

# Research on the Impact of Automobile Exhaust on Air Pollution

Juntian Su\*

Guangzhou Foreign Languages School, Guangzhou, Guangdong Province, China, 510000

\*Corresponding author. Email: 113925138661@163.com

## ABSTRACT

With the rapid development of social economy in my country, there are more and more types of vehicles, which brings convenience to people's daily travel, but the exhaust gas formed by motor vehicles not only seriously affects the atmospheric environment but also endangers human health. Therefore, in this case, it is crucial to implement effective management of motor vehicle exhaust. The article takes the main components and hazards of motor vehicle exhaust as the starting point, analyzes the impact of motor vehicle exhaust on the urban air environment, and discusses the management methods of motor vehicle exhaust pollution. The main components of motor vehicle exhaust include carbon monoxide, hydrocarbons, nitrogen and oxygen, sulfur and oxygen compounds, lead and solid particulate matter. The impact of exhaust on the urban air environment is mainly to produce "acid rain", destroy the ozone layer, form photochemical smog and cause global warming. The four main approaches to combat the problem include: improving and implementing national standards; strengthening I/M management; developing alternative fuels; and raising public awareness of environmental protection.

**Keywords:** motor vehicle; exhaust; urban; atmospheric environment; impact; management

## 1. INTRODUCTION

With the development of the economy, the number of civil motor vehicle owners is increasing, the side effects of motor vehicle exhaust emissions on urban air pollution are becoming more and more obvious, and the governance of urban air pollution, the governance of motor vehicle exhaust emissions will be a key issue. Therefore, by summarizing the management measures of urban motor vehicle exhaust emissions and putting forward some specific opinions and suggestions in a targeted manner they can provide references and materials that can be drawn from for the management of urban air pollution in practice. This study focuses on the measures and methods of how to abate air pollution through motor vehicle exhaust emission management.

## 2. MAIN POLLUTION COMPONENTS OF MOTOR VEHICLE EXHAUST AND THEIR HAZARDS

Motor vehicle exhaust is composed of gaseous compounds and solid particles produced by the combustion of fossil fuels such as gasoline and diesel by fuel-fired motor vehicles [1], and these gaseous

compounds and solid particles contain a large number of harmful substances. Since motor vehicle exhaust is a low-altitude emission that is not conducive to its diffusion, it tends to accumulate in the atmosphere or further transform and migrate to form pollution sources, leading to the formation of atmospheric pollution and causing harm to humans.

### 2.1 Carbon monoxide (CO) pollution and hazards

The main gas compound in automobile exhaust is CO, which is produced by the insufficient combustion of automobile fuel and has certain harmful effects on the human body. The oxygen content in human blood decreases, which eventually leads to the inability of human blood to carry out normal oxygen exchange. When the human inhales a small amount of CO, it will appear dizziness, nausea, headache, weakness, sleepiness, and other symptoms. Long-term inhalation will reduce human memory and injury to the human nervous system, while a short-term inhalation of a large amount of CO will lead to human coma or even suffocation death.

## **2.2 Hydrocarbon (HC) pollution and hazards**

### **HC**

In motor vehicle exhaust mainly from tank leakage, fuel volatilization, and fuel in the combustion chamber is not fully combustible [2]. The HC concentration in motor vehicle exhaust varies widely and is mainly determined by the operation of the motor vehicle engine. When the motor vehicle engine is running at high speed, the fuel is fully combusted, and the concentration of HC in the exhaust is low; when the motor vehicle is just started or idle, the fuel is not fully combusted, and the concentration of HC in the exhaust is high. HC in exhaust gas mainly includes methane, propylene, acetylene, polycyclic aromatic hydrocarbons, benzene and its derivatives, aldehydes, butadiene, etc. These substances have different degrees of harm to the environment and human body, among which methane is one of the culprits leading to the greenhouse effect. Other gases have different degrees of irritation, and some components will form toxic photochemical smog under sunlight and specific conditions. Some of the constituents will react photochemically under sunlight and specific conditions to form toxic photochemical smog that can cause harm to humans. When the human body inhales HC in the short term, it will harm the human respiratory system and the conjunctiva of the eyes, causing nausea, dizziness, and other symptoms, and long-term inhalation in large quantities will harm the human nervous system and immune system, causing the human body to have toxic reactions and even induce cellular aberrations or cancer, leading to death.

