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ENGINEERING MEASURES TO AVOID WASTE AND REDUCE EMISSION FOR THE PREVENTION OF ENVIRONMENTAL POLLUTION AND OCCUPATIONAL ACCIDENTS IN ARTISANAL REFINING IN THE NIGER DELTA REGION.

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ABSTRACT

This paper on engineering measures to avoid waste and reduce emission for the prevention of environmental pollution and occupational accidents in artisanal refining of crude oil in the Niger Delta region examines various literatures, review and gave critique to IGBEN.Vol. 25(3) 341-345 Artisanal petroleum refining and occupational dynamics in the Niger Delta Region, Nigeria. Two settlements, one far from area of artisanal refineries (controlled settlement) and the other in area of artisanal refineries (experimental settlement) were examined with analysis but engineering measures of pollution control was a gap not fulfilled. Literature findings also reveals that artisanal refineries operations are quite in close relationship to the Refineries, Petrochemicals and Chemical industries operating in the Niger Delta region but the difference is crude method of approach. And while most literatures emphasis are on policy and framework or decision making against the artisanal refineries; gaps, like capacity building is been kept aside. The act is illegal but development suggest the search for knowledge which can help to turn Pollution and accident control of modular refineries that has less financial implication to a discovery. This paper therefore suggest the engineering measures such as stacks, scrubbers, dessorbers, strippers and hydrolyzer methods used in processing organizations in managing pollution and incidents be engaged with emphasis on the need to develop the capacity of a critical mass of locals and provide low-to medium-level manpower in pollution restoration in the Niger Delta region. Preventing pollution, rather than controlling it after it has been produced, seems like such a good policy on its face that one wonders how executing it could be. Business has embraced the idea of prevention, and the Environmental Protection Agency (EPA) has adopted explicit supporting policies and conducted many pilot projects. The recently adopted National Environmental Technology Strategy is broadly supportive: by progressing from an environmental paradigm based on cleanup and control to one including assessment, anticipation, and avoidance of gas flaring, spills, emissions, particulate (smog and smoke), air, and water / land pollution .Conclusively, modular refineries should be developed by empowering the youths in the local by government via trainings through scholarships to learn more on the technology than setting fire on trucks thereby polluting the environment the more which is adding to the hazard not control. The local youths see it as only crude means to generate income for ends meet.

Keywords: Air quality, Environmental hazard, Environmental pollution, Artisanal refineries, Characterization Air pollutants, Occupational structure, Environmental degradation, Niger Delta, Smog,

INTRODUCTION:

Cities of ancient times were often noxious places, fouled by human wastes and debris. Beginning about 1000 CE, the use of coal for fuel caused considerable air pollution, and the conversion of coal to coke for iron smelting beginning in the 17th century exacerbated the problem. In Europe, from the Middle Ages well into the early modern era, unsanitary urban conditions favored the outbreak of population-decimating epidemics of disease, from plague to cholera and typhoid fever.

Through the 19th century, water and air pollution and the accumulation of solid wastes were largely problems of congested urban areas. But, with the rapid spread of industrialization and the growth of the human population to unprecedented levels, pollution became a universal problem. By the middle of the 20th century, an awareness of the need to protect air, water, and land environments from pollution had developed among the general public. In particular, the publication in 1962 of Rachel Carson's book Silent Spring focused attention on environmental damage caused by improper use of pesticides such as DDT and other persistent chemicals that accumulate in the food chain and disrupt the natural balance of ecosystems on a wide scale. In response, major pieces of environmental legislation, such as the Clean Air Act (1970) and the Clean Water Act (1972; United States), were passed in many countries to control and mitigate environmental pollution.
Stakeholders of Niger Delta in various conferences held stressed the need to tackle illegal artisanal refining through immediate multi-stakeholders engagement among operators, regulators, government security forces, and community leadership. According to them, continuous investment in stakeholders' engagement, capacity building, technology advancement and allocation of the budget are key to sustained performance on health, safety and environment in the industry.
Formulation and evaluation of slow-release fertilizer from agricultural and industrial wastes for remediation of crude oil-polluted soils has been a remedy to a last extent of food sustenance in the Niger Delta Region.

