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Original Article

Vehicular Pollution and it's Impact

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Abstract

India's most polluted cities are Kanpur, Varanasi, Patna, Gaya, Delhi, Mumbai, and Chennai. According to World Health Organization (WHO) global database (2016), Kanpur is the most polluted cityin the world, followed by Faridabad, Varanasi, Gaya, Patna, and Delhi. Many manufacturing industries, textile mills and laboratories are responsible for air pollution in Kanpur city. However, Delhi has the highest concentration of dust particles in the air i.e., 700 $\mu g/m^{3,}$ among metropolitan cities of the country. Ahmedabad has a number of cotton mills, which are primarily responsible for air pollution.

The world's most polluted fourth megacity is Mumbai. The Chamber-Trombay region of Mumbai has a majority of industrial units, which has dust particle concentration and PM_{10} levels of 238$\mu g/m^3$and 104 $\mu g/m^3$in the atmosphere. Vehicular pollution is the second major contributor to air pollution after industries. According to a WHO report, 92% of world's population breathe in polluted air as per the WHO global database as depicted in Air pollution is the greatest environmental risk, which affect health of human and other living creatures. Epidemiological evidences have suggested that cases of health problems due to air pollution are rapidly growing.

Air pollution can be controlled and many cities have succeeded in their attempts to control air pollution. Countries like England, Singapore and China have initiated strict action in order to control air pollution due to vehicular transport, such as banning 15 year old vehicles for transportation purpose. In India, Delhi and Mumbai have adopted the same strategy to control vehicular air pollution due to the fact they are the worst case scenarios.

Karnataka Government has also supported the scrapping policy of vehicles more than 15 years old. Diesel vehicles more than 15 years old, used for public transportation are banned in Bengaluru city while Karnataka Government has opposed the same ban in case of private vehicles. In spite of this, transportation agencies hardly adhere to this rule. Moreover, Bengaluru requires 8700 traffic police personnel in order to manage the increasing vehicular population. However, Karnataka Government has sanctioned only 3,594 posts in Bengaluru city, out of which only 3090 are filled and 504 posts are still vacant.The city still requires more than five thousand traffic police in order to manage vehicular population (CiSTUP, 2016; Dev A. 2016).

In India, vehicular emissions are primarily controlled by establishing and enforcing vehicular emission norms, inspecting and maintaining systems (IMS), applying traffic and congestion management, use of cleaner fuels, awareness programs, and using public transport. Poor urban

planning has led to increased requirement for private transport, which plays a significant role in increasing pollution due to vehicular emissions. Bengaluru city has a population of 11 million, which officially has seven million registered vehicles and has the second largest vehicle population after Delhi. The present vehicular population is 6.72 million in Bengaluru, majority of vehicular population is contributed by two wheelers that accounts for 4.65 million vehicles, i.e., 70% as compared to other transport vehicles such as 0.13 million taxis, 1.35 million private cars and the remaining 0.17 are autorickshaws (The Economic Times, 2017). Vehicular air pollution may lead to health issues, either due to short orlong term exposure to different pollutants such asparticulate matter, ozone, nitrogen oxide, and sulphur dioxide.

Keywords: When You can't Breathe; "Nothing Else Matters "

Introduction

Motor vehicle emissions are basically responsible for production of two types of air pollutants, primary and secondary air pollutants. The primary pollutants are directly released from the vehicle exhaust, while secondary pollutants result from components that react with the primary vehicular pollutants. The primary vehicular air pollutants are carbon dioxide, carbon monoxide, hydrocarbons, sulphur dioxide, nitric oxide and particulate matter. The secondary vehicular air pollutants are ozone, nitrogen oxide and salts of nitric acid or sulphuric acid (Faiz, Weaver and Walsh, 1996; Agbaire, 2009). Vehicles are powered mainly by diesel and petrol, but they can also be powered by other fuels such as alcohol (methanol and ethanol), alcohol and gasoline blends and nowadays a cleaner fuel is used i.e., LPG and CNG. Vehicles powered by diesel and petrol are a major air pollution contributor and these vehicles emit more than 50% of nitrogen oxide in the atmosphere, which is a primary source of global warming. Diesel powered vehicles are a major air polluter among diesel and petrol fuelled automobiles. Different types of vehicular pollutants emitted are as follows:

Ozone Gas

Ozone, a trioxygen (O_3) has both good and harmful effects. Almost 90% of ozone gas, i.e., 'good ozone'is present in the upper layer of the atmosphere called as stratosphere, 30 miles from the earth's surface, which is known as the ozone layer, shielding from harmful ultraviolet radiations. The remaining 10% of ozone gas is present in the troposphere, the lower layer of atmosphere, located 6 – 10 miles from the earth's surface, which is responsible for many health issues in human, climate change, greenhouse effects and affect flora and fauna. The secondary pollutant, i.e., ozone is primarily produced by the chemical reactions of nitrogen oxides (NOx) and volatile organic compounds (VOC)/carbon monoxide (CO)/ methane in the presence of sunlight and these components are emitted by automobile exhaust, power plants, industrial boilers, petrochemical refineries, chemical plants, etc. Ozone is also a key ingredient in smog production, which reaches highest level in hot and sunny days, mainly in urban areas. However, it can also attain high levels during colder months, a classic case of Delhi smog. The photochemical smog is a risk factor that is associated with many health problems among human beings such as asthma, reduced lung function and respiratory diseases.In spite of the fact that, ozone is a short-lived pollutant in the troposphere, however, it is a chief component of greenhouse gases (Atkinson, 2000; US EPA, 2005).