## **2.3 Nitrogen oxides (NO<sub>x</sub>) and sulfur oxides (SO<sub>x</sub>) pollution and hazards**

NO<sub>x</sub> and SO<sub>x</sub> are also the main components of motor vehicle exhaust. NO<sub>x</sub> in motor vehicle exhaust is mainly nitric oxide (NO) and nitrogen dioxide (NO<sub>2</sub>), which is dominated by NO. NO is about 9 times more than NO<sub>2</sub>. NO<sub>x</sub> is mainly from the by-products of fuel combustion. The mechanism of NO harm to the human body is similar to that of CO. At the same time, NO is also irritating and will stimulate the mucous membrane of the human upper respiratory tract, bronchial mucous membrane, and lungs after being inhaled, causing inflammation. Unlike CO, NO is very unstable and will be oxidized to NO<sub>2</sub> by oxygen in the air. SO<sub>2</sub> will be adsorbed on the surface of the catalyst of the exhaust gas purification device, causing the catalyst to be unable to fully contact the exhaust gas, resulting in the reduction of the function of the exhaust gas purification device of motor vehicles.

## **2.4 Lead (Pb) pollution and hazards**

Gasoline and diesel fuels are the fuel required by motor vehicles. Gasoline and diesel fuel have poor physical and chemical stability and are prone to volatilization and combustion explosions. To passivate gasoline and diesel fuel to make them relatively stable,

tetraethyl lead is usually added to motor vehicle fuel at a concentration of 0.2% to 0.5%. Tetraethyl lead is burned in the engine combustion chamber to produce lead oxide and is deposited in the combustion chamber to form ash. Pb is one of the five serious toxic heavy metals identified by the state, and the Pb in motor vehicle exhaust will directly inhibit the formation of hemoglobin in the human body, leading to anemia. Moreover, Pb will enter the body's organs with the blood circulation, endangering the human peripheral and central nervous system, as well as the human immune system, and causing lead kidney disease in serious cases.

## **2.5 Particle pollution and hazards**

The exhaust of motor vehicles contains a large number of respirable solid particles with a diameter of 0.03-0.50 $\mu$ m. The respirable solid particulate matter in motor vehicle exhaust is a complex composition, mainly including carbon-containing particulate matter, polymer compounds, and other unknown components, of which polymer compounds have adsorption effects on atmospheric bacteria, viruses, volatile substances, and heavy metals. Since the location of motor vehicle emissions and human respiratory belt height is the same, the human respiratory system becomes the most direct target of such pollutants. When the human inhaled such pollutants will directly endanger the human respiratory system, resulting in acute inflammation of the human upper respiratory tract and lungs, causing pulmonary edema, lung cell damage, etc. in severe cases. Such pollutants will not only remain in the human lungs for a long time but also in the blood circulation into other organs of the body. Because it absorbs more bacteria, viruses, volatile substances, and heavy metals, it can greatly increase the risk of human illness.

## **3. THE IMPACT OF MOTOR VEHICLE EXHAUST ON THE URBAN AIR ENVIRONMENT**

An important factor why motor vehicle emissions have a greater impact on the urban air environment is the total amount of urban traffic, which is mainly reflected in the number of motor vehicles. The greater the number of motor vehicles in the same condition, the more serious the pollution will be. Moreover, the actual operation of motor vehicles also has a greater impact on the number of motor vehicle emissions, i.e., the longer the motor vehicle has been in operation, the greater the number of emissions will be.

### **3.1 Generation of "acid rain"**

The pollutants emitted from the exhaust of motor vehicles contain nitrogen oxides and a small amount of sulfur dioxide, etc. Nitrogen oxides are produced during the combustion process of the engine, and when combined with water vapor in the atmosphere, acid rain

will be formed [3]. Meanwhile sulfur dioxide is related to the composition of motor vehicle fuel, and when sulfur dioxide reacts chemically with water in the air, acid rain will also be formed.

### **3.2 Ozone**

Nitrogen dioxide from nitrogen oxides produced during engine operation, when exposed to sunlight, produces a chemical reaction to form atomic oxygen, which, due to its strong oxidizing characteristics, reacts with oxygen to form ozone, which is one of the reasons for the current urban air ozone exceedances; the generated nitric oxide also tends to destroy the ozone protective layer.