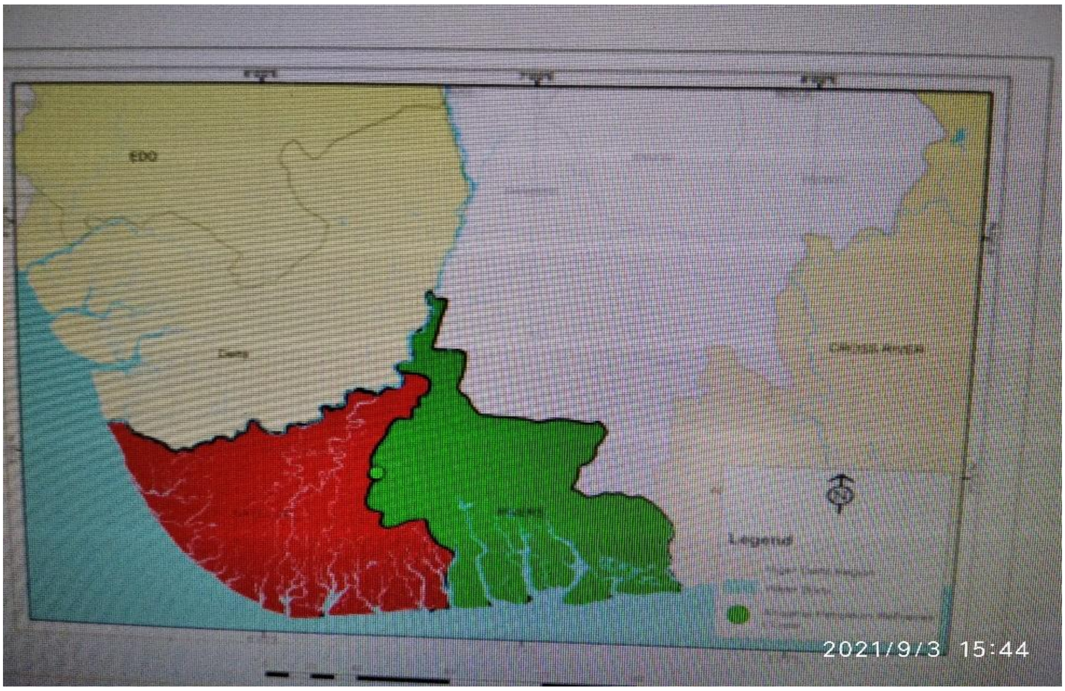


Figure 1. Niger Delta region showing Bayelsa and Rivers States.

Artisanal refining

The process of artisanal refining typically involves primitive illegal stills – often metal pipes and drums welded together – in which crude oil is boiled and the resultant fumes are collected, cooled and condensed in tanks to be used locally for lighting, energy or transport. The distilleries are heated on open fires fed by crude oil that is tipped into pits in the ground. As part of the oil burns away, some seeps into the ground. A typical artisanal refinery may comprise just one operating still and the entire refinery may be no more than 100 square metres in area. Others, however, are much bigger, containing multiple stills operating simultaneously. Stills are always located at the water's edge, primarily to facilitate the transportation of both the crude oil and refined products.

The crude is usually stored in open containers or open pits, increasing the risk of fire. Artisanal refining of crude oil has a tradition reaching back to the Biafran War, when the Biafran Government advocated the development of lowtech refineries in Biafra to make up for the loss of refining capacity during the course of the conflict. The same low-tech methods of refining continue in the Niger Delta to the present day and hundreds of artisanal refineries are to be found along the creeks. Their presence is obvious, even from a distance, marked by dark plumes of smoke rising from the fires. The practice represents a huge environmental, health and safety problem. Owing to security constraints, UNEP could only observe live refining operations from the air. Once refining operations are complete, those taking part usually leave their tools on site, presumably with the intention of returning at a later date. It was evident to the UNEP surveyors that the operation is run on a very small scale, with minimal investment. For reasons that could not be determined, the number of artisanal refineries has proliferated in Ogoniland since January 2009. Satellite images of the region taken in January 2009 and again in January 2011 show the increase in this activity .

Figure 1. (a–g): Typical Artisanal Petroleum Refinery Flow Chart from Raw Material (crude oil) Acquisition to Refined Products Delivery.

Global dependence on fossil fuels as primary energy source continues to expose the local producing communities to the risk of oil spills and attendant pollution of the environment. The Niger Delta region of Nigeria attests to the devastating effect of oil production activities. In the last decade, artisanal refining of crude oil within the creeks by untrained locals started with its own peculiar problems including pipeline vandalization and oil theft, improper disposal of residual wastes, constant destruction by government forces of storage sites and the modular apparatus leading to increase in environmental pollution. Background levels of hydrocarbon in the region are far higher than both the Department of Petroleum Resources (DPR) regulatory guide as contained in Environmental Guidelines and Standards for the Petroleum Industry in Nigeria (EGASPIN) and WHO benchmark levels in all environmental matrices as reported in the UNEP assessment of

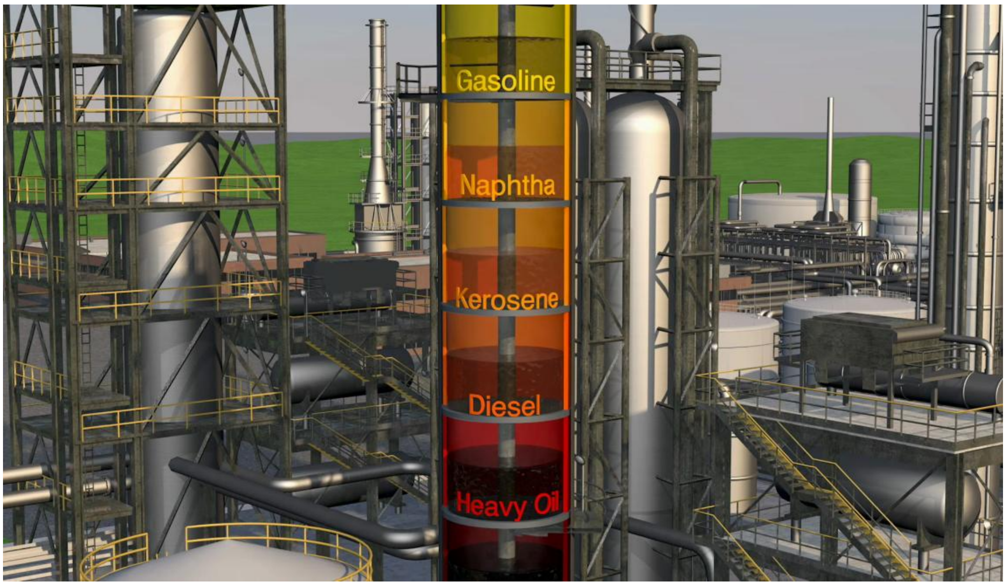
Ogoniland . Unfortunately, the UNEP assessment is in tandem with background crude oil levels observed by other researchers across the Niger Delta states . Hydrocarbon pollution is of great concern given the risk it poses to the environment and to humans especially the polycyclic aromatic hydrocarbons . A major challenge to the clean-up of these sites is the poor accessibility to contaminated sites given the intricate network of creeks, and the size of the impacted areas following a spill.


