



## ENVIRONMENTAL POLLUTION AND MITIGATION-AN OVERVIEW

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### ABSTRACT

The environment is man's immediate surrounding which he manipulates for his living. These include the air, water, land, natural resources, flora and fauna, and human beings. The wrong use of these elements introduces hazards that make the environment unsafe for living things especially man. The consciousness of the environmental challenges of our time is a vital tool for engineers and scientist to take the charge on how to manipulate the environment to protect, preserve and improve our natural resources by promoting green technologies for sustainability and innovations in materials. In recent years, much emphasis has been on environmental issues, especially in the developed countries. However, many developing countries seem to be unconcerned about the impact of environmental pollution and the importance of appropriate control measures. Therefore, this paper elaborates on environmental pollution; types, effect, design for the environment and waste management as pollution mitigation approaches for clean environment. The awareness of pollution hazard and adequate knowledge of mitigation strategies is a sure way to guarantee a tremendous improvement in our global environment.

**Keywords:** pollution, environment, waste, effect, design.

### 1. INTRODUCTION

Environmental pollution simply means the contamination or undesirable alteration of the physical, chemical and biological quality of environment. It is the release of potentially harmful substances into the environment due to man's activities. Today, the negative impact of man's activities on our environment globally cannot be over emphasized. This is because the explorations, innovations and modern technology which have to do with use of materials are now threatening the earth as a planet and hence demands urgent attention [1]. Interference with the natural components of the environment as a result of man's activities alters the ecology and imbalance is imposed in the ecosystem. Concern for the environment has been a global issue for many decades now, as early as the 13<sup>th</sup> century in the UK when reacting to the burning of coal in London because it was considered hazardous to the environment. In 1273; the King banned the burning of coal in London. The innovations and economic growth has posed a great challenge to changes in our environments especially industrialized nations [2]. However, many developed nations have intensified their efforts and strategies to minimize pollution activities and some developing countries have in recent years seen the importance of such efforts and campaign by ensuring proper waste management, Life Cycle Assessment programs and various laws on waste disposals have been imposed by many nations. But since pollution is as a result of input and output, handling the aspect of usage and disposal alone cannot effectively control the influx of these potential hazards, therefore design for the environment and waste management approach seems to be promising and economical.

Hence the awakening challenge to scientist and engineers to be equipped with the knowledge of human activities that alters the natural environment and how they

can be managed to ensure eco-friendly initiatives is very imperative.

### 2. TYPES OF POLLUTION AND THEIR EFFECTS

Environmental pollution simply implies making the environment unfit for living things especially man, plants and animals. Once the pollutants get to the atmosphere, they could directly be harmful (primary pollutants) such as soot and carbon monoxide, or form potential hazards due to their reaction with chemicals in the atmosphere (secondary pollutants). Pollution can be classified as (1) Air pollution (2) Land pollution (3) Water pollution.

#### 2.1. Air pollution

These are as a result of pollutants commonly introduced into the air such as;

- a) Smoke from automobile exhaust and burning
- b) Particulate dust e.g. asbestos, wood industries, construction industries etc
- c) Gaseous emission from industrial wastes
- d) Noise e.g. factories

#### 2.1.1. Effect of air pollution

Air pollution has serious and severe effects on human health [3, 4] and environmental degradation. It is a serious problem encounter mostly in industrial zones and populated urban areas worldwide. Some of such effects can be seen in the following areas; health problems (respiratory problems), depletion of the ozone layers, greenhouse effect, acid rain and photochemical smog.