### **3.3 Photochemical smog**

When a motor vehicle runs with its fuel in an incomplete combustion state, it produces hydrocarbons, which are catalyzed by the strong ultraviolet rays of the sun, and the hydrocarbons react chemically with nitrogen oxides, thus forming photochemical smog, which is harmful to humans.

### **3.4 Global warming**

Motor vehicle exhausts emit a large amount of carbon dioxide, and the main cause of global warming is the increase of the greenhouse gas carbon dioxide.

## **4. MANAGEMENT METHODS FOR THE IMPACT OF MOTOR VEHICLE EXHAUST ON THE URBAN AIR ENVIRONMENT**

### **4.1 Improve and implement national standards**

China started late in the prevention and control of motor vehicle emissions, so it is especially important to continuously improve and implement the standards in this area in China. The release and implementation of two new national standards, "Emission Limits and Measurement Methods for Diesel Vehicles (Free Acceleration Method and Loading Deceleration Method)" (GB3847-2018) and "Emission Limits and Measurement Methods for Gasoline Vehicles (Double Idling Method and Simple Working Condition Method)" (GB18285-2018), provides important technical support for the prevention and control of air pollution from in-use diesel vehicles, gasoline vehicles, and non-road mobile diesel machinery. It is an important technical guarantee to resolutely win the battle of blue skies and fight the battle of diesel truck pollution control. First of all, we must actively promote local legislation on motor vehicle pollution prevention and control, and formulate a new standard upgrade plan based on the actual situation of urban motor vehicle emission testing. The government should speed up the implementation of two new national standards, the detection and popularization of the heavy-duty diesel vehicle loading deceleration method, so as to

ensure the improvement of motor vehicle supervision and control the negative impact of motor vehicle exhaust emissions on the urban air environment. Second, the city's environmental protection testing institutions should rapidly increase and update hardware equipment in accordance with the requirements of the new standard, and do a good job in the metrological verification of new equipment and the expansion of metrological certification, so as to ensure the smooth implementation of the new standard.

### **4.2 Strengthen I/M management**

To effectively improve urban ambient air quality and promote the healthy and orderly implementation of motor vehicle pollution prevention and control, it is also necessary to fully promote the implementation of I / M management. I/M management in the I mainly refers to the implementation of regular vehicle emissions testing, which is an important part of the daily "annual vehicle audit", while M mainly refers to motor vehicle emissions performance maintenance (repair). Combined I/M is mainly referring to the regular testing of the real emissions of motor vehicles, so that motor vehicle purchasers can implement effective maintenance for motor vehicles, to ensure that motor vehicles can always be in a better exhaust emission state, and then effectively avoid false maintenance and maintenance of vehicles reinspection difficult to meet standards and other issues. Meanwhile, it is also helpful to achieve the vehicle "inspection, maintenance, reinspection" closed-loop management, and constantly improve the comprehensive management of motor vehicle exhaust pollution capacity. Although the current I/M management system in my country is adopted, the specific implementation cannot achieve the pre-set goals due to the inability to combine the implementation of the specific situation with the supplementary improvement [4]. In addition, many people do not pay attention to the problem of pollutants emitted by motor vehicle exhaust, which will lead to serious air pollution from motor vehicle exhaust emissions. Under this circumstance, it is necessary to strengthen the management and implementation of the I/M system, which helps to control vehicle emissions and protect the environment.

### **4.3 Development of alternative fuels**

At present, the fuels used in motor vehicles mainly include gasoline and diesel, but after these fuels pass through the power system, they will release a large amount of exhaust gas that is harmful to human health and affects the quality of the environment. To control their impact on the atmosphere, alternative fuels, including compressed natural gas and liquefied petroleum gas (LPG), need to be developed. They can serve as an alternative to gasoline and diesel and also help reduce real emissions in cities. In addition, compressed natural gas and LPG, two types of natural gas that emit

low-carbon oxides, can be used as new fuels to promote motor vehicles due to the abundant natural gas reserves in my country. [5].