Aerial view of a typical artisanal refining site in operation (Bodo West, Bonny LGA)

Refinery Processes

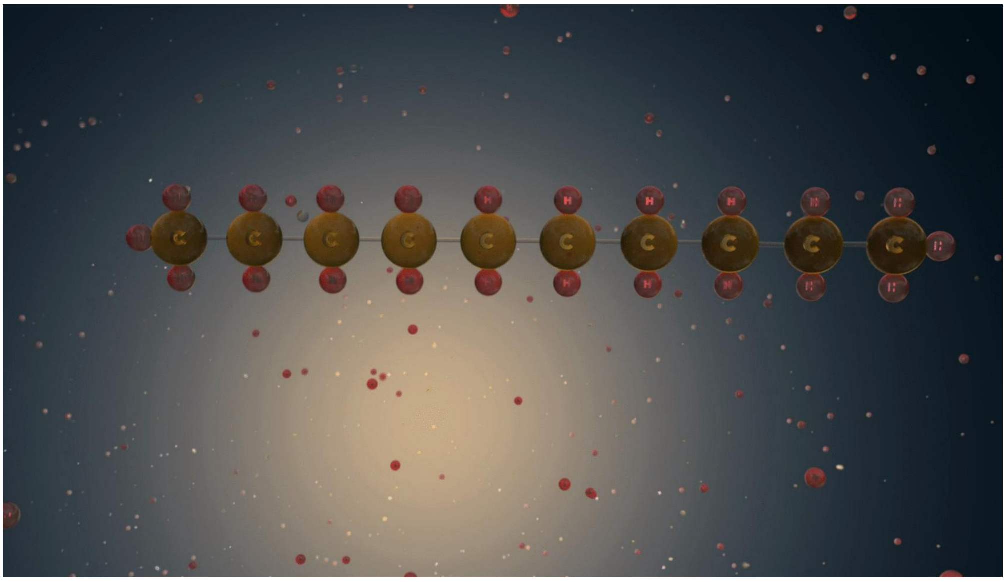
Crude oil refineries employ some of the United States' top scientists, engineers, and safety professionals to ensure that products are produced efficiently and safely. US refineries process about 17 million barrels of crude oil a day. Refinery configurations **vary**, but US refineries are undeniably some of the world's most **sophisticated**.

Distilling



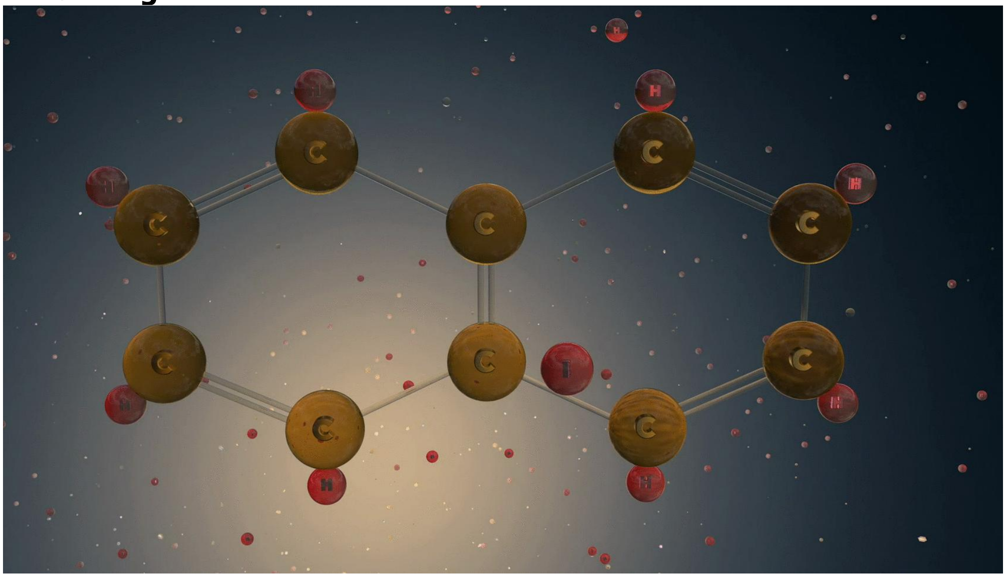
Much like a simple still, in a distilling column, liquid is heated to a vapor and lifted upward to be distilled again into separate substances. This is the beginning of the refining process. Distilling exploits the characteristic of the chemicals in crude oil to boil at different temperatures, a phenomenon that engineers chart along distillation curves. Unlike a still, a distilling column contains a set of trays that allow heated vapors to rise and collect at different levels, separating out the various liquids derived from crude oil. The top of the column is cooler than the bottom, so as liquids vaporize and rise, they condense again, collecting onto their respective trays. Butane and other light products rise to the top of the column, while straight-run gasoline, naphtha, kerosene, diesel, and heavy gas oil gather on the trays, leaving straight run residue at the base of the column. Liquids are considered "heavy" or "light" based on their specific gravity, which is determined based on its weight and density compared to that of water.

CRACKING



Because there is more demand for some distilled products like gasoline, refiners have an incentive to convert heavy liquids into lighter liquids. The term cracking comes from the process of breaking up long hydrocarbon molecules into smaller, more useful molecules. The cracking process converts heavy straight run liquids into gasoline. There are multiple versions of the cracking process, and refiners use the process extensively. Cracking is a highly controlled process, so cracking units exist separate from distillation columns. The most common type of cracking is "cat cracking," named for the use of catalysts, substances added to a chemical reaction to speed up the process.

