**ABSTRACT**

Air quality continues to be among the topenvironmental concerns in Nigeria. In nigeria, where majority of the rural population uses charcoal, verylittle is known about the impacts of the life-cycle of the fuel on thelivelihoods of the producers, who endure significant health, safety, andenvironmental risks for marginal gain in a highly lucrative industry.Population increases and deviations from the energy ladder model suggest thatcharcoal demand for heating and cooking in Sub-Saharan Africa will continue toincrease through the year 2030 and beyond. Charcoal production industrycan use an air monitoring program to assist in addressing its environmentalresponsibilities, and its responsibility as a local community member. Industryperformance monitoring enables industrial plant to be managed in anenvironmentally sustainable manner .

Asurvey of air quality in a charoal production site Amukpe sapeleand environs in the Niger delta area of Nigeria revealed that airquality in the area is affected to varying degrees by industrial activities inthe production site.

This report covers a brief background of thestudy, state of the problems, aims andobjectives of the work done, the scope of the research and also the relevance of work done withregards to the analysis of emissions produced by a charcoal production facilitylocated in amukpe sapele delta state. Anaccredited environmentalist was involved as a third party. Consulting anindependent third party to perform the measurements give more credible results and provide unavailable equipmentrequired for the analysis.

The aim andpurpose of the project is the evaluate the concentration of particulate matterand gaseous pollutants present within a 2km radius of the charcoal productionfacility. The significance of thisexperiment is to detect if air in thesurrounding environment is polluted with emitted gase from the productionsite, which can be detrimental to humanhealth. A survey of air quality in amukpesapele and environs in the Niger delta area of Nigeria revealed that airquality in the area is affected to varying degrees by industrial, human andnatural activities.

Thediscussed results indicate that a local charcoal production facility can be sustainableand without a significant environmental impact in sense of its emissions.

Howeversome deeper environmental performance evaluation could take place with the availabilityof measurement equipment with a wider measurement range, higher precision andmore suitable for measurements in a charcoal factory. Also, the resultsindicates large amounts of concentration of pollutants within the immediateenvironment of the immediate environment. It is recommended that charcoalproducers in amukpe sapele waer appropriate PPE's and follow WHO guidelines andrecommendations to control and reduce emissions.

## CHAPTER ONE

## 1.0INTRODUCTION

### 1.1BACKGROUND OF STUDY

Charcoal is a woodfuel produced in ruralareas and consumed in cities and towns. Some of the factors influencing thechoice of using charcoal instead of firewood in urban areas include: Charcoalhas a higher calorific value per unit weight that firewood, it is thereforemoree conomic to transport charcoal over longer distances as compared tofirewood; Storage of charcoal takes less room as compared to firewood; Charcoalis not liable to deterioration by insects and fungi which attack firewood;Charcoal is almost smokeless and sulphur – free, as such it is ideal fuel fortowns and cities. It is estimated that approximately 1.5 billion people indeveloping countries derive at least 90% of their energy requirements from woodand charcoal. Another one billion people meet at least 50% of their energyneeds this way. In most developing countries, 90% of the people depend onfuelwood as their chief source of fuel and each year the average user burnsanywhere from a fifth of a ton, in extremely poor, wood short areas such asIndia, to well over a ton in parts of Africa and South Asia (GFC, undated). In1999, it was estimated that 1.9 billion $m^3$ of wood was burned for cooking, to provideheat or to manufacture charcoal for later burning (FAO, 1999).

Large-scale charcoal production, primarilyin sub Saharan Africa, has been a growingconcern due to its threat of deforestation, land degradation and climate changeimpacts. It is cited as the most environmentally devastating phase of thistraditional energy supply chain, and despite increasing per capita income,higher electrification rates, and significant renewable energy potential,charcoal still remains the dominant source of cooking and heating energy foreighty percent of households in Sub Saharan Africa (SSA) (Arnold et al, 2006;Zulu and Richardson, 2013). As a traditional fuel that has been used

forhundreds of years, it serves as a lifeline for the rapidly increasing populationsin the urban centers of the region, in addition to potentially significant portionsof the rural population. Due to its low cost compared to other fuels like keroseneand liquefied petroleum gas, as well as other factors that will be discussed inthe coming sections, the demand for charcoal is expected to continue rising dramaticallyin the coming decades, despite best efforts by modern energy advocates. Charcoaluse in SSA is predicted to double by 2030, with over 700 million Africans relyingon it as a durable, preferred, and cheap source of energy. With a forecasted increasein consumption, there is a great need to identify real versus perceived energy futureswith respect to charcoal. Research has shown that large-scale transitions to modernenergy sources will only occur once a certain income threshold is met, while otherstudies have indicated that even with large increases in earned income, thelarge majority of many SSA countries continue to utilize charcoal. If acontinued reliance on charcoal is suggested, there is an even greater need toevaluate and address the environmentaland social issues associated with this highly influential, and largely informal,industry.

