1170**	**1320**	**1080**	**1120**	**1070**	**1100**	**1260**	**1305**	**1320**	**1310**	**1210**

Table 2 shows the sales of Diesel in thousand litres for 2008 in Abraka.

S/N	Filling stations	Sales of Diesel (in thousand litres) for 2008											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Emole Nig Ltd	30	30	-	45	30	-	30	20	30	-	30	30
2	Texaco	30	45	-	30	30	-	45	30	30	20	30	30
3	Total	45	30	-	30	30	30	30	20	30	30	-	30
4	Buovo	30	45	45	-	30	30	30	25	30	-	30	30
5	Blue Point	30	30	60	45	40	45	40	30	60	35	40	30
6	SpringBeds	30	30	50	45	45	45	40	30	45	30	45	30
7	Acod	30	30	45	-	30	30	30	20	30	-	30	20
8	Pellucid	30	-	30	20	30	30	20	30	30	30	20	30
	TOTAL	**255**	**240**	**230**	**215**	**265**	**210**	**265**	**255**	**285**	**145**	**225**	**230**

Table 3 shows the sales of Kerosene in thousand litres for 2008 in Abraka.

S/N	Filling stations	Sales of Kerosene (in thousand litres) for 2008											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Emole Nig Ltd	26	26	39	39	39	26	13	13	26	26	26	39
2	Texaco	26	13	20	15	26	-	-	39	39	26	26	13
3	Total	15	13	13	26	-	-	26	26	13	13	26	26
4	Buovo	26	26	13	13	26	13	26	26	13	-	-	-
5	Blue Point	15	15	15	15	25	20	15	25	20	15	10	15
6	Spring Beds	26	13	15	26	39	39	39	39	26	26	13	13
7	Acod	26	26	13	39	39	13	13	26	26	39	26	29
8	Pellucid	15	15	15	-	-	15	15	15	15	15	15	15
	TOTAL	**175**	**147**	**143**	**173**	**194**	**126**	**147**	**209**	**178**	**160**	**142**	**149**

4. RESULTS AND DISCUSSION

The total consumption of petroleum products for year 2008 in Abraka is: petrol, 14,375,000 litres; diesel, 2,820,000 litres and kerosene, 1,943,000 litres (see Tables 1, 2 and 3). Therefore the amount of CO_2 emitted is as follows:

14,375,000 litres of petrol will emit 3.2689×10^7 kg of CO_2

2,820,000 litres of diesel will emit 9.2000×10^6 kg of CO_2

1,943,000litres of kerosine will emit 4.927×10^6 kg of CO_2

It follows that the average CO_2 emission in Abraka per day will be 128,104 kg which is equivalent to an emission of 1,220 ppm. This is less than the world health organisation (WHO) stipulated maximum of 20,000 ppm and therefore according to Greiner [15], this quantity is not high enough to cause health hazard. However, the CO_2 emission is about 3 times higher the global concentration of atmospheric CO_2 which has increased from 280 ppm in 1700 to over 370 ppm today [4].

Ndoke *et al* [16] in their study on the contribution of vehicular traffic to CO_2 emissions in Kaduna and Abuja using CO_2 measuring gadgets shows that an average of 1160 – 1840 ppm of CO_2 is emitted in the area. Also, Ndoke and Jimoh [17] in an earlier similar study for Minna, observe that the CO_2 concentration in the area was as high as 5000 ppm. With these results, it is expected that the CO_2 emission in cities like Lagos and Port-Harcourt with high population density and increase economic activities may have reached alarming levels.

5. CONCLUSION

The major greenhouse gas is atmospheric CO_2 which is believed to have increase by about 30% since the industrial revolution. It is emitted from the world major sources of energy, which is burning of fossil fuels such as coal, oil and gas. The large population, poor power supply from the national grid and deforestation makes Nigeria a potential high CO_2 emitting country. However, there is no database of CO_2 emission to initiate actions to study and predict the nature of the possible impacts of global warming at a local scale within the country. This is the project we have embarked upon. Getting data on consumption of petroleum products in various parts of the country from government agencies have been a herculean task. The methodology we have developed in this preliminary report is to get such data from the oil marketers operating in our places of interest. It is therefore hoped that we can use this methodology in all parts of the country and then be able to develop a database of CO_2 emission in the country which will become very useful to researchers, town planners and policy makers.

Acknowledgement

We appreciate the kind assistance of the Abraka branch of the Oil Marketers Association of Nigeria for providing us their monthly sales output in 2008. We also appreciate the useful discussion with Dr Edmond Atakpo. This work is supported in part by AFAHOSITECH.

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