Reforming

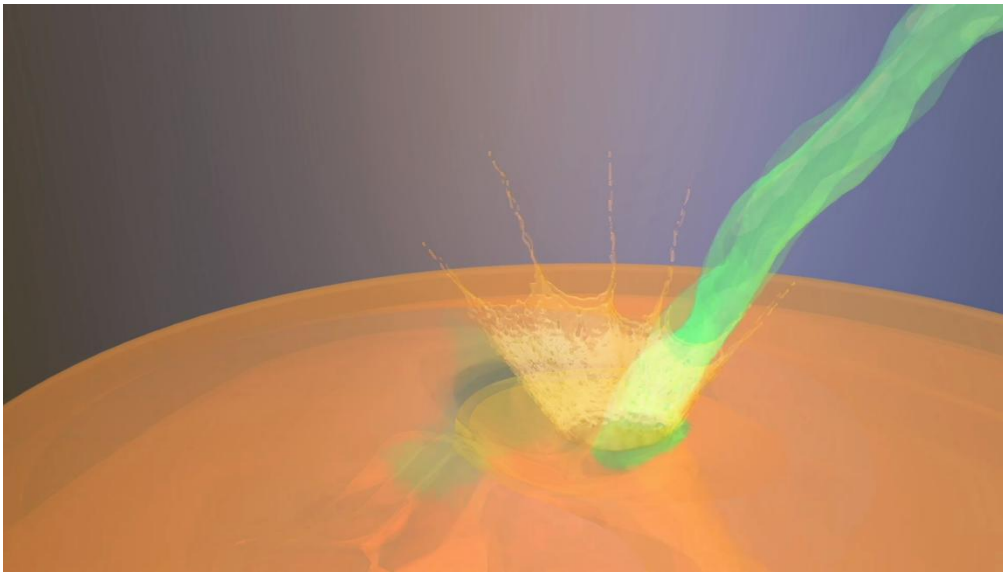


The process of reforming was developed to raise both the quality and volume of gasoline produced by refiners. Using a catalyst again, after a series of reforming processes, substances are converted into aromatics and isomers, which have much higher octane numbers than the paraffins and napthenes produced by other refinery processes. Most simply, reforming rearranges the naphtha hydrocarbons to create gasoline molecules. The reforming process produces reformate, which is needed to increase the octane for today's cleaner burning fuels. Interestingly, hydrogen is also produced by the catalytic reforming process - this hydrogen is then used in other refining processes such as hydrotreating.

TREATING

Crude oil naturally contains contaminants such as sulfur, nitrogen, and heavy metals, which are undesirable in motor fuels. The treating process, primarily hydrotreating, removes these chemicals by binding them with hydrogen, absorbing them in separate columns, or adding acids to remove them. The recovered molecules are then sold to other industries. Refineries that process sour crudes produce more sulfur than refineries that process sweet crudes. Following the treatment, blending, and cooling processes, the liquids finally look like the fuels and products you're familiar with: gasoline, lubricants, kerosene, jet fuel, diesel fuel, heating oil, and petrochemical feedstocks that are needed to create the plastics and other products you use every day.

Blending



The last major step of the refining process is blending various streams into finished petroleum products. The various grades of motor fuels are blends of different streams or "fractions" such as reformate, alkylate, catalytically cracked gasoline, etc. Refineries **blend compound**s obtained either from their internal refining process operations as noted above, or externally, to make gasoline that meets specifications for acceptable motor vehicle performance. A typical refinery may produce as many as 8 to 15 different streams of hydrocarbons that they then must mix into motor fuels. Refiners might also mix in additives like octane enhancers, metal deactivators, anti-oxidants, anti-knock agents, rust inhibitors, or detergents into their hydrocarbon streams. Blending can take place at the refinery along the pipelines and tanks that house processed fuel or even at off-site locations or on ships or terminals once the fuel has left the refinery gate.