Air pollution is the introduction ofchemicals, particulate matter, or biological materials that cause harm ordiscomfort to humans or other living organisms, or cause damage to the naturalenvironment or built environment, into the atmosphere. It can be defined as thepresence in the outdoor or indoor atmosphere of one or more gaseous orparticulate contaminants in quantities, characteristics and of duration such asto be injurious to human, plant or animal life or to property, or whichunreasonably interferes with the comfortable enjoyment of life and property(Odigure, 1998). It has been difficult to achieve cooperation for air pollutioncontrol in developing countries like Nigeria, whose chief concern is to providesuch basic need as food, shelter and employment for her populace.

Asubstance in the air that can cause harm to humans and the environment is knownas an air pollutant. Pollutants can be in the form of solid particles, liquiddroplets, or gases. In addition, they may be natural or man-made (Anderson,2005). The atmosphere is a complex dynamic natural gaseous system that isessential to support life on planet Earth. Stratospheric ozone depletion due toair pollution has
long been recognized as a threat tohuman health as well as to the Earth's ecosystems.

Indoor air pollution andurban air quality are listed as two of the world's worst pollution problems inthe 2008 Blacksmith Institute World's Worst Polluted Places report (Anderson,2005).

**1.2 STATEMENT OF THE PROBLEM**

The pollutants emitted from a charcoal production site have the abilityto cause adverse health affects such as respiratory diseases. The charcoalproducers in this region are not well enlightened and do not consider the thedangers these emissions possess if the enter the environment in significantlevels. Hence, they would not be able tackle the problem of air pollution andgreen house gas emissions produced by the pryolysis of charcoal.

Worryingly,the government through the medium of environmental protection agencies do notpay much attention to these process produces considerable amounts of greenhouse gases and suspended particle matter which are discharged into naturalreceptors, (majorly air) leading to major environmental problems inthe long run.

Areview of the literature surrounding charcoal supply chains in Sub-Saharan Africapaints a clear picture that the demand for this energy source will not remain stagnant,but will increase dramatically through the year 2030 . Even in countries whereelectrification rates are at their highest, as in Ghana, 60-70% of the population still use charcoalfor cooking and heating , a finding identified in numerous studies thatdeviates from the traditional energy ladder model. Electricity rarely replaces charcoalas a fuel, though increases in income lead to higher usage of more refinedfuels, like kerosene and LPG, to replace biomass; this helps to illustrate thenegative, and often misleading, correlation found between charcoal andelectrification. In some of the least developed countries, like Liberia, whereless than one percent of the population is connected to grid electricity, 95%rely on traditional biomass fuels in the form of wood and charcoal. In thegrowing rural areas, charcoal is the primary fuel used for heating and cooking,as poor infrastructure, high cost, and low-income levels limit market growthfor refined cooking fuels.

Health-relatedimpacts associated with woodfuels have traditionally focused on effectsfrom their consumption. Indoor air pollution (IAP) is the primary concern giventhe high concentrations of smoke and particulate matter released duringwoodfuel combustion. Smith et al (2002) documented trends in respiratoryillness among disproportionate numbers of

women and children as a result of IAPfrom woodfuel combustion throughout the developing world. However, little isknown about the nhealth impacts endured by charcoal producers during extractionand production phases. For example, it is known that pyrolysis, the processutilized for the production of charcoal, releases significant amounts ofgaseous by-products, including carbon monoxide, sulfur dioxide and others known to be deadly to humans in moderate concentrationsthrough the use of dose-response studies. Rural producers are known to work within closeproximity to high temperature kilns that off-gas these highly toxic compounds,generating potential high risk for poisoning. In addition, use of primitive toolscan potentially lead to moderate or severe injuries, which can prove fatal inrural areas that lack access to adequate medical care. Academic literature andgovernment reports refer to the working conditions of charcoal producers asunsafe; government officials and research papers alike mention these ‘hazards’in passing.

Additional indicators of social threatsinclude widespread child labor, gender differences in education and productionoutcomes, extreme price variability often at the hands of merchants and thelack of potential for poverty alleviation in current methods of production. Thelack of regulation in the charcoal industry creates the highest risk of exploitationand safety hazards, yet no studies have investigated in-depth the health andsocial risks associated with the production of this highly demanded fuel.

**1.3 Aim and Objectivesof Study**

The aim of this study is to determine the presence of air pollutants insignificant concentrations and its spatial distribution to its surroundingenvironment along a two kilometre radius and its effects on in one of it.

The specific objectives are to

1. Determine the presence of air pollutants in gaseousemissions discharged from a charcoal production facility.
2. Run ambient air quality analysis to determine thespatial distribution of these air pollutants in the surrounding environmentover a 2km radius.
3. Compare results of the study to national andinternational standard such as the world health organisation and draw outconclusions.
4. Suggest solutions to the problems of these airpollutants to the surroundings and give

recommendations and control methods.

**1.4 SIGNIFICANCE OFPROJECT**

This study will help confirm the true distribution of air pollutantsdischarged from t production of charcoal in the sampled community. Theconcentration, translocation and distribution of the specified air pollutantsin relation to the distance will also bedetermined; this should help complete a holistic pollution cycle analysis. Resultsof this research project should further serve as baseline studies for furtherresearch work on charcoal production in amukpe sapele and studies on theeffects of the charcoal industry's activities.

