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The Influence of Primary Air Pollutants on Human Health Related Risk

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Abstract
Air pollutant is one of the major health related risk today. The presence of air pollutants as atmospheric substances or energy in uncontrollable quantities and of unimaginable duration is liable to cause harm to life, damage to man-made materials and structures, or changes in the weather and climate. This paper attempts to explain air pollution upon human health from the primary source point of view. It also looked at the historical background of air pollution, the source, Nitrogen Oxide (NOx), Carbon monoxide (CO), Sulphur oxide (SOx), Particulate matter ($PM_{10,}$ $PM_{2.5}$), Hydrocarbons (HCs) to the Health effects of primary air pollutants such as Cardiovascular disease (CVD), Cancer, Chronic obstructive pulmonary disease (COPD), Asthma, Indoor air pollution, Control of primary Air pollutants. Based on these, evaluations are made and Conclusions were drawn with some recommendations.
Keywords: Pollution, Health, Air index, industry, Primary, Control, Countries

1. Introduction

Air pollutant is viewed as the presence in the atmosphere of substances or energy in such quantities and of such duration that is liable to cause harm to life, damage to man-made materials and structures, or changes in the weather and climate (Elsom 1992; in Yang and Omaye, 2009). Air pollutants are classified as primary and secondary sources. However, this paper focuses mainly on the primary sources and their effect on human health. Also tends to identify the primary source of air population with the focus on the effect on human health in the developed and developing countries of the world. It explores the general standard of air pollution index to evaluate the level of air pollution in the atmosphere and the severity as regards human health.

1.2 General overview of Primary air pollutants

Taking into consideration the human health; ranging from heart attacks, lung cancer and diseases affecting the respiratory track which are more often much in people who are exposed to dirty air (polluted air) compared to those in clean air environment. William, (2007) states that this conditions is worse in China, United State and other big cities. From the united nation estimate, about 1.3 billion people are exposed to hazardous pollutants. Figure 8 (1) $SO_{2,}$ and NO_x acts as eyes and respiratory irritants and cause damage to vital tissues and organs in the body. When Carbon monoxide binds with oxygen-transporting substance in the blood (hemoglobin) it decreases the ability of the red blood cell to carry oxygen around the body of the victim this might lead to severe health effect, like Bronchitis and emphysema, it is also important to note that smoking is the largest most common cause of lung obstructive disease and preventable death in the world. Research also finds out that indoor air pollutants are often higher than outdoor pollutants. This is because people spent more time indoor than outdoor and are therefore exposed to higher concentration of air pollutants from cigarette smokers in the western world. the developing countries like Latin America, Africa and Asia, the burning of firewood, cooking stoves with kerosene, room lanterns with diesel, charcoal and agricultural waste as cooking source by the majority of household, with a poorly ventilated kitchen and rooms.

Figure 8 (1)
Source: Geography of India

Figure 8 above is an illustration of incinerator releasing large amount of pollutants indiscriminately into the atmosphere.

1.3 Air Quality Index

The United State Environmental Protection Agency (US EPA), in 1994 came up with a standard to measure Air Quality: The Pollutant Standards Index. Table 1 below explains the ranges and quality of air and the possible health effects.

EPA Air Quality Index and Clean Air Standard for outdoor Warning

AQI Range	**EPA Colour Scale**	**EPA Descriptor**	**Warning**
0 to 50	Green	Good	Green indicates good air quality people can engage in outdoor physical activity without health concerns.
51 to 100	Yellow	Moderate	The air is safe for most people. Though, some sensitive people might react to ozone at this range, especially those with heart and lung diseases such as asthma, and children, are especially susceptible. People in these categories, or people who develop symptoms when they exercise at "yellow" ozone levels, should consider avoiding prolonged outdoor exertion during the late afternoon or early evening when the ozone is at its highest.
101 to 150	Orange	Unhealthy for Sensitive Groups	In this range the outdoor air is more likely to be unhealthy for more people. Children, people who are sensitive to ozone, and people with heart or lung disease should limit prolonged outdoor exertion during the afternoon or early evening when ozone levels are highest.
151 to 200	Red	Unhealthy	In this range even more people will be affected by ozone. Most people should restrict their outdoor exertion to morning or late evening hours when the ozone is low, to avoid high ozone exposures.
201 to 300	Purple	Very Unhealthy	Increasingly more people will be affected by ozone. Most people should restrict their outdoor exertion to morning or late evening hours when the ozone is low, to avoid high ozone exposures.
Over 300	Black	Hazardous	Everyone should avoid all outdoor exertion.

