ENVIRONMENTAL AND HEALTH IMPACT OF WASTE ENGINE OIL DISPOSAL IN NIGERIA: A REVIEW

U. Obinia and J.N. Afiukwaa
Department of Industrial Chemistry,
Ebonyi State University, P.M.B. 053, Abakaliki, Ebonyi State, Nigeria.

Abstract

Environmental degradation and pollution through anthropogenic activities is a perennial problem that challenges the development efforts of all tiers of government in Nigeria. Petroleum hydrocarbon pollution arising from indiscriminate and deliberate disposal of waste engine oil in the environment is also worrisome. In this paper, a preliminary assessment of environmental contamination by petroleum hydrocarbon pollutants emanating from the utilization of mineral-based crankcase oil and a review of the impacts of these pollutants are presented. This review highlights the need for periodic evaluation of petroleum hydrocarbon contaminated sites. The results of such evaluation would be important in order to better define exposure estimates in the general population and to examine the relationship between the background levels of these pollutants in the environment and their subsequent health effects as panacea for tackling development challenges.

Keywords: *Waste Engine Oil, Mineral-based Crankcase Oil, Pollution, Development, Petroleum hydrocarbons, Nigeria*

Introduction

Environmental pollution especially from pollutants originating from petroleum hydrocarbons has been a serious challenge to development in Nigeria. The World Commission on Environment and Development (WCED), (1987) opined that sustainable environment leads to sustainable development. Odjegba and Sadiq, (2002) noted that pollution arising from the disposal of waste engine oil in Nigeria is more widespread than crude oil pollution itself. The generation and pattern of disposal of waste oils in Nigeria especially spent engine oil from the crankcase of vehicles is so rampant and therefore calls for immediate review of the legislative aspect of used oil management in Nigeria in order to nip to the board the escalating rate of environmental degradation arising from the uncontrolled and reckless disposal of waste engine oil. The disposal of spent engine oils on every available space is a daily routine by all artisans involved in auto-repairs. They do this out of ignorance to its attendant environmental and health implication.

A survey of most cities in Nigeria showed that there were little or no organized disposal practices for waste engine oil. Bamiro and Osibanjo (2004) had estimated the total national used oil generating capacity in Nigeria to be over 200 million litres per annum in 2004. Over 75 % of this figure represented contribution from used crankase engine oil while the remaining 25 % came from industry-based used oil. This shows the alarming nature of waste engine oil generation in Nigeria. The common disposal methods varied from indiscriminate spraying on land, pouring down the sewers and storage in plastic containers such as kegs, jerry-cans and drums. The fact that there is little or no organized treatment facility in the country for waste oil re-cycling (Bamiro and Osibanjo, 2004) coupled with the high volume of waste oil generated per annum and the reckless and deliberate ways these waste oils are disposed, calls for regular evaluation of the health and environmental effects of waste oil. The spill arising from disposal of waste engine oil is a visible problem that is not only attributed to auto-mechanic repairers who drains oil off from automobiles but generator sets also account for some amount of waste engine oil dumped into the ecosystem especially now that the epileptic nature of public power supply in Nigeria has increased the use of generators and demand for engine lubricating oils (Anoliefo and Vwioko, 2001). However, there are other applications which introduce significant amounts of spent engine oil in the environment. They include the use of waste engine oil as a weed killer and dust control where it is sprayed onto soil surface to control weeds and suppress dusts, wood preservation against termite and road construction where it is mixed with bitumen. Apart from the dermal contact and inhalation of fumes from waste engine oil especially by automobile repairers who handle this substance frequently, human exposure to waste engine can be through its application in hair creams to protect the scalp from the burning sensation of hair relaxers, application of waste engine oil to open wounds or cuts on the skin with mere belief that it aids the healing process is also a common practice among motor mechanics (Bamiro and Osibanjo, 2004). All these acts and practices results from poor handling and disposal of waste engine oil and as such had become a widespread source of environmental degradation and ecological damage in Nigerian environment.

Waste engine oil is a mixture of petroleum hydrocarbons, chlorinated biphenyls, chlorodibenzofurans, additives, decomposition products and heavy metals that come from engine parts as they wear away (Wang et al., 2000; ATSDR, 1997). These used engine oils (colloquially called "condemned oil") is usually obtained after servicing and subsequently draining off oil from the crankcase of automobiles and generator engines (Sharifi et al., 2007). Accordingly, the main sources of waste engine oil in Nigeria have been idenitified to include the industry and transportation sectors. The amount, types and exact composition of waste engine oil generated depend on the kind, age, size of the vehicle, origin, extent of use and degradation products that were formed in the oil during use (Bamiro and Osibanjo, 2004). These waste oils and solvents form part of the most hazardous wastes commonly generated in auto-repair workshops and mechanic villages around cities in Nigeria (Ipeaiyeda and Dawodu, 2008 and Iwegbue, 2007).

In this paper, the environmental and health effects arising from the disposal and exposure to waste mineral-based motor engine oil is presented.

