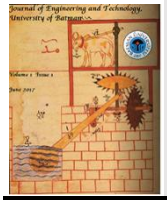

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Air pollution, pollutant emissions and harmfull effects

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ABSTRACT

Present paper is an overview of the engine and air pollution problem especially in the urban areas. Air pollution is caused bu pollutant emissions is popular problem that should be solved in the world by means of its harmfull effects. The combustion processes of diesel and gasoline fuels in realted engines and other hydrocarbon fuels in termical machines are main sources of air pollutant emissions. These main pollutants are nitrogen oxides (NOx), carbon dioxide (CO_2), sulphur oxides (SOx), hydrocarbons (HC), carbon monoxide (CO), particulates matter (PM), lead (Pb), and volatile organic compounds (VOCs). All these emissions are firstly introduced and classified in the view of their sorces and formation processes. Then, their negative and harmfull effects on global warming, environment and human healt have been presented.

1. Introduction

Human and other creatures live on the part of the atmosphere closest to earth. The air in here consists mainly of nitrogen (78%) and oxygen (21%); besides other gases in very small amounts. The other gases consist of argon, carbon dioxide, water vapor, helium, neon, hydrogen, methane, krypton, nitrogen monoxide, nitrogen dioxide, ozone, xenon, and ammonia. This altered composition of air; in gas, liquid or solid forms which can also be found in chemical substances are called air pollutants. The increased amount of pollutants in the atmosphere decreases the air quality and adversely affects the human and other lives.

The air pollution problem was local and had minor effects until recently but the world is faced with the problem of air pollution and global warming. The increased industrialization and the increase in vehicles are contributing air pollution problem. However, air pollution has grown so much with advanced technology and the earth can no longer clean all air pollutions.

The main air pollutants generally found in urban areas are; CO, CO_2, HC, NOx, NO, NO_2, PM, SOx, nd smoke emissions. These pollutant emissions are emmisted to the atmosphere in high concentrations enough to gradually lead serious health problems.

The EPA (Environmental Protection Agency) aims 6 pollutants considered to be the main factors leading to the air pollution. The agency sees them critical emissions. These air pollutants cause some diseases lung disease and like cancer.

Smog accumulated over urban areas is the obvious and most familiar form of air pollution. In order to protect the health of humans and other living things, some limit values for air quality have been identified. This limits the environment to prevent the occurrence of short and long term adverse effects of air pollutants in the atmosphere, which is determined by taking into consideration the harmful effects of changing values.

Air pollution has the effects on human health in many different ways. High amounts of air pollutants in a short time, short term acute effects resulting from aerosolization of the short-term limit values for the given boundary values are known as short term health effects. Some of the short term effects are on to the eyes, throat and nose, and upper respiratory systems such as asthma and emphysema, pneumonia and bronchitis. Other symptoms are nausea, headache, and allergia. Generally, the air quality limit values, lower amounts of air pollutants resulting from aerosolization of a long period of time the upper limit values for chronic effects that are known as long-term limit values. Long-term health effects are summarized as heart disease, lung cancer, chronic respiratory disease, and even damage to the brain, liver, nerves, or kidneys. Continual air pollution also may affect growing children [1].

Many studies have been carried out to reduce the limit values for amounts of air pollutants that are harmful to human and other lives lifes. Some organizations in the some countries have developed standards for concentrations of common pollutants in outdoor air. European Union Member Countries have brought limitation with some lawful regulations for harmful exhaust gas emission products like 88/77/EEC, 91/77/EEC, 91/242 / EEC, 91/441/EEC and 91/542/EEC. According to the first of 3 standard emission limits for CO (g/kWh) are from 11.2 to 4.9, for NOx (g/kWh) are from 14.0 to 9.0 and for HC (g/kWh) from 2.4 to 2.3 [2- 4]. Limits of NOx (g/kWh) emissions are from 8.0 to 5.0, PM (g/kWh) from 0.61 to 0.15 and HC (g/kWh) from 1.1 to 0.6 according to specific emissions calculated by the fuel consumption of motor vehicles prepared by European Union countries, EURO 1, EURO 2 and EURO 3 [5-7]. In the past three decades, levels of some pollutants are quite reduced thanks to emission controls and limitations [8-10].