REFINERY PROCESS

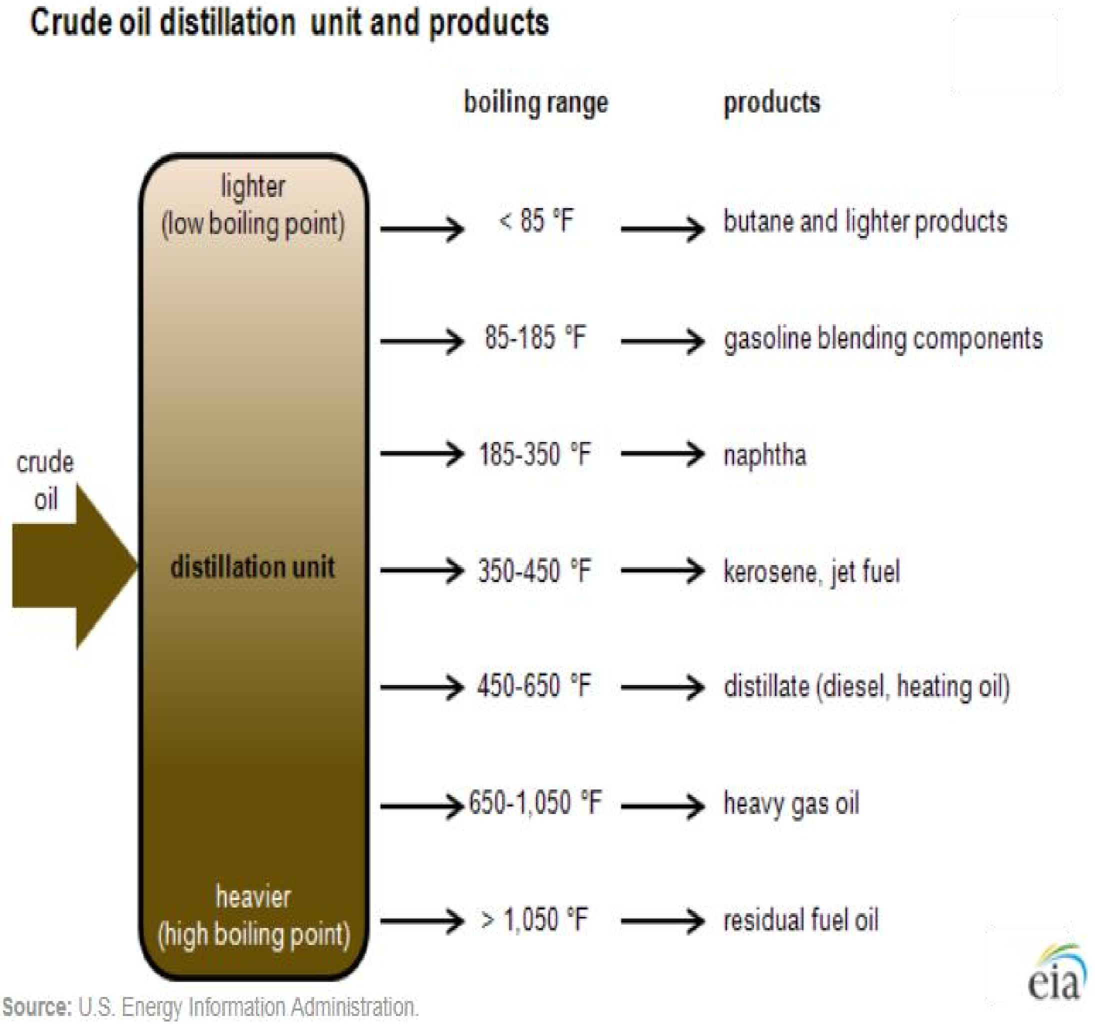
How crude oil is refined into petroleum products

Petroleum refineries change crude oil into petroleum products for use as fuels for transportation, heating, paving roads, and generating electricity and as feedstocks for making chemicals.
Refining breaks crude oil down into its various components, which are then selectively reconfigured into new products. Petroleum refineries are complex and expensive industrial facilities. All refineries have three basic steps:

- Separation
- Conversion
- Treatment

Separation

Modern separation involves piping crude oil through hot furnaces. The resulting liquids and vapors are discharged into distillation units. All refineries have atmospheric distillation units, while more complex refineries may have vacuum distillation units.



Source: U.S. Energy Information Administration.

Inside the distillation units, the liquids and vapors separate into petroleum components called fractions according to their boiling points. Heavy fractions are on the bottom and light fractions are on the top.

The lightest fractions, including gasoline and liquefied refinery gases, vaporize and rise to the top of the distillation tower, where they condense back to liquids.

Medium weight liquids, including kerosene and distillates, stay in the middle of the distillation tower.

Heavier liquids, called gas oils, separate lower down in the distillation tower, while the heaviest fractions with the highest boiling points settle at the bottom of the tower.

Conversion

After distillation, heavy, lower-value distillation fractions can be processed further into lighter, higher-value products such as gasoline. This is where fractions from the distillation units are transformed into streams (intermediate components) that eventually become finished products.

The most widely used conversion method is called **cracking** because it uses heat, pressure, catalysts, and sometimes hydrogen to crack heavy hydrocarbon molecules into lighter ones. A cracking unit consists of one or more tall, thick-walled, rocket-shaped reactors and a network of furnaces, heat exchangers, and other vessels. Complex refineries may have one or more types of crackers, including fluid catalytic cracking units and hydrocracking/hydrocracker units.

Cracking is not the only form of crude oil conversion. Other refinery processes rearrange molecules to add value rather than splitting molecules.

Fluid catalytic cracking distillation unit
Source: Chevron (copyrighted)

Refining workers overlooking a refinery
Source: Chevron (copyrighted)

Alkylation, for example, makes gasoline components by combining some of the gaseous byproducts of cracking. The process, which essentially is cracking in reverse, takes place in a series of large, horizontal vessels and tall, skinny towers.

Reforming uses heat, moderate pressure, and catalysts to turn naphtha, a light, relatively low-value fraction, into high-octane gasoline components.

Treatment
The finishing touches occur during the final treatment. To make gasoline, refinery technicians carefully combine a variety of streams from the processing units. Octane level, vapor pressure ratings, and other special considerations determine the gasoline blend.

Storage
Both incoming crude oil and the outgoing final products are stored temporarily in large tanks on a tank farm near the refinery. Pipelines, trains, and trucks carry the final products from the storage tanks to other locations across the country.

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While the footprint of individual artisanal refining operations is localized, the cumulative impact exerts a significant environmental stress on Niger Delta. The main problems are:

Clearance of coastal vegetation when setting up an illegal artisanal refinery, leaving land Vulnerable to erosion

Contamination of soil and groundwater in the immediate vicinity

Damage to surrounding vegetation from fire While the footprint of individual artisanal refining operations is localized, the cumulative impact exerts a significant environmental stress and spread of pollution beyond the refinery area With any crude left behind after the refining process can be picked up by higher tides and transported over a wider area

Contamination of water in the creeks and coastal and mangrove vegetation, as well as soil exposed to layers of oil at low tide

Air pollution – those involved in the artisanal refining process are at high risk of exposure to extreme levels of hydrocarbons, which can have both acute and chronic impacts, while the smoke blowing from the area can adversely
Affect entire communities although the impacts of each illegal refinery are quite much.

