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International
Journal
Of Modern Engineering Research (IJMER)

Generation of Electricity througha Non-Municipal Solid Waste Heat fromanIncinerator

[1]Abaka J.U*, [2]Ibikunle A.A, [3]Chukwunyeaka C, [4]Ogunniyi S.A,[5]Adeleke, D.A

ABSTRACT: *Energy production, waste disposal, and pollution minimization are key problems that must be addressed for sustainable cities of the environment. Waste management has become a major concern worldwide, and incineration is now being used increasingly to treat waste that cannot be recycled economically. The total heat content of non- municipal waste varies from countries to countries. The tonnage of generation in Nigeria is expected to soar over the next few years and the exploitation of this renewable energy locked up in urban solid municipal waste into grid energy can be taken advantage off. The heat generated from this incinerated plant can be used to generate electricity which will reduce overdependence on fossil fuel and the use of generator which in turn reduces pollution disposal of this waste is incinerated plant for the production of electricity. Hence, this paper intends to review the non-municipal waste potential in Nigeria, evaluate its environment and economic cost, and energy content of municipal solid waste deposits in Nigeria.*

Keywords:*power generation, Incineration plant, pollution minimization, Non-municipal waste*

I. INTRODUCTION

Generally, waste is said to be an unwanted substance(s) emanating as a result of human, animal and other biodegradable materials associated with it. Municipal and Non Municipal Solid Waste (MSW)&(Non-MSW) includes household garbage , market spoils , rotten food stuffs, construction and demolition debris, sanitation residues, non-hazardous industrial refuse, treated biomedical solid waste and agricultural waste etc. (Udoakah and Akpan,2013).The nature of solid waste in Nigeria differs significantly. Non-Municipal Solid Waste (MSW) is characterized to contain organic as well as inorganic materials. The latent energy present in its organic content can be recovered for gainful utilization through adoption of suitable Waste Processing and Treatment technologies. The total quantity of waste gets reduced by nearly 67% to over 90%, depending upon the waste composition and the adopted technology. The cost of transportation of waste to far away landfill sites also gets reduced accordingly and the Net reduction in environmental pollution is another important factor (Tsunatu et al, 2015).Waste collection and disposal strategy differs from country to country. Landfills, incineration, and recycling are often used in developed countries to dispose Non Municipal Solid Waste. In Nigeria, these categories of wastes are often disposed in an unsustainable manner in open dumps, streets, rivers , and in other cases into drainages which eventually flows into streams which serves as a source of water to the people residing in such locality. In this, the unregulated waste disposal pattern continues to pose serious health and environmental hazards. These waste are biologically diverse, dangerous, and highly dangerous and may breed zoonotic pathogens which revealed that most diseases which infects human are caused by protozoa including amoebic dysentery. Furthermore most waste material host a good number of fungi numbering up to 100,000 species out of which number, 100 are pathogenic to animals and humans (Udoakah and Akpan, 2013). If all municipal solid waste was converted into energyinstead of simply discarded, we could end up reducing our dependence on oil and coal by at least three or four percent, which translates into hundreds of thousands of barrels of oil and thousands of tons of coal.

Municipal Solid Waste is a renewable energy sourcethat shows great promise, and all waste to energy facilities follow almost the same procedures when the waste is first received. At this point, a waste to energy facility that burns the waste will put the materials into the incinerator to burn, so the released energy can be captured in the form of steam. This steam is then used to create electricity (Jaeger, Mayer, 2000 and Weitz et al, 2000).Municipal Solid Waste is an alternative energy sourcethat is renewable, sustainable, and ecologically friendly, and this renewable energy source may be the answer to an energy crisis. Developed countries produce up to one tonne of municipal solid waste per person per year (Oskamp, S, 1995).The high cost and large energy requirement of reuse and recycling limit the application of this apparently desirable technique to a few specific

constituents of the waste. The remaining option is to recover as much of the energy content of the waste as possible.