Nitrogen Oxide

Nitrogen dioxide (NOx) is a collective term used for all the oxides of nitrogen such as nitric oxide (NO), nitrogen dioxide (NO_2), nitrous oxide (N_2O), dinitrogen trioxide (N_2O_3) and nitrogen pentaoxide (N_2O_5). Vehicular exhausts are chiefly responsible for NO and NO_2 emissions and other sources include manufacturing and power industries (Faiz, Weaver and Walsh, 1996; Atkinson, 2000). NO_2 is reddish brown and extremely reactive in ambient air. NO_2 is produced by either direct combustion of fuel or indirectly from other chemical reactions in the atmosphere while NO is produced due to the indirect result of fuel combustion (Han and Naeher, 2006). Usually NO_2 levels are higher in winter as compared to the summer and it decreases significantly due to increase in distance downwind from traffic. Many studies have contributed to the conclusion that vehicular exhausts are the primary source of NO_2 in ambient air (Gilbert et al., 2003; Department of

Environment and Energy, 2005b; Crouse, Goldberg and Ros, 2009).

Sulphur Dioxide

Sulphur dioxide (SO_2) is a highly toxic gas, primarily produced due to burning coal, petroleum and other fuels, which are often present in an impure form in the environment. It can also be produced by smelting of mineral ores containing sulphur. Previously, the sulphur content of diesel and gasoline vary as per the Bharat Stage (BS) III norms and BS IV norms, implemented nationwide and in selected cities, from the year 2010. However, nationwide only BS IV norms are implemented in order to control SO_2due to vehicular transport (Faiz, Weaver and Walsh, 1996, Department of the Environment and Energy, 2005; Atkinson, 2000).

Carbon Monoxide

Carbon monoxide (CO) is a colourless, odourless and poisonous gas, primarily emitted by automobile exhaust. The other sources are household devices such as air conditioner, fridge and heater, industrial processes and natural process such as volcanic eruption and forest fire. This gas is produced during incomplete burning of fuels in lower or little amount of oxygen in automobile engines (Faiz, Weaver and Walsh, 1996; Han and Naeher, 2006). High levels of CO are generally found in heavy traffic and congestion areas. Moreover, traffic tunnels may accumulate CO due to their roofed structure. Chow and Chan (2003) studied 11 enclosed tunnels and observed that CO levels are higher inside the tunnel than outside. This level increases during peak hours from 6–21 ppm to 8 to 28 ppm and suggested for a better ventilation system design in order to prevent accumulation of CO in the enclosed tunnels.

Carbon Dioxide

Carbon dioxide (CO_2) is a naturally occurring gas and part of the breathing process of human beings, animals and plants. Hence, not considered a pollutant. However, the increased amount of CO_2 is a result of combustion of fossil fuels, which includes automobile fuels, industrial operations and deforestation that is associated with many problems such as global warming and health effects on human beings (Vehicle Exhaust Emissions, 2017).

Volatile Organic Compounds

Volatile organic compounds (VOCs) are basically chemicals that readily evaporate and become gases at normal temperatures and pressures. These are primarily solvents used in paints, wax, and varnishes. VOCs are also called as unburned hydrocarbon, composed of hydrogen and carbon. However, their long term exposure has led to many chronic health problems. VOC playsa role in ozone and smog formation. More than 300 different kinds of VOCs can be detected by chromatography. However, the VOCs related to vehicular emissions are aromatic compounds such as benzene, toluene, ethylbenzene and isomers of xylene (ortho, meta and para-xylene). Benzene naturally occurs in petrol and diesel less than 2%, but it is a toxic and carcinogenic gas and may lead to leukaemia due to long-term exposure (Han and Naeher, 2006; https://www.greenvehicleguide.gov.au/pages/Information/Vehicle Emissions). VOCs is converted to carbon dioxide and water in case of complete burning, which is less toxic, however incomplete burning can result in carbon monoxide production, which is more toxic and eventually can contribute to smog.