These **Artisanal Refining processes and Petroleum refinery/Chemical processes** examined through production processes are quite relative except one is much localized while the other is mechanized. They pollute, contaminate and endanger the environment of Niger Delta, while one has Engineering control, Remediation, Monitoring/ Treatment and the former has engineering gaseous emission control.

In-built engineering control for processing of waste management during production

- Desorber
- Hydrolyser
- Scrubber
- Solution sump
- Neutralization basin
- Curbed perimeter of product synthesis(containment)

These are all controlled by trained and certified Operators.

Artisanal Refinering Engineering gaseous emission control for air pollutants are Characterized and quantified based on various unit operations involved in evaluating their impacts and examine engineering controls by measuring emission directly from source using E8500 portable combustion Analyzer. It also categorized oven sizes / processing capacity of the refineries into various ranges in order to estimate emission according to processing capacity. Result reveals that, pollutants emissions varied significantly between the unit operations and increased with increase in processing capacity.

The presence of environmental pollution raises the issue of pollution control. Great efforts are made to limit the release of harmful substances into the environment through air pollution control, wastewater treatment, solid-waste management, hazardous-waste management, and recycling. Unfortunately, attempts at pollution control are often surpassed by the scale of the problem, especially in less-developed countries. Noxious levels of air pollution are common in many large cities, where particulates and gases from transportation, heating, and manufacturing accumulate and linger. The problem of plastic pollution on land and in the oceans has only grown as the use of single-use plastics has burgeoned worldwide. In addition, greenhouse gas emissions, such as methane and carbon dioxide, continue to drive global warming and pose a great threat to biodiversity and public health

Petroleum refining is a technology that **uses fossil fuels as raw materials and chemical catalysts** as a means to achieve conversion of petroleum through once, twice, and deep processing to get a series of chemical products, which are further used as the basic raw materials for synthetic fibers, synthetic rubber, ...

Petroleum refining, transportation, and storage are the main sources of soil contamination. Mechanical and chemical techniques, such as storage, landfill, relocation, and incineration, are the commonly applied remediation methods. But they are expensive, complicated, and not adequate for complete removal of such oil contaminants. Moreover, the chemical technique would cause a second pollution to the environment, throughout the unexpected release of some artificial toxic materials. To confront and resolve this enormous problem, remediation must be simple and cost-effective for both industrialized nations and underdeveloped countries. Therefore, bioremediation is considered as a viable alternative for this purpose.

Microbial agents of bioremediation

Microbial remediation is the conversion of organic pollutants, in this case crude oil hydrocarbon into less or nontoxic products like carbon dioxide and water through the metabolic activities of microorganisms especially bacteria, fungi and algae. Microbial remediation is an effective, carbon-neutral and environmental friendly approach for the removal of hydrocarbons from the environment. Laboratory scale remediation projects mainly on pure individual components of crude oil are widely reported. However, in practice crude oil does not exist as pure compounds; more so, different microorganisms are reported for degradation of different components, as such microbial degradation of hydrocarbon require chain of enzymes and a variety of microorganisms for complete removal. Identification of hydrocarbon degraders therefore becomes necessary, as it is foundational to the determination of their roles and eventual application during remediation projects. Also, biomolecules derived from hydrocarbon degrading bacteria can improve biodegradation, through the enhancement.

Total petroleum hydrocarbons (TPHs) and polycyclic aromatic hydrocarbons (PAHs) determination

Biosurfactant production screening

Biosurfactant production was determined using both the Tilted glass technique, a modification of the drop collapse method of Satpute et al., and the emulsification index (E24%) methods. For the tilted glass method, isolates were grown for 24 h on nutrient agar plates. A sample colony picked and mixed with a droplet of 0.85% NaCl at one end of the glass slide. The slide was tilted and droplet observed. Biosurfactant producers were detected by the observation of droplet collapsing. The emulsification index method described formerly, involves the detection of emulsification activity by adding 2 ml of crude oil + 2 ml cell free supernatant. The resultant mixture is homogenized in a vortex for 2 min at high speed and allowed to stand for 24 h to ensure emulsification stability. Height of the emulsified layer is measured and the height of the total liquid noted.[Math Processing Error]E24%=totalheightofemulsifiedlayertotalheightofliquidlayer×100

RESULTS

Physicochemical analyses of the polluted site

Equally essential to bioremediation of crude oil is the ability of microorganisms to produce surface active agents. The screen for biosurfactants/bioemulsifiers production from the indigenous bacteria was positive. Pseudomonas aeruginosa, Klebsiella pneumoniae, Bacillus cereus and Enterobacter cloacea produced biosurfactants. These biosurfactant producing bacteria are pivotal to the bioavailability of the hydrocarbon. Availability of a pollutant to the microorganisms is critical to the pollutant removal as only bioavailable portions can be acted upon by the microorganisms. The biosurfactant breaks the hydrocarbon into tiny mycelles exposing greater surface area for bacteria degradation and making most PAHs more water soluble. It could be harvested and used alone to facilitate bioremediation. Biosurfactant are favored over chemical surfactants which cause secondary pollution and have been reported to be toxic to native microbial species in certain concentration.

Conclusion

This study determined for certain that Bie-Ama polluted site has the requisite bioresource in terms of bacterial strains for hydrocarbon clean-up. However, it will be requiring increase in the amount of nitrogen and phosphorus which were determined in this study to be limiting nutrients to facilitate optimal performance of the microorganisms. This will further enhance bioremediation using indigenous microflora and eventual clean-up activity.