2. Human Health Effects of Pollutant Emissions

Air pollution caused by fossil fuel-based energy production facilities, motor vehicles, fuels used for heating and industrial establishments have many effects on human health. Although low concentrations of air pollutants have the compounds that are contained larger carcinogenic effects. At the beginning of the hazards that cause air pollutants comes from lung cancer, bronchitis, rheumatic fever, rickets, and variety of dangerous diseases such as heart disease. In addition, air pollution causes burning human eye, blurred vision, shortness of breath, loss of appetite, also leads to disadvantages such as blood poisoning [11-15]. With the accumulation of harmful emissions in the human body begins loss of appetite and ultimately accelerate to being effect to diseases with the body's resistance weak. With various dusts by combining with the sweat on the skin tissue, skin breathing pores are closed and skin breathing is hindered, and difficulty in breathing starts. At the end of difficulty in breathing show sing over fatigue and aging in humans.Also included in the emissions of toxic substances through the respiratory tract, as a result of taking these substances into the blood and blood poisoning occurs. Residues which make up the pollution in people with a variety of ways affect the human body's neurological and mental disorders.

Generally, SOx and NOx in the atmosphere help the formation of acid particles. In addition, nitric and sulfuric acids formed stick on the particulate matter and by inhalation of these particles caused by these acids go directly to the lungs. These acid powders and gases as going to lungs are mixed the blood by affecting alveolus in the lung.

3. Sources of Air Pollutions

According to the EPA the most part of the polluting emissions are resulted from human activities, such as vehicles engines, industrial and agricultural production. In any activity, the combustion of fossil fuels creates the most air pollution. Major sources of emissions are internal combustion emission.

Vehicles, jet airplanes, trucks and other internal combustion engines are the main causes of air pollution. The exhaust gasses from these contain CO, NOx, PM, SOx soot and other gaseous oxide. Power generating stations, office buildings, homes, factories, and and the others that uses fossil fuels also cause air pollution in urban areas. This air pollution reduces life quality in cities. Besides, UHC and PM from petroleum refineries pollute the air in cities. Chemical plants, cement plants, asphalt plants, steel mills, and iron mills supply emissions into the atmosphere causing air pollution.

4. Sulfur Oxides (SOx)

Sulfur dioxide (SO_2) is a pollutant and a component of smog. In term of air pollution that is one of the important chemical substances is SOx. Usually, SOx exists as the organic and inorganic sulfur in solid fuels. Inorganic sulfur is found in the soil and organic sulfur is found as sulfate sulfur within the combustion of carbon in the atmosphere and then taking turns into SO_2. The most common air pollutant emissions are sulfur oxides, and therefore of sulfur dioxide. In fact, volcanoes used to be the main source of atmospheric sulfur dioxide. Sulfur element is found with particulate matter in the exhaust emissions and the density of the fuel varies linearly with the amount of sulfur [17-19]. The amount of sulfur in diesel fuel in internal combustion engines are closely related to the density and cetane number of diesel fuel and fuel has sulfur content in the low density, andthe amount of sulpur in the particulate matter is to low [20].

The most polluting and the most found sulpur compounds in the world are SO_2 and SO_3; and tons of SO_2 is emitted into the atmosphere every year from various sources. A large amount of sulfur oxide emissions occur with solid and liquid fuel-fired power plants for electricity production. With this or a similar path SO_2 is mixed up atmosphere; and its atmospheric transformation products in the sulfite (SO_3) and sulphates (SO_4) spread through as dust particles; or other particles merge with each other and grow. Sometimes SO2 in the air can be potable until the very high layers of the atmosphere with air flows. During this movement, SO_2 chemically react with water droplets or moisture in the air and forms acid. Firstly SO_2 forms sulfurous acid (H_2SO_3) and then it forms sulfuric acid (H_2SO_4), which is an effective acid.