**1.5 SCOPE OFRESEARCH**

**1.5.1Analysis of Emissions And Controls**

There are five types of products andbyproducts from charcoal production operations: charcoal, noncondensible gases(carbon monoxide [CO], carbon dioxide [$CO_2$],methane, and ethane), pyroacids (primarily acetic acid and methanol), tars andheavy oils, and water. With the exception of charcoal, all

of thesematerials are emitted with the kiln exhaust. Product constituents and thedistribution of these constituents vary, depending on raw materials and carbonizationparameters. Organics and CO are naturally combusted to $CO_2$ and water before leaving theretort. Because the extent of this combustion varies from plant to plant,emission levels are quite variable. ethanol, and polycyclic organic matter. Ifuncombusted, tars may solidify to form SPM emissions, and pyroacids may formaerosol emissions.

The charcoal briquetting/stacking processis also a potential source of emissions. The crushing, screening, and handlingof the dry raw charcoal may produce PM and PM-10 emissions. Briquette pressingand drying may be a source of VOC emissions, depending on the type of binderand other additives used. Continuous production of charcoal is more amenable toemission control than batch production because emission composition and flowrate are relatively constant. Emissions from continuous multiple earth charcoalkilns generally are controlled with afterburners. Cyclones, which commonly areused for product recovery, also reduce PM emissions from continuous kilns.

Afterburning is estimated to reduce emissionsof PM, CO, and VOC by at least 80 percent. Control of emissions from batch-typecharcoal kilns is difficult because the process

and, consequently, theemissions are cyclic. Throughout a cycle, both the emission composition andflow rate change. Batch kilns do not typically have emission control devices,but some may use after-burners. Particulate matter emissions from briquettingoperations can be controlled with a centrifugal collector (65 percent control)or fabric filter (99 percent control).

### 1.5.2 CHARCOAL AT AGLANCE

Charcoal is produced in slow pyrolysiscarbonisation process. The charcoal yield being dependent on such processparameters as the final temperature, the biomass particle size, the heatingrate and the reaction atmosphere (Elyounssi et al., 2012). Charcoal contain alarge number of pollutants and known health hazards: particulate matter (PM),carbon monoxide (CO), nitrogen dioxide, sulfur oxides (mainly from coal),formaldehyde, and polycyclic organic matter, including carcinogens such as benzo[a]pyreneand benzene (*5-8*). Exposure to indoor air pollution from the combustionof solid fuels has been implicated, with varying degrees of evidence, as acausal agent of several diseases in developing countries, including acute respiratoryinfection (ARI) and otitis media (middle ear infection), chronic obstructivepulmonary disease (COPD), lung cancer (for coal smoke), asthma, nasopharyngealand laryngeal cancer, tuberculosis.

In amukpe sapele, charcoal is traditionallymade in small, simple batch-type kilns where the parameter management and control is verylimited.The charcoal production feed can be a wide range of materials. Different typesof biomass feed lead to the production of different charcoal grades – basicgrade biochar, premium grade biochar and charcoal. The used biomass can bestarting from biodegradable waste from local waste collection services tohardwood (Schmidt et al., 2012). The use of biodegradable waste for productionof valuable materials and energy is highly recommendable in order to reach theEU targets for minimization of the share of landfilled biodegradable waste aswell as to avoid resource scarcity (Pubule et al., 2014). In the early 1940’s the mostsuccessful charcoal production technologies were developed- the Lambiotte and SIFIC process. This is a continuous carbonization processwhere the retort is filled continuously with wood from the top, whiledownstream simultaneously carbonisation takes place. The cooled charcoal isremoved from the bottom. The process is energy autonomous gaining the necessaryheat from burning

gases attained from pyrolysis. The gases go through a condenserand afterwards are blown in the bottom of the retort where it cools the fresh charcoalwhile preheating the gases (Vertes et al., 2010). This technology has much higherprocess control and it offers the possibility of producing charcoal moreefficiently and with higher increased yields then the traditional batchmethods. This leads to the conclusion that with an increased interest ofcharcoal production this kind of technologies have to be evaluated form theenvironmental performance aspects.

The drying of the firewood is crucialfor proper functioning of the retort torch, where the excess pyrolysis gases areburnt before emitting to the atmosphere.

The fresh wood is received with around 55%moisture content, while the technological process requires the moisture contentof the input fuel to be below 25%. Thedrying takes place in four chamber dryers heated with wood-fuelled waterboilers. The retort is operated under experimental conditions in order to carryout the relevant measurements thatdescribe the production facilities' environmental performanceregarding the emissions. The discovered results can be used to evaluate whetherthere is place for charcoal production in an economically developed country wherethe environmental performance is of high importance, and it is strictlyregulated.

## ASSESSMENT OF AMBIENT AIR WITHIN THE VICINITY OF A CHARCOAL PRODUCTION SITE IN AMUKPE SAPELE, DELTA STATE