Source: US EPA; 1994

The Index table make possible for the public to determine whether air pollution levels in a particular location are Good, Moderate, Unhealthy for Sensitive Groups or worse. In addition, EPA and local officials use the AQI as a public information tool to advise the public about the general health effects associated with different pollution levels and to describe whatever precautionary steps may need to be taken if air pollution levels rise into the unhealthy range (US EPA, 1994).

2. Related Review of Literature

The effects/influence of primary air pollutants in the atmosphere has continued to generate concern within the scientific society, regulatory bodies, and public communities. According to Yang and Omaye (2009) there is a need to address the critical gaps in perception of how air pollution contributes to human health problems, that we can further use such understanding to efficiently ease the problems associated with health in regards to air pollutions. According to (Goldsmith and Kobzik 1999, cited in Yang and Omaye in 2009 p.46), Brunekreef and Holgate also in Yang and Omaye 2009 p.46), a great deal of information exists with reference to the effects of 'gaseous air pollutants' but our understanding as far as human morbidity and mortality is concerned is limited. Goldsmith and Kobzik 1999, states "*Also limited is our understanding about the level of metabolic changes associated with changes in oxidative stress and how such changes modulate health. Since several exhaustive reviews on air pollution have been published"* Goldsmith and Kobzik 1999, cited in Yang and Omaye in 2009 p.46), Brunekreef and Holgate also in Yang and Omaye 2009 p.46).

This review is concerned with the health problems associated with air pollution and effective public health prevention of diseases associated with air pollution. According to Nigel et al, (2000) indoor air pollution is a prehistoric phenomenon, where the early human beings migrated to temperate climatic regions and in the search for warmth burnt wood in the room to keep warm. In our modern and civilised era burning of wood has been replaced with petroleum and electricity. In the developing world wood burning is still the major source of heat. According to Smith 1987, in Nigel et al, 2000, wood and kerosene stoves are burnt inside most of the rooms in Africa and India. This is as a result of poverty barriers and it is believed that this will continue for years Smith 1987, in Nigel et al, 2000).

In December 5th to 9th of 1952, London air was stagnant and most of the solar radiation could not penetrate the cloud cover, it was reported that the humidity was 80% and the temperature dropped to approximately 1^{0C} Edward (2002). For details see figure 1 below: (2)

Heavy Smog in Piccadilly Circus, London (December 6, 1952)

Figure 1: (2) *Source: (Photo by Central Press/Hulton Archive/Getty Images in Rosenberg, 1997)*

According to Rosenberg, (1997) there was a severe cold that swept through London, in early December of 1952. The smoke from the burning of coal mixed up with the dense layer of fog in the atmosphere and engulfed the city for five days long. Rosenberg (1997) further stresses that the smoke emitted from the factories was prevented from escaping into the atmosphere by 'Inversion' which led to a mixture of fog and smoke called 'smog'. After the fog had gone in December 9th 1952, it was reported that about 4000 people were dead, with another 8000 people reported dead after a week from the exposure to what was referred to as "the Great smog of 1952" making the death toll to be approximately 12,000 people. This eventually led to the Clean Air Act that was passed by the Parliament in 1956 and 1968, this Act created room for the elimination of coal burning both at homes and factories Rosenberg, (1997).

In December 11 2002, Nielsen, remembered the event with the following words "Fifty years ago this month, a toxic mix of dense fog and sooty black coal smoke killed thousands of Londoners in four days. It remains the deadliest environmental episode in recorded history".