#### a) Ozone (O<sub>3</sub>) layer depletion

A squeaky layer of ozone gas, a form of oxygen surrounds the earth, about 24.5km from the earth surface protects the earth from potentially harmful ultraviolet



radiation from the sun, studies has revealed that this ozone layer is been destroyed as a result of gases discharge into the atmosphere. Examples of such gases are; Chlorofluorocarbons from refrigeration, aerosol spray, carbon tetrachloride, Halons from fire extinguishers 00, 1, 1, 1- trichloroethane from degreasing agents. Research has shown that an enormous depletion of the ozone layer was experienced in the Arctic region (Europe and Asiatic Russia) in 2011 as shown in Figure-1. This depletion which is often referred to as hole resulted when the total

ozone column (TOC) is less than 220 Dobson units and 1Dobson unit is equivalent to 0.01mm ozone thickness at s.t.p [5]. Similar depletion was observed few years back in the Antarctic region [6, 7] and this phenomenon is observable globally in recent time. An in surface UV radiation result to eye damage and skin cancer, retards crop growth, human death [8] as well as damaging the wider environment. For this reason some of the chemicals are prohibited today and various research work are going on to incorporate eco-friendly chemicals.

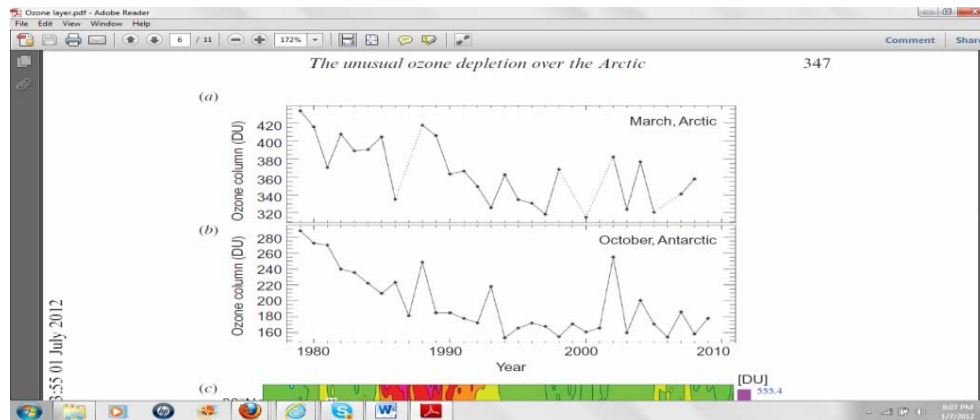


Figure-1. Time series of minimum total ozone (Dobson units) in the polar region [5].

#### b) Greenhouse effect (Global warming)

Normally, gases released in the course of naturally occurring events, such as volcanic eruptions, forest fires, decaying vegetation and living beings are absorbed by plants and trees [9]. However, the large amount of gases released into the atmosphere by man's activities are more than what the plants can absorb as a result, the unabsorbed gases create an envelope round the earth. This envelope acts as an insulator preventing the infrared

rays reflecting from the earth surface, this causes the global temperature to rise. The process is known as the greenhouse effect because of its similarity to the effect of glass in a greenhouse which allows the sun's energy to enter but prevents some of the radiated heat from escaping. The effect of this global warming has led to more generation of gases and noise to the environment as man developed mechanical devices for cooling and was predicted that by 2030 one in every four homes in the UK will be cooled mechanically [10] this involves energy consumption. Besides the aforementioned effects, it could result in death especially for adults' women of ages 65 and above [11], glacier shrinkage and sea level rise. Examples of greenhouse gases are; Carbon (fossil fuels, deforestation, road vehicles, forest fires), Methane (Agriculture, and natural decay of vegetation), Nitrous Oxide (fossil fuels, road vehicles), Chlorofluorocarbons (refrigerants, aerosol spray).

#### c) Acid rain

Acid rain is a serious environmental pollution problem especially in industrial zones [12]. Acid rain is rain that absorbs gases such as sulphur, lead and nitrogen compounds in the atmosphere as a result of burning and industrial activities. The acidified rain leads to soil acidity which retards crop growth, wastage of forest and damage to the fabrics of buildings. Acid water can cause leaching of aluminium which destroys aquatic life.

#### d) Photochemical smog

This occurs when strong sunlight acts upon a mixture of nitrogen oxides released from vehicle emissions which combine with oxygen in the air to form ozone, when this combines with hydrocarbon from vehicles, a number of complex substances are formed which condense as minute droplets and create the characteristic haze as shown in Figure-2.