$$SO_2 + H_2O \rightarrow H_2SO_3 \text{ then } SO_3 + H_2O \rightarrow H_2SO_4$$

As a result of these conversion equations, these acids lead to the acid rain. With increasing levels of SO_2 and PM in the air together increase lung function disorders and various diseases occur death events. When taken in high concentrations of SO_2 through the tract, SO_2 and other sulfur compounds in the atmosphere is absorbed a large part of the upper respiratory tract. As a result, bronchitis and other lung diseases occur. When peoples inhaled SO_2 with the air, SO_2 combines with moisture in the lungs, such as the above mentioned equations, firstly it transforms into H_2SO_4 and then H_2SO_3 acid. This acid can irritate the respiratory tract and respiratory organs and it makes respiratory tract diseases that are connected to respiratory organs.

5. Nitrogen Oxides (NOx)

Nitrogen oxides (NOx) are of the main emissions in the air pollution. Nitrogen oxides in the atmosphere are result of N transformation in the combustion processes. The major parts of the NOx come from exhausts of vehicle engines and stationary combustion plants. NOx are emitted as NO which rapidly reacts with ozone or radicals in the atmosphere forming NO2. NOx occur such as oxides of nitrogen in the fuel that nitrogen is founded in high temperature reacted with oxygen. Generally, nitrogen oxides are in the NO, NO_2, NO_3 forms and NO_2 and NO are the most important of pollutant gases. Although there are many factors that influence the formation of nitrogen oxides at the result of a good combustion, NOx formation rate increase with temperature rises and the when temperature rises above 1800 ^oK [21].

In combustion period O break down and then O_2 occurs, and then $O+N_2 \leftrightarrow NO+N$ occur according to Zeldovich mechanism, then it is accepted to free radicals $N+O_2 \leftrightarrow NO+O$ with the equation. Because activation energies of these reactions is large in both of two reactions, in the low-temperature, reaction speed are very low [22, 23].

NO_2 in the air by combining with moisture convertes to nitrate acide and this acid has important effects on the health of the lives. Nitrogen oxide emissions in the atmosphere complete with resulting nitric acid (HNO_3) formation chain reactions. High temperatures and lightning in the air may have form NO. According to the following equation when NO contact to the air it converts to NO_2 and NO_2 may form acid solution easily.

$NO + 1/2O_2 \rightarrow NO_2$ and $2NO_2 + H_2O \rightarrow HNO_3 + HNO_2$

Stable and unstable nitrogen oxide compounds react with oxidizing substances in the atmosphere and as a result of chemical reactions they produce photochemical fog. HNO3 in the atmosphere helps to the formation of acid rains. Because nitrogen dioxide found gas, it has many effects on the health of lives through the respiratory tract. When gaseous nitrogen dioxide is breathed, it accumulates in the respiratory tract of lives and it gives to harmful influences [24-26].

6. Carbonmonoxide (CO)

CO which is formed in incomplete combustion of fuels is colorless, odorless, and it is equal the average molecular weight of air and it is a toxic product of combustion. CO emissions that are not destroyed so easily in the atmosphere change with amount of air that is participated to combustion. The amounts of CO increase when gas temperature is low, the lack of sufficient oxygen for combustion and due to the short time of incomplete combustion for conversion to CO2 from CO.

Combustion reaction rate in combustion systems changes to the energy level of the fuel from the combustion chamber, density and the collision temperature of molecules that make up the exothermic reaction. During combustion, by the lack of adequate combustion air, incomplete combustion occurs and the amount of CO increases [27].

According to the oxygen amount the combustion reactions occur as $C + 1/2O_2 \rightarrow CO$ if oxygen is sufficient, or $C + O_2 \rightarrow CO_2$ if oxygen is insufficient.

Carbon monoxide formation is based on oxidation of carbon and hydrogen with oxygen containing fuels. CO consists of the following reactions, as shown at following reacts CO occurs by the disintegration of the products.