When the energy content of wastes can be recovered cleanly and efficiently, their combustion represents a reuse of material and thereby contributes to our energy needs in an environmentally friendly manner. If waste is not properly handled, it may result to indiscriminate dumping and open dumping of rubbish whichcan cause landfill (Eniola et al, 2014).

II. Status Of Non- Municipal Waste In Nigeria And Other Countries

There are many issues that surround reporting waste. It is most commonly measured by size or weight, and there is a difference between the two. For example, organic waste is much heavier when it is wet and plastic or glass bottles can have different weights but be the same size. On a global scale it is difficult to report waste because countries have different definitions of waste and what falls into waste categories, as well as different ways of reporting (Eniola et al, 2014).The top destination of waste is China, which in 2010 imported around 7.4m tonnes of discarded plastic, 28m tonnes of waste paper and 5.8m tonnes of steel scrap (Kara M, 2013). Between 2000 and 2008, European exports of plastic waste increased by 250% – and about 87% of these exports ended up in China (including Hong Kong).The trade is being driven by tough EU legislation forcing local authorities and businesses to recycle more, and increasing landfill charges, making it cheaper to send the waste abroad. According to a report to the secretariat of the Basel Convention in 2003, the Netherlands, Switzerland, Belgium and Germany were the highest exporters of waste, while Italy, France and, perhaps ironically, Germany, were the top waste importers. In 2013, Brazil and United States of America waste generation were estimated as 64 and 250 million tonnes respectively (Brent and Fainan, 2011). In Nigeria, The commonly practised waste management option in Nigeria, basically involves the collection of mixed waste materials and subsequent dumping at designated dumpsites. It is not a practice to separate waste materials at source or any point during its management (Adekunle et al, 2011). In Nigeria waste streamdespite these inconsistencies, waste reporting is still useful on a small and large scale to determine key causes and locations, and to find ways of preventing, minimizing, recovering, treating, and disposing waste.

Table 1:Waste generation in some urban cities in Nigeria

Cities	Population	Agency	Tonnage/month	Density (kg/m^3)	Kg/capita/day
Lagos	8,029,200	Lagos state management authority	255,556	294	0.63
Kano	3,348,700	Kano state environmental protection agency	156,676	290	0.56
Ibadan	307,840	Oyo state environmental protection commission	135,391	330	0.51
Kaduna	1,458,900	Kaduna state environmenta l protection agency	114,443	320	0.58
Markurdi	249,00	Urban development board	24,242	340	0.48
Onisha	509,500	Anambra state environmen tal protection agency	84,137	310	0.53
Abuja	159,900	Abuja state environmenta l protection agency	14,785	280	0.66

Source :(Kadafa et al, 2013)

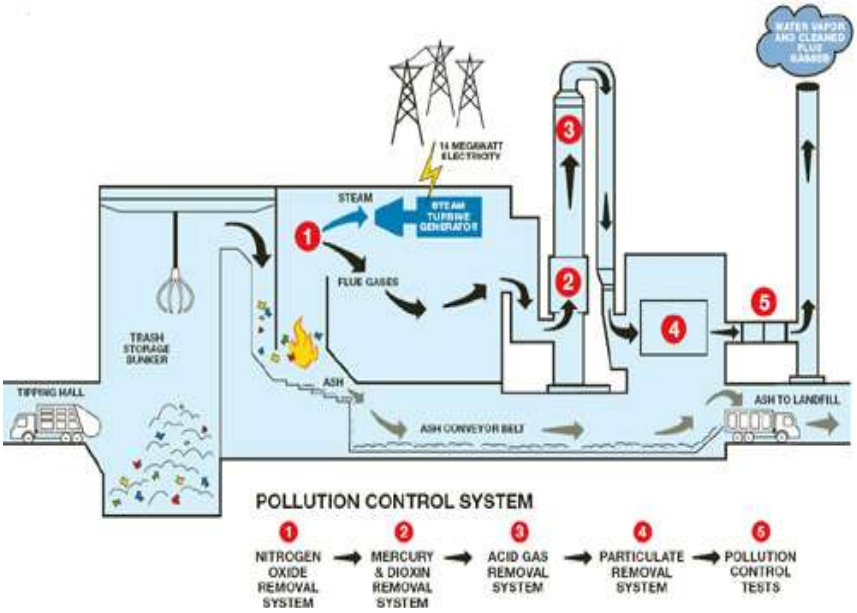
III. Non –Municipal Solid Waste Potential in Nigeria