Some other countries that have experience air pollution disasters are; Belgium 1930, Mexico 1950, New York 1953, 1962, 1963 and 1966, India 1984, Hunt, (2012) described this events as "Air Pollution Episodes. The major objective of this paper is to identify the primary source of air pollution with regards to health related risk in the developed and developing countries of the world.

3. Primary air pollutants and their sources

Primary air pollutants are pollutants that are directly added to the atmosphere from a used energy source or process. They are particulate matter, sulphur dioxide, carbon monoxide, nitrogen oxides and hydrocarbons.

3.1 Nitrogen Oxide NO and NO_2 (NOx)

Nitrogen oxides are gotten from automobile combustion of fuel (diesel, petrol, natural gas and coal). It is also produced naturally during thunderstorms, chemical reactions is expressed in the equation; $N_{2(g)} + O_{2(g)} \rightarrow$

$2NO_{(g)}$.

3.2 Carbon monoxide (CO)

Carbon monoxide is one of the major sources of air pollutants that results from incomplete combustion of petrol and diesel (hydrocarbon) emanating from motor vehicle, Agricultural waste burning, (biomass) and residential heating. The chemical reaction is defined by the equation; $2C_{(s)} + O_{2(g)} \rightarrow 2CO_{(g)}$. For detail description and visual perception of Carbon monoxide emission into the atmosphere, see fig. 2 and 3 below. (3 and 4)

Figure 2: (3) Source: http://cdn4.explainthatstuff.com/burningforest.jpg
Bush burning and the emission of carbon monoxide into the atmosphere

Figure 3: *(4) Source: Kiva up energy local firewood burner for cooking in the villages*

Figure 2 and 3 (3 and 4) above illustration burning of agricultural farm land releasing carbon monoxide into the atmosphere. These figures above illustrate the extent of air pollution in the typical African setting and forest bush burning. These are observed to have greater effect on the level of primary air pollution and its consequent effect on human health and the atmosphere globally.

3.3 Sulfur oxide (SOx)

Sulphur oxides is produced primarily from incomplete combustion of fossil fuel, coal or the burning of oil, volcanoes, figure 4,(5) power generation plants and industries, Refineries, and Diesel Engines. The chemical reaction is represented by the equation below:

$S_{(s)} + O_{2(g)} \rightarrow SO_2$

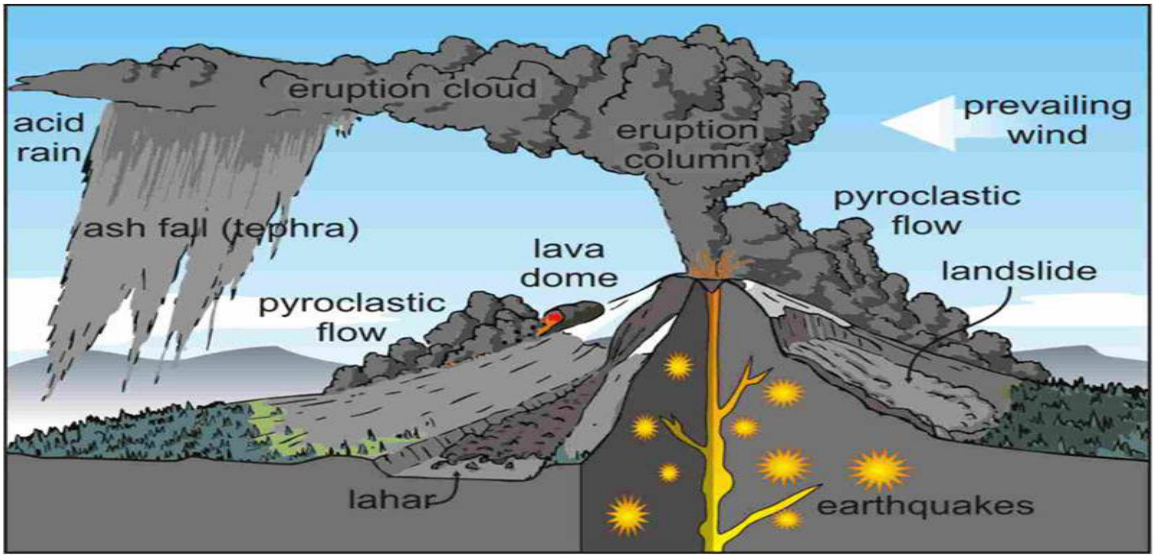

Figure 4 (5)
Source: worldly wise wiki diagram of a volcano- A volcanic eruption, releasing volcanic ash into the atmosphere with lots of sulphur content in it.