Health effects can include irritation of the eyes and respiratory problems.

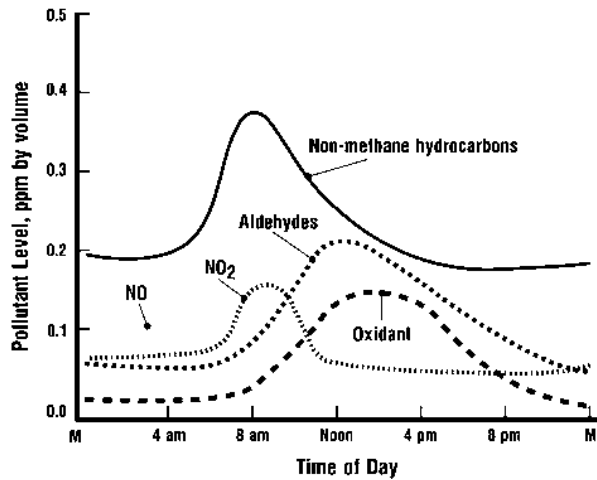


Figure-2. Daily chemical changes in the formation of photochemical smog [13].

## 2.2. Land pollution

Land is contaminated by chemicals allowed to drain into the ground, or waste disposed of by indiscriminate burying. Other sources of contamination are acid rain, agrochemicals, refuse, dung and oil spillage.

### 2.2.1. Effects of land pollution

Effects of land pollution can be seen in the following perspectives.

It introduces health hazards, stunted growth in vegetation, reduced land use, public nuisance etc.

## 2.3. Water pollution

Hazardous pollutants from commercial and industrial sources commonly pollute water e.g. sewage and discharge from sewage treatment work, oil spillage and industrial wastes. Bisphenol A (BPA) is one of the common toxic chemicals released frequently into the water bodies from municipal waste water treatment plants [14, 15]. However, in recent time marine oil spills pose a great and severe treat to our coastal environment as shown in Figure-3. The contaminants (oil) are often discharged into the water bodies as a result of accidental discharge. For example, demolition of oil storage tanks and sometime from oil rig drilling, war, natural occurrence and vandalized pipelines [16].



Figure-3. Oil spill activities [17].

### 2.3.1. Effect of water pollution

Water pollution has detrimental effects such as;

- Contamination of surface/underground wastes
- Destruction of aquatic life
- Silting of water bodies
- Interference with the riparian environment

## 3. DESIGN FOR THE ENVIRONMENT

With the growth of environment consciousness, questions about the environmental impacts of manufactured products are increasingly being asked, the creation and use of an engineering product carries with it an environmental burden (cost). Much effort have been geared towards controlling the environmental impact of manufacturing output, this can mainly be actualised by proper orientation and design for the environment. Materials contribute to the environment in their; production, usage and disposal as shown in Figure-4.

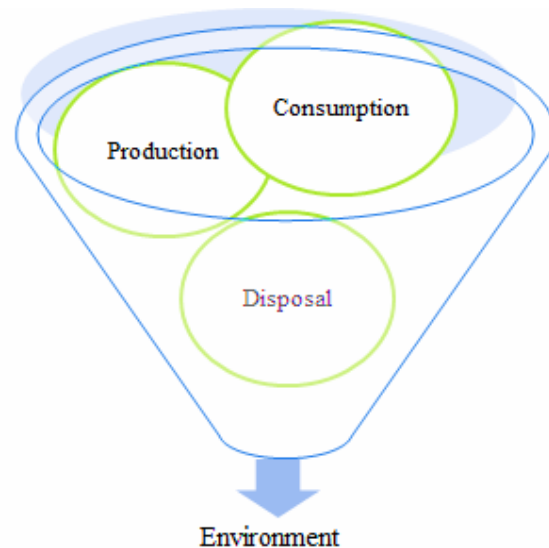


Figure-4. Three ways materials contribute to the environment.

### 3.1. Elements of design for the environment

Three basic elements of design can be identified as stated in section 3.1.1.