#### ***4.4 Raising the public's awareness of environmental protection***

Raising the environmental awareness of the general public to achieve good management of the adverse effects of motor vehicle emissions on the urban air environment from the root. In a specific way, it should be used in many media such as newspapers, TV, communication devices, car TV, etc., to promote knowledge about energy saving and environmental protection to the general public, and to do a good job of promoting China's policy in the purchase of clean energy vehicles, etc., to continuously enhance the general public's awareness of environmental protection. In addition, we must also pay attention to the publicity and popularization of motor vehicle emissions on the atmosphere and the human body itself. "June 5th" World Environment Day, the government should make good use of the daily open day, and let the general public effectively understand the emission reduction of motor vehicles through the broadcast of environmental protection short videos, the distribution of brochures, and environmental protection lectures. This is not only extremely beneficial to protect the environment, but also extremely important to protect your own health. It is also necessary to increase the publicity and guidance to the majority of car owners, and advocate not to buy or use large-displacement cars. Advocate green travel and choose travel modes such as shared bicycles and public transportation. At the same time, remind car owners to pay attention to the daily maintenance and repair of vehicles, eliminate heavy loads on the road, establish good driving habits, etc., and encourage environmental responsibility.

#### ***4.5 Improve the responsibilities of regulatory departments***

In the current regulatory system for the prevention and control of motor vehicle emissions, it is important to highlight the important position of the environmental protection department, clear objectives, division of responsibilities, multiple measures to strengthen regulatory measures to further strengthen the comprehensive pollution prevention and control of motor vehicle emissions. For the environmental protection department, this work is mainly carried out in strict accordance with relevant laws and regulations. The first is to strengthen the supervision of motor vehicle emission inspection institutions, and to strictly manage the assessment and management of motor vehicle emission inspection institutions. Through on-site inspection process inspections, online video inspections, platform data inspections, and key vehicle spot checks, the government implements "double randomness, one disclosure" (random selection of inspection objects,

random selection of law enforcement inspectors, and timely disclosure of investigation results) and several effective measures to further improve the effectiveness of the supervision of motor vehicle emission inspection agencies. Second, the government should improve the quality traceability system for inspection work, establish a linkage mechanism for the law enforcement of motor vehicle exhaust pollution by the environmental protection and public security departments, normalize the joint law enforcement work on road inspections for motor vehicle exhaust pollution, and implement centralized parking of roads and vehicles to monitor random testing. Third, strengthen the management of new car purchase access. The environmental protection department and the public security department should closely cooperate with the supervision of automobile production and sales, jointly carry out environmental protection inspections in the registration of new vehicles, and strictly enforce vehicle access. Finally, increase the application of scientific and technological means of motor vehicle pollution prevention, strengthen the construction of motor vehicle supervision platform, to achieve the whole process of motor vehicle emissions inspection, all-round monitoring; the use of mobile remote monitoring equipment in key sections of the city, the road motor vehicle exhaust remote monitoring, remote monitoring, and road inspection and road inspection of excessive data screening and pushing work, to promote the implementation of information technology and modernization of motor vehicle testing, strengthen the inspection Data audit and analysis, remote video monitoring and on-site inspection linkage. In addition, it is necessary to further promote urban high-emission diesel vehicles, urban "oil, road, and vehicle" governance, and in-depth implementation of clean diesel vehicles, clean diesel engines, clean transportation, and clean oil. And the government should strengthen the supervision and sampling of non-road mobile machinery emissions, including large urban construction sites, logistics parks, agriculture, landscaping and other places. All departments should also conduct supervision and spot checks on the use of various types of machinery. Especially during the early warning period of heavy pollution in winter, supervise and spot checks on machinery such as snow removal and cleaning in winter. Finally, the government must establish and improve a long-term mechanism to promote the realization of the important goal of energy saving and emission reduction of motor vehicles.

## **5. CONCLUSION**

Congtrolling urban air pollution can be conducted by controlling motor vehicle emissions. The main methods of treatment are from the policy aspect, to improve and implement national standards to provide important technical support; to strengthen I/M management to promote the healthy and orderly development of motor

vehicle pollution prevention and control; to develop alternative fuels to effectively reduce the actual emissions of motor vehicle exhaust; and to improve public awareness of environmental protection to reduce vehicle exhaust emissions from the root. However, the focus of economic development of each city is different, and the mechanism of air pollution formation is also slightly different, so this paper refers to the reduction of urban air pollution through motor vehicle exhaust pollution control. This does not exhaust all cities, but only provides a way of thinking. Further targeted analysis and analysis of cities with better air quality are needed to provide more targeted opinions and suggestions on motor vehicle management.

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