3.4 Particulate matter ($PM_{10}\mu m$, $PM_{2.5}\mu m$)

Particulate matter are formed from both organic and inorganic matter examples include road dust, burning of fuel in agricultural area, incomplete combustion from motor vehicles figure 5 (6) (diesel and petrol), asbestos from industries and metallic particles. It is also formed from the reaction of other pollutants (acid rain, NOx, SOx, beryllium, lead and mercury).

Figure 5 (6)
Source:http://b.static.trunity.net/images/176529/500x0/scale/AirPollution_AutoDischarge_1.jpg
Release of carbon monoxide by vehicles in traffic.

3.5 Hydrocarbons (HCs)

Hydrocarbons are natural bacterial decomposition of organic matters from trees, animals and plants; (micro-planktons) with the C_1 to C_4 being gases (Methane to Butane); and C_5 to C_{12} being liquids (Pentane to dodecane). They also form volatile organic compound (VOC) from C4 to C22.

4. Health effects of primary air pollutants

Having examined the various primary sources of air pollutants, the health related issues required discussion. The health complications of primary pollutants include cancer, asthma pulmonary heart diseases, respiratory tract infection cataract and death. These are characterised by a high level of particulate matter, carbon monoxide and sulphur dioxide pollution.

4.1 Cardiovascular disease (CVD)

This is caused as a result of carbon monoxide (CO) in combination with other offensive by-products from automobile exhaust; the patients can also develop 'atherosclerotic heart disease' sometimes having a higher carboxyhemoglobin (COHb) concentration. Yang et al (in Yang and Omaye, 2009) believed that ambient carbon monoxide (CO) leads to air pollutants and (CVD) mortality.

4.2 Cancer

Particulate matters are the major cause of chronic and acute respiratory diseases that sometimes lead to cancer. This depends on the chemical composition of the particulate matter (PM-2.5, PM-10); they irritate the tissue of the throat, nose, lungs and that of the eye. This is mainly from cigarettes smoke and incomplete combustion of motor vehicles exhaust.

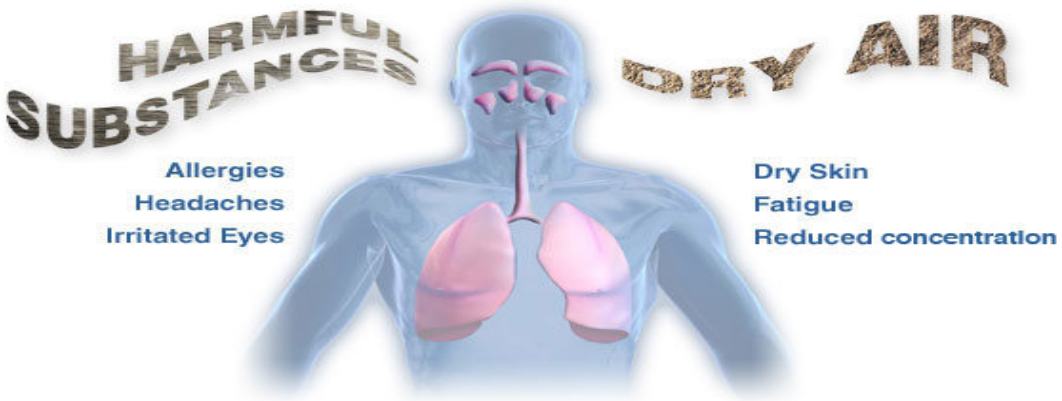

Figure 6 (7)

Source: Vicks Evaporative Humidifier (VEH). Some of the allergic effects of carbon monoxide inhaling

4.3 Chronic obstructive pulmonary disease (COPD)

A lot of studies confirmed that the presence of PM10 plays a very significant role in the (COPD) infection particularly in the study of Schwartz (1995, in Yang and Omaye, 2009). Schwartz (1995), studies indicates that pollutants (SO_2, CO, NO_2) are the active factors for COPD.