#### 3.1.1. Design for environmental manufacturing

Design plays a major role during product manufacturing. The following processes reduce pollution largely if they are taken into consideration by the manufacturing and production sectors.

- Non-toxic processes and production materials
- Reduced energy utilization
- Reduced emissions
- Reduced waste, scrap and by-products



### 3.1.2. Design for environmental packaging

The greatest land pollution world-wide is caused by mainly packaging materials. The following design approach will minimize such occurrence.

- Minimization of packaging materials
- Eco-friendly pallets and packaging
- Recyclable packaging materials
- Biodegradable packaging materials

### 3.1.3. Design for disposal and recyclability

- Re-use of components and assemblies
- Materials selection to enable re-use
- Avoids filler materials in plastics (fibre glass and graphite)
- Reducing number of materials/ colours to facilitate separation of materials and re-use
- Materials identification to facilitate re-use
- Design to enable materials to be easily separated
- Design for disassembly (fastening vs. bonding)

## 4. WASTE MANAGEMENT

Waste can be defined in a technical point of view as any unavoidable material that results from an activity or industrial process, but has no immediate economic value or demand and must be disposed of. Waste varies and their exposure to the environment is dependent on their handling. A thorough approach to waste management is believed to have positive effects on various sectors of the economy. According to the Environmental Protection Agency (EPA), the United States of America produced around 243 million tons of municipal solid waste in 2009 of which 82 million were recycled, 29 million incinerated to produce electricity through waste-to-energy process [18, 19, 20].

### 4.1. Form of waste

Waste can be classified into three basic categories as given in (a-c). However, they can be converted from one state to another depending on whether they are properly managed or not.

- Gaseous waste e.g. gas flaring, waste gases from stack, acid fumes etc.
- Liquid waste e.g. industrial effluent, acid waste, waste oil from workshop etc.
- Solid waste e.g. broken bricks, refuse, cans, plastic, broken glasses and bottles etc.

#### 4.1.1. Waste classification

In general, there are three classes of waste according to their sources. These can be viewed as;

- Domestic or municipal wastes
- Industrial wastes
- Hazardous wastes

### 4.2. Principles of waste management

- Waste inventurisation - Cataloguing of all waste types, quantities and sources
  - Waste characterisation- Checking the physio-chemical and toxicological properties
  - Waste segregation- Selective separation of waste
- Minimisation - This involves the 4Rs: Reduce, Re-use, Recycle and Recovery



Figure-5. Waste management principles.

### 4.3. Waste disposal options

The role of waste disposal techniques cannot be overemphasized. However, some countries are still negligent of these essentials. Some of the sure ways of proper and conventional waste disposal methods are:

- Ocean dumping
- Re-injection
- Bio-treatment
- Thermal treatment-incineration
- Encapsulation (compress into solid)
- Land fill - biodegradable are buried in land fill, hazardous waste like nuclear reactors are buried deep down the earth at about 9500m below the surface. Land fill technique is simple and less expensive, thus the most widely used methods of waste disposal [21].

## 5. CONCLUSIONS

The interference with the natural components of the environment as a result of man's activities alter the ecology and thus imposes imbalance in the ecosystem which tends to pose great challenges in our modern societies. However, the knowledge of these challenges of our time as regards the environment is a vital asset for the engineers and scientists to take the responsibility on how to influence the environment through innovations in designs and waste management to promote green technologies for sustainability. This can effectively be



accomplished by adherence to appropriate design for the environment during production, processing, and disposal through eco-friendly waste management principles and techniques and proper compliance to Environmental Protection Agencies (EPA) code of conduct and regulations.