Non-municipal solid waste is a large category of waste that is often divided into three categories: mining waste, agricultural waste, and industrial waste. Sources of solid waste generation in Nigeria among others are commercial, industrial, household, agricultural and educational establishments. The solid waste types include paper, nylon, wood, dust, cloth, metal scraps, electronic gadgets, bottles, food remnants and vegetables; saw dust, ashes, rubber, bones and plastics. Of total solid waste generated in Ibadan, 66.1% are domestic, 20.3% commercial and 11.4% industrial (Adewumi et al., 2005). Average medical solid waste generation in Lagos lies

between 0.562Kg/bed/day and 0.670Kg/bed/day (Longe and Williams, 2006). In Abuja, the Federal Capital Territory, medical solid waste of 2.78Kg/bed/day was generated (Bassey et al., 2006), and in Ibadan, 150g/head/day (Coker et al., 1999). Several thousand used computers are imported to Nigeria through Lagos seaport monthly and many of them lose the desired value within a short time, ending up to build the e-waste pile in Nigeria (Ukem, 2008).Territory, medical solid waste of 2.78Kg/bed/day was generated (Bassey et al., 2006), and in Ibadan,150g/head/day (Coker et al., 1999). Several thousand used computers are imported to Nigeria through Lagos seaport monthly and many of them lose the desired value within a short time, ending up to build the e-waste pile in Nigeria (Ukem, 2008). In view of some of these challenges associated with MSW in Nigeria, the Federal Government of Nigeria laws and regulations in Nigeria promulgated to protect the environment of which include the Federal Environmental Protection Agency (FEPA) Act of 1988 where each state and local government in the country set up its own environmental protection body for the protection and improvement of the environment within its jurisdiction, thus making MSW management a major responsibility of state and local government environmental agencies (Udoakah and Ogu)

IV. Non –Municipal Solid Waste To Energy Process Of Incineration

Waste incineration is carried out at a high temperature of about 870-1200^{o}C. (1600 to 2200 ^{o} F) (Obong and Uduak, 2013). This very high temperature allows enough time for at least about 99% of the organic substances such as minerals, metals and water contained in the waste to be oxidized. An Incinerator producing exclusively heat can have a thermal generating efficiency of about 80-90%(FRM, 2012) .Incineration uses waste as a fuel, burning it with high volumes of air to form carbon dioxide and heat. In a waste-to-energy plant that uses incineration, these hot gases are used to make steam, the high pressure steam is then used for power generation. Also, flue gases (CO_2, H_2O, O_2, N_2) which are generated contains a good majority of fuel energy available as heat. (Murphy, Keogh and. Morris, 1998). It asserted that the volume and weight of waste is reduced by 90% and 70% respectively through incineration. As sustainable as the idea of energy generation through incineration may sound, studies have shown that depending on the operating conditions, type and composition of the incinerated material, little quantity of HCl, Hl, HF, HBr, NOX, SO2 CO, VOCs, PCDD/F, PCBSs and heavy metal compound are left over. The technology for electricity generation via incineration is categorized into four processes namely: Waste collection and pre-treatment, waste combustion, gas scrubbing with pollution control and electricity/steam generation. The generated steam is fed into a steam turbine, where it is channelled to flow over a series of turbine blades that is connected to an electric generator which on rotation produces electricity. The power produced can be further increased by employing a condensing turbine technology which is used in cooling the steam (Obong and Oduak,2013). Non-Municipal solid waste incineration technology has been proven over time to be a sustainable system of waste disposal which is capable of not only limiting the amount of poisonous substances emitted into the atmosphere, but also contributing to sustainably meeting the energy need of the society(Murphy and Keogh,2006).