Discussion

Environmental Impacts of Waste Mineral-Based Crankcase Engine Oil

Mineral-based crankcase oil also known as spent or waste engine oil is a petroleum product composed of a complex mixture of low and high molecular weight (C15-C50) aliphatic and aromatic hydrocarbons, metals and additives. It is a brown-to-black liquid produced when fresh engine oil is subjected to high temperature and high mechanical strain inside the engine. The chemical composition of the oil varies widely depending on the original crude oil, the refining processes, types of additives and the efficiency of the engine. Others are the mechanical condition and type of engine; the type of fuel used in the engine and the length of time the oil was used in the engine. The hydrocarbon constituents are mainly straight and branched chain alkanes, cycloalkanes and aromatics. Other components include small amounts of water, gasoline, antifreeze, additives (examples detergents, metallic salts such as molybdenum and zinc salts), organometallic compounds, metals and polycyclic aromatic hydrocabons (PAHs) (ATSDR 1997). These compounds in the oil increases with continued use of the oil in the engine. The toxicity of waste engine oils has been attributed to the nature of additives and the chemical decomposition products that accumulate in the oil with use.

Impacts on Soil and Plants

Hydrocarbons from waste engine oil can increase the toxicity level of the soil thereby reducing its fertility and productivity (Christensen and Argerbo, 1981). The aesthetic value of the soil is greatly affected as commonly evidenced by the change in colour and texture of the contaminated soil. Aina et al., (2009) showed that soil polluted with waste engine oil reduced the microbial life and organic matter of the soil.

Waste engine oil disposed on soil can lead to inactivity of microorganisms and this can lead to poor aeration causing the affected soil become more like a dust (Synder, 2005). Heavy metals in waste engine oil can be retained in soils in the form of oxides, hydroxides, carbonates and exchangeable cations. These may become bound to organic matter in the soil and can lead to die-off of microbial life in the soil (Yong et al., 1992). Though some of these metals at low concentrations are essential micronutrients for plants, at high concentrations they can cause metabolic disorders and growth inhibition for most of the plant species (Fernandes and Henriques, 1991).

The movement and fate of chemicals found in waste mineral-based crankcase oil in the environment depends on their individual properties. Most high molecular weight hydrocarbon components of the oil generally stick to the soil surface. Contamination of soils with waste engine oil leads to significant reduction of soil moisture (Akoachere et al., 2008). Spent oil extensively inhibits the activities of soil catalase and dehydrogenase (Achuba and Peretiemo-Clarke, 2007), delays germination of seeds and causes reduction in the growth of plants (Adenipekun et al., 2008). The PAHs in spent oil have been shown to have indirect secondary effects like disruption of plant-water-air relationship (Renault et al., 2000) and effects on microorganisms like mycorrhizal fungi (Nicolotti and Egli, 1998). Soils contaminated with waste engine oil are always darker than uncontaminated ones. This makes the contaminated soil to absorb and retain more heat than the uncontaminated soil. Donahue et al., (1990) reported that soils contaminated with waste engine can reach temperatures of about 65-70 oC, which are lethal to many plants that would otherwise grow in those soils at optimum temperatures of 24-32 oC (Raven et al., 2005). Anoliefo and Vwioko (1995) reported that the contamination of soil with spent engine oil caused growth retardation in plants, with a more adverse effect on tomato than pepper. Odjegba and Idowu (2002) have also reported defective germination of Amaranthus hybridus (spinach) seeds in waste engine oil-polluted soil. The seedlings growth, chlorophyll and protein contents were seriously affected (Odjegba and Sadiq, 2002). Ekundayo et al., (1989) showed that visible changes in physical, chemical and microbiological properties occurred in soils polluted with used engine oils. Oil pollution of soil leads to build up of metals in soil and the eventual translocation in plant tissues (Vwioko et al., 2006). Osunbor and Anoliefo (2003) equally reported that both growth and oxygen uptake of Arachis hypogea seedlings were affected in spent engine oil polluted soils. All these constitute threat to soil ecosystem balance and the overall environmental and health impacts can be attributed to the levels of PAHs, heavy metals and other combustion products of the waste engine found in the soil.

Impacts on Aquatic System and Air

Waste engine oil upon disposal on soil surfaces can migrate and eventually seep into water bodies (Olugboji and Ogunwole, 2008). Groundwater contamination results when the oil absorbs through soil layers and makes its way into lakes, streams, and rivers. Its impacts on the aquatic systems range from forming tiny films or sheens on the surface of the water which reduces the level of oxygen penetration needed by fish and other living organisms that comprise the aquatic food chain. The reduction in oxygen penetration into the water automatically leads to suffocation and death of aquatic biota. This kind of pollution can as well ruin the use of such water for drinking depending on the extent of contamination. The hazards of water contaminated with waste oil range from mild symptoms of accumulation of toxic compounds in the liver to complete impairment of body functions and even death of aquatic biota (Noln et al., 1990). Groundwater flow pattern is very slow and this makes the residence time of metals found in waste oil littered in the environment longer. The pollutants from crankcase oil also enter the air through the exhaust system during engine use or when burnt or used as a fuel in boilers, incinerators and cement kilns. Combustion products of used crankcase oil may include metals such as lead, zinc, chromium, aluminum, nickel, copper and iron. Others are sulphur, nitro-compounds, sulphur dioxide, phosphorus, calcium, hydrochloric acid, and nitrogen oxides (Vasquez-Duhalt, 1989). PAHs formed via combustion of the oil can leave the engine via the exhaust as particulates and pollute the air (Teresa et al., 2005). Besides, the volatile organic components of the spent engine oil can vaporize from the littered soil surface into the air. All these find their way into the atmosphere causing pollution and deterioration of air quality.