4.4 Asthma

Asthma is influenced by air pollution and hereditary. Smoke and dust within a given area where vehicular activities is more concentrated contribute to the risk of Asthma, a high risk of the disease likely to exist in hazy and dusty environments.

4.5 Indoor air pollution

This is known by environmentalists as one of the most serious environmental health hazards. According to Edward (2002, p.477) people are exposed to pollution on a daily basis both at home and work. Indoor air has variety of pollutants (figure 7(8) below shows the different kinds of pollutant indoor and the associated health effects) including smoke, chemicals and disease carrying organisms.

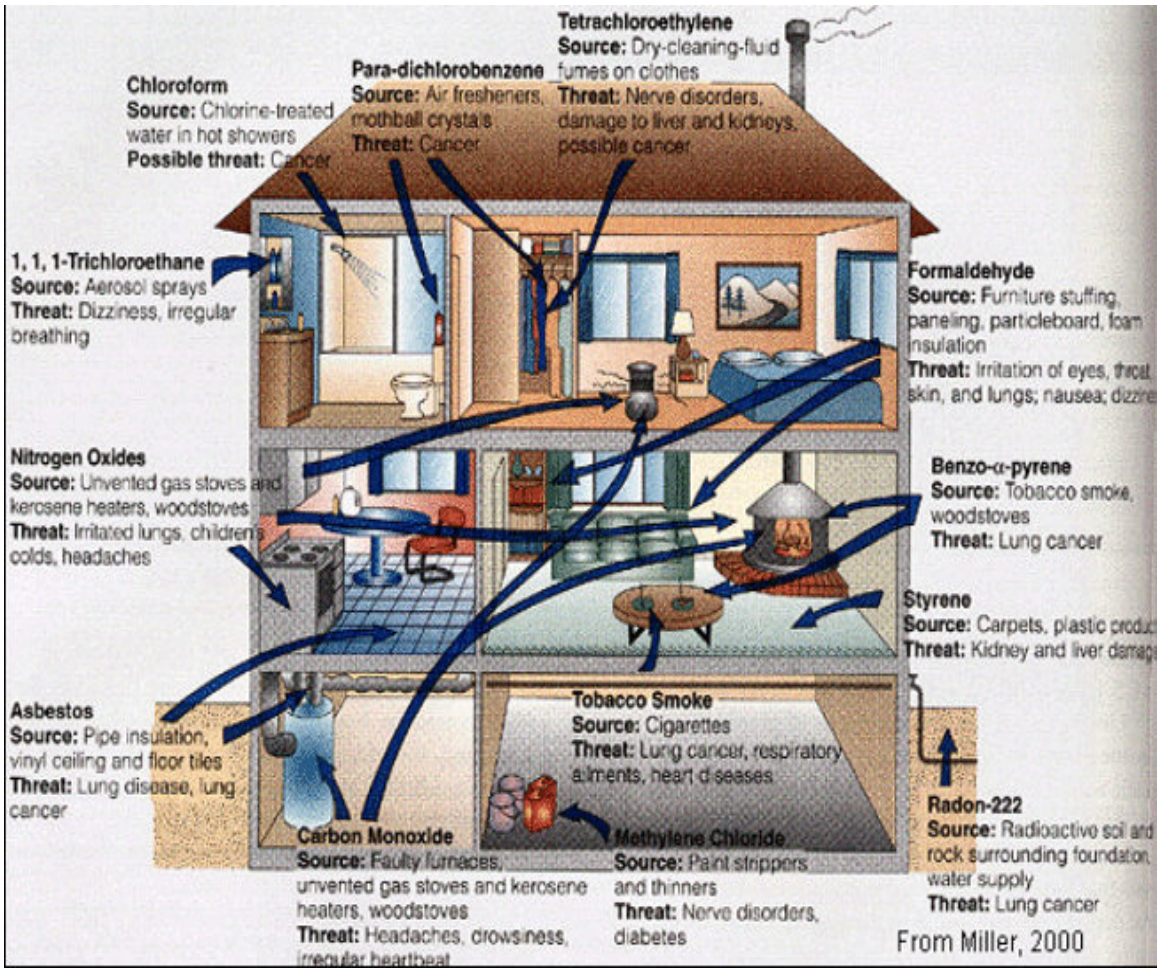

Figure 7 (8)
Source: Miller, 2000 *http://www.mikerougeecorp.com/Indoor-Air-Pollution.gif*

Other sources of indoor air pollution include smoke from nearby houses, burning of forests, agricultural and household waste, the use of kerosene lamp and stoves, industrial and vehicular emissions. From the experiment carried out by Nigel et al, (2000) shows that prolonged exposure to wood smoke or forest fire could be deadly, or causes asphyxia as a result of carbon monoxide intoxication which may also cause severe damage to the respiratory epithelium.

Edward (2002, p.478) is also of the view that heating, air conditioning and ventilation systems of buildings if not well maintained, constitute indoor air pollutants, giving rise to moulds and bacterial growth in buildings. Furniture, asbestos and carpets in buildings also contain toxic chemicals like formaldehyde that may be release in the buildings.

Other indoor facilities that contribute to the pollutions are printers, coffee machines, computers and fax machines which may release pollutants such as ozone (O_3). The World Health Organisation (WHO, 2008) outlined the common indoor pollutants as; Particulate matter, Carbon monoxide, Second-hand tobacco smoke, Pesticides, Solvents, Volatile organic compounds, Biological pollutants (Mites, Allergens, Moulds), in built environment, Radon, Asbestos and Occupation-related contaminants.

Moya et al, (2004; in WHO, 2008) is of the opinion that 'Infants and young Children' are more venerable than the Adult because Children has a higher rate of metabolic and oxygen intake per unit body weight. Moyal et al, (2004) went further to state that, children grow more rapidly than adults and therefore are more exposed to air pollutants. They become more venerable because of their narrow airways. The adverse health effects of indoor air pollutants by (WHO, 2008) are;