POLLUTION:

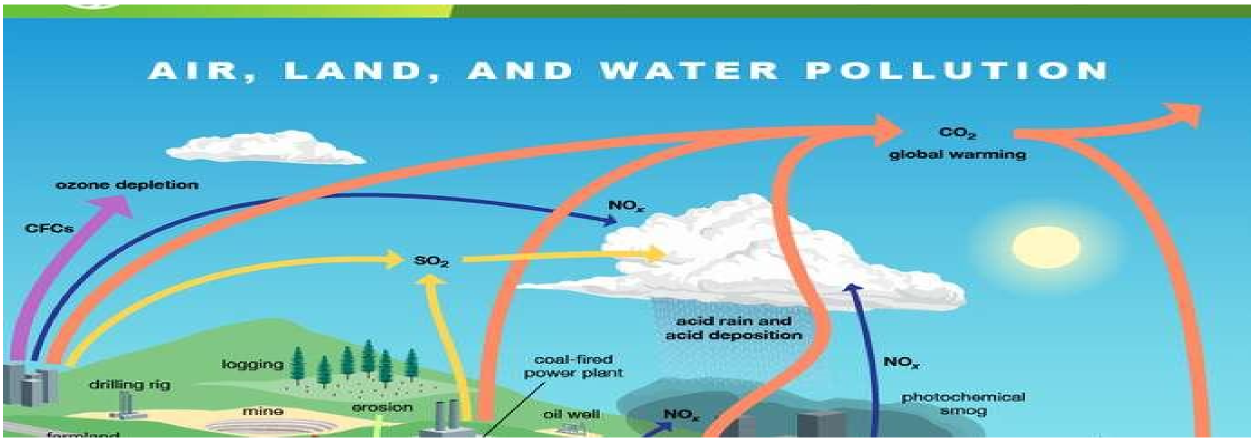
Pollution, also called environmental pollution, the addition of any substance (solid, liquid, or gas) or any form of energy (such as heat, sound, or radioactivity) to the environment at a rate faster than it can be dispersed, diluted, decomposed, recycled, or stored in some harmless form. Major kinds of pollution usually classified by environment, are air pollution, water pollution, and land pollution. Modern society is also concerned about specific types of pollutants, such as noise pollution, light pollution, and plastic pollution. Pollution of all kinds can have negative effects on the environment and wildlife and often impacts human health and well-being. Although environmental pollution can be caused by natural events such as forest fires and active volcanoes,

use of the word pollution generally implies that the contaminants have an anthropogenic source—that is, a source created by human activities. Pollution has accompanied human kind ever since groups of people first congregated and remained for a long time in any one place. Indeed, ancient human settlements are frequently recognized by their wastes—shell mounds and rubble heaps, for instance. Pollution was not a serious problem as long as there was enough space available for each individual or group. However, with the establishment of permanent settlements by great numbers of people, pollution became a problem, and it has remained one ever since. Also, Industrial development among these areas of settlement geographically led to activities inimical to the citizenries like Niger Delta whose occupational dynamics of the populace is artisanal refining of crude oil using structured artisan refineries both controlled and experimental.
The increase in price of the available refined petroleum products for local consumption in Nigeria had led to the emergence of indigenous technology for petroleum refining in some parts of Nigeria, the Niger Delta region. Niger Delta located in the south of the nation and on the delta of "River Niger" comprises of nine oil-bearing states namely Abia, Akwa-Ibom, Bayelsa, Cross River, Delta, Edo, Imo, Ondo, and Rivers, whose lands and waters provide all of Nigeria's crude oil supply. Coastal Barrier islands, fresh water swamp forests, lowland rain forests, and mangrove forests comprise its main ecological zones which are considered as one of the most heavily populated regions in Africa. The Niger Delta occupies 70,000 square kilometers of southern Nigeria, and constitutes the flood plain through which rivers Benue and Niger discharge into the Atlantic Ocean. Essentially, a network of creeks connecting rivers, rivulets, and streams, including rivers Benin, Bonny, Brass, Cross, and Nun , it serves as a repository of national resource of significance. Geographical location and topography of the area is such that air borne pollutants travel fast and the farthest, as high lands are practically absent. Studies suggest that periodic plumes of pollutants from industrial discharges, a principal source of air pollution, constitutes a frequent occurrence in the area. Furthermore, occurrence of land breeze, as well as Harmattan, facilitates emission transfer into the cities.

Smog and air pollution
For years London was synonymous with smog, the word coined at the turn of the 20th century to describe the city's characteristic blend of fog and smoke. The capital's "pea-soupers" were caused by suspended pollution of smoke and sulfur dioxide from coal fires. The most severely affected area was the 19th-century residential and industrial belt of inner London—particularly the East End, which had the highest density of factory smokestacks and domestic chimney pots and the lowest-lying land, inhibiting dispersal. As recently as the early 1960s, the smokier districts of east Inner London experienced a 30 percent reduction in winter sunshine hours. That problem was alleviated by parliamentary legislation (the Clean Air Acts of 1956 and 1968) outlawing the burning of coal, combined with the clearance of older housing and the loss of manufacturing.
The less visible but equally toxic pollutants of carbon monoxide, nitrogen dioxide, ozone, benzenes, and aldehydes continue to spoil London's air. Traffic fumes and other exhausts are liable to become trapped between the surrounding hills and below a stagnant capping mass of warm urban air at an altitude of about 3,000 feet (900 metres), causing immediate increases in eye irritation, asthma, and bronchial complaints. But London's weather is too fickle for the development of a full-scale photochemical smog of the kind that can build up under the more stable weather conditions of cities such as Los Angeles.