Health Impacts of Waste Mineral-based Crankcase Engine Oil

Health effects due to waste engine oil result from exposure to it. Owing to the physicochemical properties of used oil, the dermal route is the most susceptible route of exposure (Christopher et al., 2011). Other exposure routes such as oral and inhalation become prevalent in victims exposed to drinking of water polluted by waste oil and workplace artisans who are in regular contact with the condemned oils. Indirect inhalation of exhaust fumes of automobiles, generators and roadside dusts may also contribute to the level of exposure. Factors such as dose, duration and exposure route, individual characteristics such as age, gender, nutritional status, family traits, life-style and state of health can determine whether or not harmful health effects will occur and the severity of such health effects upon exposure.

Health effects due to used mineral-based crankase oil could range from death, systemic, immunological, neurological, reproductive, developmental, genotoxic and carcinogenic effects. Exposure periods are usually described in terms of acute (14 days or less), intermediate (15-364 days), and chronic (365 days and above) (ATSDR, 1997). The combustion products of waste engine oil contain hazardous organic components such as polychlorinated biphenyls (PCBs), chlorodibenzodioxins (CDDs) and chlorodibenzofurans (CDFs) which are very damaging to health. People who live or work in the vicinity of a recycling facility and where used mineral-based crankcase oil is burned for heating fuel may inhale high levels of the metal particles and PAHs. Indiscriminate spraying of waste engine oil around households and in landfills to ward off snakes or scorpions as some people believe also constitutes another route of exposure.

The resultant health impacts of used mineral-based crankcase oil depends on whether the chemicals are taken up, stored or excreted by the host body after exposure and on the individual properties of the chemicals in the oil. Studies on cattle that swallowed used mineral-based crankcase oil showed that lead and other metals in the oil were absorbed and distributed to various organs, such as the liver and kidney. Studies on mice showed that the PAHs that build up in used mineral-based crankcase oil were absorbed when the oil was applied to the skin (Granella and clonfero, 1991).

The health effects vary depending on the properties of the chemicals found in the oil. Each brand of oil contains slightly different mixtures of oils and additives. The characteristics of the engine in which the oil is used may also affect its final composition. Thus, effects experienced after exposure to one batch of used mineral-based crankcase oil may not be the same after exposure to another batch. Parts-fitters (mechanics) and other automobile repairers who were exposed to used mineral-based crankcase oil from a large number of motor vehicles experienced rashes on the skin, blood stool (anemia) and nervous system perturbation (headaches and tremors) (Hazelett, 2005). However, these workers were also exposed to a large number of other chemicals in the workplace. Inhalation of mists of used mineral-based crankcase oil for a few minutes can cause slight irritation of the nose, throats and the eyes. Ingestion of large amounts of used mineral-based crankcase oil can lead to diarrhea (ATSDR, 1997). Although, the International Agency for Research on Cancer (IARC, 1984) did not identify used oil as human carcinogens, Teresa et al., (2005) identified PAHs in used engine oils as cancer-causing agent in humans.

Conclusion

In consequence of the chemical composition, mode of disposal and overall impacts on the environment and health, waste motor engine oil is considered to pose serious environmental and health problem. Periodic evaluation on the extent of waste engine oil contamination of sites can be important tool in defining exposure estimates in the general population and accessing the relationship between the background levels of these pollutants in the environment and their subsequent health effects development.

Recommendations

In view of the large quantity of waste engine oil generated in Nigeria per annum, we therefore recommend the following:

(i) Recycling as a benign means of reducing environmental pollution and health effects due to waste engine oil. The provision of at least one functional recycling plant in every State of the Federation including Abuja is advocated to ensure re-use of the waste engine oil, wealth generation and provision of employment.

(ii) Provision of a central collection unit within every auto-mechanic site in Nigeria for purposes of recycling as this will go a long way in reducing the indiscriminate spraying and dumping of spent engine oil on every available space especially on the soil.

(iii) The Bank of Industry (BOI) should to facilitate and make funds available for coperative societies, individuals or entrepreneurs who are into waste oil management and recycling or who may wish to start up a recycling plant for waste oil.

(iv) The Federal and State Ministries of Environment, Health and other cognate Ministries, Departments and Agencies (MDA) of the Federal and State governments should ensure strict implementation of the existing legislation on sound environmental management as regards used oil disposal in Nigeria such as the Waste management regulations 5.1.15 of 1991 LFN, Environmental impact assessment (EIA) Decree No of 1992 and the National Environmental Standards and Regulation Enforcement Agency (NESREA) Act of 2007 among others.

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