$CH_3 + O_2 \rightarrow CHO + H_2O$
$CH_2 + O_2 \rightarrow CO + H_2O$
$CHO + OH \rightarrow CO + H_2O$

Because of carbon monoxide decreases carrying oxygen, when it mixed to respiration hinder oxygen carrying capacity of blood, due to the lack of oxygen in the blood at the walls of blood vessels, brain, heart, such as the precise function of organs and tissues are affected. When CO connects to hemoglobin it replaces oxygen in the blood the heart and nervous behavior leads to problems. Due to this gas has toxic property, when CO enters blood it is absorbed by red blood cells in the blood and the formation mechanism blood is deteriorated.With inhaled a small amount of CO gas, it causes to dizziness, nausea and blurred vision and it is shown a killer feature when it is inhaled large amounts of [28].

7. Carbondioxide (CO_2)

CO_2 a greenhouse gas and is the main factor that leads to global warming in the Earth. CO_2 gas emissions enter the atmosphere with a large extent in the exhaust of vehicle engines with the plants and lives as a result of respiration and in energy production plants as burnt gas. In engine vehicles, power generation facilities and systems used for heating purposes, the quality of combustion participating in burning the air/fuel ratio determine and this ratio influences significantly the production of CO and CO_2.

There is an important relationship between formation of CO and CO_2. During burning the fuel increase CO emission level if it is not reached the value of sufficient air as a result of incomplete combustion. Maximum formation of CO causes reductions in the amount of formation CO_2. On the other hand, because of combustion is not good enough it is not reached to high temperature combustion as a result NOx is reduced. If the amount of air is much from stoichiometric ratio, it is seen this opposite [29]. OH root plays an important role in conversion of carbon monoxide to CO_2 and this root occurs with following reaction and the OH root react with CO again and it is converted to CO_2.

$$H + H_2O \leftrightarrow OH + H_2$$
$$H + O_2 \leftrightarrow OH + O$$
$$CO + OH \leftrightarrow CO_2 + H$$

In the combustion process, at the state complete combustion occurs the regional incomplete burns and increases the formation of CO, the CO_2 gas also decreases accordingly. As temperature and pressure increases, the concentration of CO increases depending on the oxidation reactions. To form CO_2 by breaking down into CO_2 reacts with oxygen varies in direct proportion to the increase in the combustion chamber temperature.

CO_2 has the ability to absorb long-wavelength infrared radiation that comes to earth. CO_2 balances the heat that are required for lives in the world, methane, water vapor and other greenhouse gases by keeping a portion of this heat radiation,. However, CO_2 allows for the passage of short wavelengths of radiation in the atmosphere. With the increase in CO_2 in the atmosphere by absorbing more infrared light is blocked out of their. This event is known as the greenhouse effect causes warmer to atmosphere and it causes global warming. Unless taking precaution reduce emissions of gases that cause global warming, the temperature on earth will be increase each year and consequently a temperature of earth the next century is expected to be increased between 2 and 5°C [30-33]. Accordingly, with global warming, melting glaciers and polar sea-level would raise, flood a portion of the black pieces is expected to be caused

8. The Effect of Acid Rain on Environment and Live Health

The exhaust gases from motor vehicles, energy-producing thermal power plants using fossil fuels, and industrial activities and residential heating using fossil-based fuels make the air dirty by emitting pollutants such as sulfur dioxide, nitrogen oxide, particulate matter and hydrocarbon emissions. These contaminants may remain suspended in the air for a few days; and ultimately they undergoe various chemical reactions which can be carried too far in the atmosphere. In the meantime, these pollutants in the atmosphere react with moisture in the air and they complete the chain reactions by reacting with other component, and sulfurous acid (H_2SO_3), sulfuric acid (H_2SO_4) and nitric acid (HNO_3). Occurrences of these chemical compounds are precipitated in rain and they provide to form acid rain. These harmful compounds may reach to levels that may directly affect human health, as a result, acid rain indirectly effect people, especially children's health with precipitation in soil [34]. As a result of combustion events, a variety of airborne SO_2, SO_3, NOx gases in the atmosphere cause the formation of acid and acid rain forms by reaching to earth these acids.