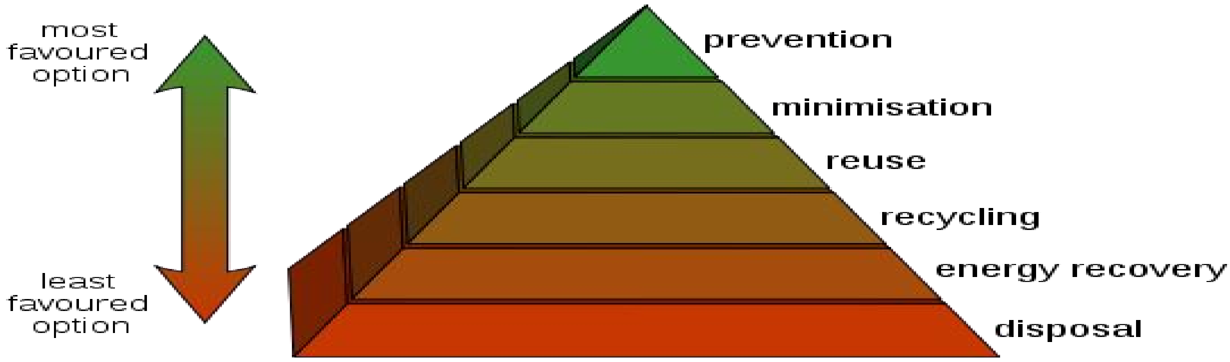
Smog, community-wide polluted air. Its composition is variable. The term is derived from the words smoke and fog, but it is commonly used to describe the pall of automotive or industrial origin that lies over many cities. The term was probably first used in 1905 by H.A. Des Voeux to describe atmospheric conditions over many British towns. It was popularized in 1911 by Des Voeux's report to the Manchester Conference of the Smoke Abatement League of Great Britain on the more than 1,000 "smoke-fog" deaths that occurred in Glasgow and Edinburgh during the autumn of 1909. At least two distinct types of smog are recognized: sulfurous smog and photochemical smog. Sulfurous smog, which is also called “London smog,” results from a high concentration of sulfur oxides in the air and is caused by the use of sulfur-bearing fossil fuels, particularly coal. This type of smog is aggravated by dampness and a high concentration of suspended particulate matter in the air

This paper therefore characterized and quantified artisanal refineries’ gaseous emissions for possible air pollutants based on various unit operations involved evaluated their impacts and examine Engineering control as seen. It measured the emissions directly from source using E8500 Portable Combustion Analyzer. It also categorized oven sizes/processing capacity of the refineries into various ranges in order to estimate emissions according to processing capacity. The result revealed that; pollutants emission varied significantly between the unit operations and increased with increase in processing capacity. When the emissions were compared with daily limits set by the Environmental Guidelines and Standard for Petroleum Industry in Nigeria (EGASPIN) 2002, the emissions (CO, NOx, and SO2) breached the available set limits. While with the Federal Environmental Protection Agency (FEPA), 1991 set limits for emissions from stationary source; HC and CO breached their limits. SO2 and H2S breached their lower limits but were below the upper limit, while NOx emissions were found within its set limit.



The major kinds of pollution, usually classified by environment, are air pollution, water pollution, and land pollution. Modern society is also concerned about specific types of pollutants, such as noise pollution, thermal pollution, light pollution, and plastic pollution.
Encyclopædia Britannica, Inc./Patrick O'Neill Riley

Avoid Waste and Reduce Emission



Environmental Management Processes

Process 1	Env /P/01	Environmental Monitoring & Remediation
Process 2	Env /P/02	Final Liquid Effluent Treatment & Discharge
Process 3	Env/P/03	Solid/Hazardous Waste Management

Key Steps in Managing the Process

- Identification of Aspects
- Identification of parameter to analyze
- Identification of sources
- Identification of sample location
- Application of regulatory standards in the analysis

Classes of Environmental Monitoring

The classes of environmental monitoring are:

Effluent monitoring

- pH
- Temp
- TDS (Total Dissolve solute)
- NH_3 (aq)
- NH_4
- Urea
- TSS (Total suspended Solute)
- Turbidity
- Cations
- Anions
- COD (Chemical Oxygen Demand)

The classes of Environmental monitoring are:

Ambient Air Monitoring

- Ammonia in air
- Dust particulates in air
- Ambient temperature

- Relative Humidity
- Acid Gas(SO_x,NO_x,CO_2,H_2S) monitoring
- Green House Gas monitoring
- Radiation monitoring

Other classes of environmental monitoring are:

- Sewage monitoring
- Potable Water Monitoring
- Surface Water Monitoring
- Underground Water Monitoring
- Solid and Hazardous Waste Monitoring

Noise monitoring

Battery limit area

Sampling

Underground Water Sampling

Pollution Abatement Structures

In-built engineering control for process waste management :

- Desorber
- Hydrolyser
- Scrubber
- Urea solution sump
- Neutralization basin
- Curbed perimeter of urea synthesis(containment)

These are all controlled by trained and certified Operators

DESORBER
and **HYDROLIZER**

SCRUBBER

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Neutralization Basin

STACKS

Secondary Waste Effluent Treatment System

- Neutralizer points
- Outfall
- Sewage treatment Plant
- Oily water separator

Sewage Treatment Plant

Oily Water Separator

Sludge Containment Pond 1

Discharge Equalization Basin

Sluicegate 1 & Neutralization Point

Sluicegate 2 & Neutralization Point

Outfall

Solid and Hazardous Waste Management System

Guided by 'waste to wealth' & 'cradle to grave' philosophies

- Waste characterization and segregation
- Waste bin colour code
- Demarcated dumpsites

REFERENCESS

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