## REFERENCES

- [1] T. Gulumser, C. Akca and M.I. Bahtiyari. 2009. Investigation of the effects of Ozone on whiteness degree in wool finishing. *Journal of Environment*. 19: 52-55.
- [2] B. Harris-Roxas and Harris. 2011. *Environmental Impact Assessment Review*. 31: 393-395.
- [3] I. Komar, B. Lalic and D. Dobrota. 2010. Air pollution Prevention from Crude Oil Tankers with Volatile Organic Compound Emission Nase More. 57: 138-145.
- [4] K. Marilena and C. Elias. 2008. Human Health Effects of Air Pollution. *Journal of Environmental Pollution*. 151: 362-367.
- [5] A.V. Costa, P.C. Arthur and T. Chris. 2012. The Exceptional Ozone Depletion over the Arctic in January-March 2011. *Remote Sensing Letters*. 3(4): 343-352.
- [6] S. Chubachi. 1985. Dung A Special Ozone Observation at Syowa Station, Antactic, from February 1982 to January 1983. *Proceedings of the Quadrennial Ozone Symposium*. 3-4: 285-289.
- [7] J.C. Farman, G. Gardiner and J.D. Shanklin. 1985. Large Losses of Total Ozone in Antarctica Reveal Seasonal ClOx/NOx Interaction, *Nature*. 315: 207-210.
- [8] H.J. Weigel, J. Bender. 2012. Ground-Level Ozone-A Risk for Crops and Food Security? *Gesunde Pflanzen*. 64(2): 79-87.
- [9] Bradley Rowe. 2011. Green Roofs as a Means of Pollution Abatement. 159(8-9): 2100-2110.
- [10] G. Rajat and G. Mathew. 2012. Using UK Climate Change Projections to Adapt Existing English Homes for a Warming Climate. *Journal of Building and Environment*. 55: 20-42.
- [11] S. Hajats, R.S. Kovats and K. Lachowyczk. 2007. Heat Related and Cold Related Deaths in England and Wales: Who is at Risk? *Occupational Environment Med*. 64: 93-100.
- [12] D. Yan-Jun, J. Ning-Jun and S. Shui-Long. 2012. Experimental Investigation of Influence of Acid Rain on Leaching and Hydraulic Characteristics of Cement-Based Solidified/Stabilized Lead Contaminated Clay. *Journal of hazardous materials*. 225-226: 195-201.
- [13] 2012. <http://mtweb.mtsu.edu/nchong/Smog-Atm1.htm> July 20.
- [14] D.A Crain, M. Eriksen, T. Iguchi, S. Jobling, H. Laufer, G.A. LeBlanc and L.J. Guillette. 2007. An Ecological Assessment of Bisphenol-A: Evidence of Comparative Bilogy, *Reprod. Toxicol*. 24: 225-239.
- [15] J. Oehlmann, U. Schulte-Oehlmann, W. Kloas, O. Jagnytsch, I. Lutz, K.O. Kusk, L. Wollenberger, E.M. Santos, G.C. Paull, K.J. Van Look and C.R. Tyler. 2009. A Critical Analysis of the Biological Impacts of Plasticizers on Wildlife. *Phil. Trans. R. Soc. B364*, 2047-2062.
- [16] A. Bayat, S. Aghamiri, A. Moheb and G. Reza. 2005. Oil spill clean up from seawater by sorbent materials. *Chemical Engineering and Technology*. 28(12): 1525-1528.
- [17] A. Aziz, A. Adebayo and M. Hossain. 2012. A sustainable approach to controlling oil spills-A review. *Journal of environmental management*. 113: 213-227.
- [18] N. Bernd and D.B. Thomas. 2007. Occurrence, Behaviour and Effects of Nano particles in the Environment. *Environmental Pollution*. 150: 5-22 Review.
- [19] Alessandra Poletini. 2012. Waste and Climate Change: Can Appropriate Management Strategies Contribute to Mitigation? *Waste Management*. 32: 1501-1502.
- [20] <http://epa.gov>. 2011. Environmental Protection Agency of Municipal Solid Waste Generation; Recycling and Disposal in the United States: Facts and Figures from 2009.
- [21] K.R. Kim and G. Owens. 2010. Potential for Enhanced Phytomediation of Land Fills Using Biosolids: A Review. *Journal of Environmental Management*. 91(4): 791-797.