- Irritation of the mucous membranes of eyes, nose and throat
- Cough, wheeze and chest tightness
- Increased airway responsiveness to allergens
- Increased incidence of acute respiratory illness
- Cold, pneumonia and otitis media

- Tracheobronchitis
- Exacerbation of asthma

5. Control of primary Air pollutants

According to William (2007) early technology of pollutions control, are usually to move the pollutants to remote area for the improvement of local air quality or using smokestacks to disperse emission. William (2007) gives details of how other pollutants are removed from the atmosphere as explained below:

a. Control/Removal of Particulate matter

Using filters to remove particles physically by trapping them in a porous mesh of cotton cloth, spun glass fibers, or asbestos-cellulose, this allows air to pass through but holds back the solids. The most common particulate control is the use of electrostatic precipitators, in power plants. "Fly ash particles pick up an electrostatic surface charge as they pass between large electrodes in the effluent stream". The Performance electrostatic precipitators depend on the size of the particle and chemistry, strength of the electric field and flue gas velocity (William, 2007).

b. The control/removal of Sulphur

Sulphur could be removed in different ways this statement is credited to William, (2007) either by reducing the level of sulphur in hydrocarbon or using low-sulphur fuel or by removing it from effluents.

i. Emission of sulphur can also be greatly reduced by fuel switching and fuel cleaning;

- Switching from soft coal with high sulphur content to low-sulphur coal can significantly reduce sulphur emission into the atmosphere.
- Using other fuel, such as natural gas or nuclear energy, can eliminate all sulphur emissions as well as those of particulate matter.
- Alternative energy sources, such as wind and solar power, are preferable to either fossil fuel or nuclear power, and are becoming economically competitive.
- Coal can be crushed, washed, and gassified to remove sulphur and metals before combustion, as in the case of 'IRONBRIDGE' Power Station (EON's).

ii. Limestone injection and fluidized bed combustion

Sulphur emissions can be reduced as much as 90 percent by mixing crushed limestone with coal before it is fed into a boiler. A relatively new technique for burning, called fluidized bed combustion, offers several advantages in pollution control.