Source: (Willian et al, 2014)

V. WASTE INCINERATING PLANT

Factors affecting solid waste collection and generation

Several factors influence the solid waste generation in Nigeria. Lack of advanced technology, facility for separation at source, strength of solid waste, Management policy and enforcement, environmental education and awareness and income status of individuals among others, are factors affecting solid. Waste scenario in Nigeria showed that education, income and social status are important factors influencing per capita solid waste generation insome states (Abel, 2009). Age, location, occupation and amount charged for waste collection are determinant factors for using public waste collection Services in Ibadan (Ajani, 2007). The quantity and categories of solid waste generation also varies with socio-economic groups.

Environmental Costs.

Inappropriately managed waste can attract rodents and insects, which can harbor gastrointestinal parasites, yellow fever, worms, the plague and other conditions for humans, and exposure to hazardous waste, particularly when they are burned, can cause various other diseases including cancers. Toxic waste materials can contaminate surface water, groundwater, soil, and air which cause more problems for humans, other species, and ecosystems.

Waste treatment and disposal produces significant greenhouse gas (GHG) emissions, notably methane, which is contributing significantly to global climate change (Lavee D. (2007) and Decker, 2000).

Economic Costs.

The economic costs of managing waste are high, and are often paid for by municipal governments; money can often be saved with more efficiently designed collection routes, modifying vehicles, and with public education. Environmental policies such as pay as you throw can reduce the cost of management and reduce waste quantities. Waste recovery (that is, recycling, reuse) can curb economic costs because it avoids extracting raw materials and often cuts transportation costs. The location of waste treatment and disposal facilities often has an impact on property values due to noise, dust, pollution, unsightliness, and negative stigma. The informal waste sector consists mostly of waste pickers who scavenge for metals, glass, plastic, textiles, and other materials and then trade them for a profit. This sector can significantly alter or reduce waste in a particular system, but other negative economic effects come with the disease, poverty, exploitation, and abuse of its workers (Eniola et al, 2013).

Waste Supply.

For an electricity generating system using waste to work, having a large, stable supply of material is crucial. Two legislative options could be used to create such a supply: mandatory waste collection and refuse bans (Kathiravale, 2004). Mandatory collection laws will set recycling targets for cities to aim for, usually in the form that a certain percentage of a material must be diverted from the city's waste stream by a target date. The city is then responsible for working to meet this target. The second method of increase supply of waste is to ban the disposal of certain materials as waste, often including used oil, old batteries, tyres and garden waste. One aim of this method is to create a viable economy for proper disposal of banned products. Care must be taken that enough of these recycling services exist, or such bans simply lead to increased illegal dumping. One advantage of these legislative measures is that valuable land that would have been destined to become landfills can be judiciously utilized. To meet this requirement, the different waste streams (e.g., municipal solid waste, industrial waste, pharmaceutical waste, etc.) must be treated differently (Eniola, et el, 2013).

VI. RECOMMENDATION AND CONCLUSION

The sustainable management of Non-Municipal solid waste which will lead to the generation of Electricity is very realistic in Nigeria taking into consideration the large amount of waste generated in only some regions where the study was conducted. The informal Non-municipal solid waste disposal habit must be prohibited by legislation while conscious efforts should be made to educate and create public awareness about the severe health and environmental impacts caused by unsustainable disposal and management of the municipal solid waste. As noted in the course of the study that although the cost of under taking such projects may appear quite high, the benefits of doing it would certainly outweigh the cost at the long run. It is therefore strongly recommended in this study that incinerating facilities with energy recovery be installed at waste disposal sites for the efficient and sustainable management solid waste. By implementing the above proposed strategy, they study believes that the current waste management crisis that is stirring the administrators and resident of most of the cities in Nigeria would be greatly eliminated.

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