Particulate Matter

Particulate matter (PM) is primarily solid particles and liquid droplets that are suspended in air. They can arise from natural and anthropogenic activities. Naturally occurring PM sources are soil and pollen grains while anthropogenic sources are burning of fuel and waste, vehicular transport and industrial operations. Most of the PM is generated from automobile exhaust. PM can be categorized into three classes depending upon size: Total Suspended Particulate Matter (TSPM), Respirable Suspended Particulate Matter (RSPM) and Fine Suspended Particulate Matter (FSPM). TSPM is largest among all PMs and has a size of >10μm and <70μm and settle down in a short period of time due to high setting velocity. RSPM is also known as PM_{10} because the particle size is less than 10μm and FSPM is known as $PM_{2.5}$, has particle size less than 2.5μm PM consists of mineral dust, pollen grains, water, carbon black, ammonia, sodium chloride, heavy metals (like iron and lead) and manyions such as sulphate and nitrates. PM can cause respiratory problems by entering lungs of a human being as smoke released from vehicles and factories. It can also blacken buildings, which is a major problem from the point of view of historic building preservation such as colour changes in the case of Taj Mahal. Carbon black is the primary component

of $PM_{2.5}$ and is also known as a short-lived climate pollutant (SLCP) due to its shorter persistence period as compared to CO_2 and it can drive climate change. Although, SLCP has shorter atmospheric lifetime, it is one of the major contributors to global warming and can decrease agriculture yield and also accelerate the melting process of glacier (Kumar et al., 2010; Hinds, 2012; http://www.aqhi.gov.hk/en/health-advice/health-effects-of-air-pollutantsa37a.html?showall =&start=5).

Ammonia

Ammonia is one of the vehicle exhaust pollutant, which has recently gained attention due to various health hazards due to formation of ammoniated aerosols and includes studies in closed tunnels and specific types of vehicles (Kean et al., 2000; Gertler, Sagebiel, and Cahill, 2001; Durbin 2001, Pinder, Adams and Pandis, 2007; Paulot and Jacob, 2014). Ammonia from vehicle exhaust is very crucial in developing countries such as India and China due to comparatively higher emission norms than European countries and rapid increase in vehicular population. Yao et al. (2013) observed that more than 10% ammonia is contributed by automobiles in urban areas. Sun et al. (2017) had studied vehicular ammonia emission in US and China and observed that ammonia emission from vehicle exhausts are higher in US than in China. Many automobile companieshave introduced three-way catalystsystemsin their vehicle exhaust, with good efficiency to reduce NOx emissions, hence, now ammonia dominates among the vehicle pollutant in reactive oxygen species category (Bishop and Stedman, 2015). Moreover, SO_2 and NOx pose serious health hazards in many countries, including India.

Lead and Heavy Metals

Lead and other heavy metals are found in ambient air as either toxic compounds or aerosols, emitted by the exhaust from industries and fly ash from the incinerator or thermal plants. Previously, lead was also released into the atmosphere due to vehicular exhaust, however, leaded petrol and diesel have been phased out in India since 1995. However, braking system of automobiles and heavy metals such as iron, copper, chromium, strontium, manganese and antimony are potentially harmful to human health (Pucher et al., 2005; Schauer et al., 2006; Kam et al., 2013).

Conclusion

Most ambient air pollution emissions are from either local or regional sources, however, under certain atmospheric conditions air pollution may travel long distances across countries, such as windblown dust, particulate matter, fungal spores and bacteria, which may have an impact on human health and cause poor ambient air quality in remote areas. Hence, global cooperation is required to tackle sources of air pollutants. Local and regional efforts should be initiated to manage air pollution.

The wording of Roy Chowdhury for Kanpur city is"If Kanpur does not want to wheeze, choke and sneeze, it has to act now. Its work with CNG shows that it can make a difference. It is time to set new terms of action." The same can be applied for Bengaluru city. Hence, this is the peak time to control and implement measures in order to control vehicular air pollution. As cars are the major source of air pollution in urban areas, people can use either public transport system, walk or use bicycle for shorter distance or household work. Moreover, a car owner should drive efficiently in order to save fuel and money, which eventually can control vehicular air pollution. Moreover, manufactures have modified their cars, where conventional gasoline engines are now routinely fitted with catalytic converter, remove exhaust gases pollutants in minor quantity. In some cases, it is better to avoid cars, such as increased smog; it will reduce visibility and affect the driver's efficiency, which will further reduce the ambient air quality. Some measures can be taken to reduce vehicular air pollution, such as CNG program strengthening, introduction of more advanced and cleaner vehicle technologies and fuel, implementation of transport and mobility plan for Bengaluru city, encouraging public transport system, introduction of parking policy to reduce congestion and use of electrical vehicles. Other nationwide measures are implementation of better national fuel quality standard, support implementation of standards with tighter vehicle emission norms and promotion and use of alternative fuel. One such example is emission of SO_2. At present, strict emission standards are set in order to control the level of SO_2 in ambient air. Karnataka government is endeavouring the process to improve road quality, affectinghigh density traffic areas. Moreover, the Department of Urban Land Transport (DULT) has announced a Public Bicycle Sharing project in Bengaluru city, which will cover around 28 km in the first phase

expected to start by October 2018. Thus, all attempts are taken to manage vehicular pollution, and improving ambient air quality.

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