Flue gas desulphurization

Crushed limestone, lime slurry, or alkali can be injected into a stack gas stream to remove sulphur after combustion.

Sulphur recovery processes

Sulphur can be removed from effluent gases by processes that yield a usable product, such as elemental sulphur, sulphuric acid, or ammonium sulphate.

c. Control of Nitrogen Oxide

One of the most effective ways of controlling Nitrogen oxide from automobile exhaust is by recirculation of the gas within the automobile's engines Edward, (2002). This process work by diluting the air-to-fuel mixture burned; the temperature of the combustion is greatly reduced, thereby decreasing the oxygen concentration in the mixture being burnt. When this process is complete the fuel will be rich and produce fewer Nitrogen oxides. According to Edward, (2002) this has been a common practice in the United State for over 20 years.

5.1 Controls of Hydrocarbon and Carbon monoxide

Based on the findings of (Stoker and Seager, 1976; in Edward, 2002), it is concluded that the most commonly used method for the removal of hydrocarbon and carbon monoxide from car exhaust (automobile) is the catalytic converter. This mechanism converts carbon monoxide to carbon dioxide and convert hydrocarbon to carbon dioxide and water.

William (2007) believes that closed systems that prevent escape of fugitive gases can reduce many hydrocarbon emissions (e.g. positive crankcase ventilation (PCV) systems in automobiles) drastically reduce hydrocarbon emission through;

- Controls of fugitive losses from valves, pipes, and storage tanks in industry can significantly impact on air quality.
- Afterburners are often the best method for destroying volatile organic chemicals in industrial exhaust stacks.

6. Evaluation of Current Conditions and Future Prospects

William (2007) is of the view that the Clean Air Act goals have not been achieved. However, air quality has been better considerably in the last decade in terms of the main volume of pollutants. Given the fact that

automobiles are the major source of NO_x, most cities where pollution is largely from traffic as a result of (traffic congestions) still have serious air quality challenges. Most urban areas of developing countries are growing at unpredictable rates to incredible sizes and the environmental quality is still extremely bad in many of them for instance- Mexico City and many large cities in the world and China. These countries are not meeting with the standards.

7. Conclusion

In the fore goings, primary air pollutants have been seen as chemicals that are brought about either by natural processes or human (anthropogenic) activities resulting in air quality degradation and have been in existence as long as man existed on earth. The burning of forests, fossil fuels, and wastes are being considered in the study continually as the largest source of anthropogenic air pollution. Common primary pollutants such as NO_x, SO_x, CO, particulate matters, volatile organic compounds (hydrocarbon) are majorly the sources of air pollution and still remain sources from transportation, industrial processes, stationary fuel combustion, and solid waste disposal. While Indoor air pollutants, like formaldehyde, asbestos, ozone and tobacco smoke comprise some exceptional pollutants with relatively high risk of health related problems. It is also very reasonable to note that Children are more expose to indoor pollution and have higher mortality rate than the adults.

8. Recommendation

This study recommends that vehicle above ten years old should be removed from the road for recycling purpose since old vehicle cause more pollution than the new one. Government (in the developed and developing) should continually run enlightenment campaign on the danger and health risk associated with air pollutants in the atmosphere. Suggestively, more of electric vehicle should be introduced into the transport industries with considerable fare cost for easy affordability by the populace. This will result in decrease rate of cars on the road giving rise to greener environment and contributing to air quality. More so, (fossil fuel) vehicles should be minimised as much as possible, as it is known (for their cause)?? (For being responsible) of more health related problems than petrol cars or vehicles on the road. Rural sensitisation should be showed case in the rural communities particularly on the risky role of coal burning for local cooking or industrial purposes with the keen effort to discourage such practices.

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