Acid rain affects the biological conditions and chemical structure of soil. It carry to deep soil by washing that is consist of the soil such as calcium, magnesium, elements, and it causes to weakening of soil and to decrease efficiency in agriculture. In addition, acid rain hinders the activities of beneficial microorganisms that is provided enrich the soil by breaking down organic matter in terms of live. Beside these, acid rain affects other organisms and leads to deterioration of the ecological balance among lives. The most contributing substances are sulfur compounds and acid moisture in the acidification of soil. Nitrogen compounds play a role in the acidification of soil when the soil is more than the amount of absorbing the soil. In addition, soil moisture creates harmful effects trough drinking water or food chain by reacting poisonous substances such as mercury, cadmium thatinsoluble under normal conditions or aluminum. Acid rain does negative impact on drinking water, groundwater, soil, heavy metals, plants and fishes. Acid rain cause, as a result, by using these influenced substances, storage of acids in the human body in the long term.

9. Particulate Matter (PM)

PM is the umbrella term used for a type of emissions, consisting of varying and complex mixtures of particles suspended in the atmospheric air. The main components are organic compounds, biologic origin materialsreactive gases, and the soot [35]. PM is made up of tiny particles formed as the result of the combustion processes. They also come from the dust, smoke from power plants, engines and industry. The main outdoor sources of PM's are internal combustion engines, power plants and the biomass combustion [36].

PMs are classified by their sizes. Particles in diameter less than 10 microns are named as PM10, and those are less than 2.5 μm are PM2.5. If the diameter of the particles are smaller than 0.1μm, it is called ultrafine particle, smaller than 1 μm it is called fine particle and larger than 1 μm it is called coarse particle [37, 38].

Exposure to high concentrations of PM that are small enough to inhale and pass into the lungs and bloodstream can decrease lung function and cause respiratory symptoms, chronic bronchitis, nonfatal heart attacks, irregular heartbeat and early death in people with heart or lung diseases. Particulate matter makes lakes and streams acidic, changes or reduces coastal water and soil nutrients and damages forests and farm crops.

10. Volatile Organic Compounds

VOCs (Volatile organic compounds) are made up of hydrocarbons, aldehydes, alcohols, and ethers. VOCs play an important role in ozone formation and are emitted by vehicle engines and many industrial applications. Their sources are also cleanning agents used indoors. They are emitted as gases from many solids or liquid fuels especially in vehicles fuel tanks. VOCs include a different types of chemical gasses those may inherently have shortterm and longterm harmfull health effects.

11. Conclusions

This paper is an overview of the engine and air pollution problem especially in the urban areas. The combustion processes of diesel and gasoline fuels in realted engines and other hydrocarbon fuels in termical machines are main sources of air pollutant emissions. These main pollutants are NOx, CO_2, SOx, HC, CO, PM, lead, and VOCs. All these emissions are firstly introduced and classified in the view of their sorces and formation processes. Then, their negative and harmfull effects on global warming, environment and human healt have been presented.

In many energy production systems in energy production facilities, CO, HC, CO_2, SO_2, NOx and PM emissions are formed. In inernat combustion engines vehicles combustion of fuels are found to be the most considerable sources of many presented emissions. These emissions become an important problem to particularly of human, animal and plant health, and environmentally. A lot of works are done for dropping of exhaust emission levels or being brought under control. For this purpose, it is used including dual-fuel systems and a wide variety of utilizing high-performance alternative fuels. Most of the developed countries provide exhaust emission levels within certain limits by emission regulations and emission standards.

In developed countries, air pollution by taking to be treated with cautions against the problem of exhaust emissions were prepared emission standards and developed new control techniques. At the beginning of 1993, European Union countries put into action the ECE R 49.02 (EURO I) Norm; this norm brings various restrictions on exhaust emissions and noise standards. This norm has been adopted as TS 10623 standard in Turkey.

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