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**AUTOMOBILE EXHAUST EMISSIONS AND ITS CONTROL TECHNIQUES:**  
**A REVIEW**

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### Abstract

*The biggest Problem of the 21st century is the Global warming caused due to Greenhouse effects which have their source in the automobile emission. Today if we look at the scenario of the modern world, If the two world war is between human beings, then the third one will be between human being and the nature. The main pollutants contributed by automobiles are - carbon dioxide (CO<sub>2</sub>), nitrous oxide (N<sub>2</sub>O), methane (CH<sub>4</sub>), and other pollutants- carbon monoxide (CO), total nitrogen oxides (NO<sub>x</sub>), sulphur dioxide (SO<sub>2</sub>), and particulate matter which all are responsible for a number of adverse environmental effect such as global warming, death of rain forests, acid rain, photochemical smog, health hazards and reduced atmospheric visibility. In addition to this, all fuel burning systems emit CO<sub>2</sub> in large quantities and this is more concerned with the Green House Effect which is going to decide the health of earth. This paper reviews the new parameters of emission control techniques.*

**Index Terms:** *Emission control, Exhaust Gases, Exhaust gases consequences, Effect of pollutants, Emission control Techniques, Observations etc.*

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## 1. INTRODUCTION

In today's world, the Engines (C.I. or S.I.) are the key to the entire transportation sector. Transportation is the heart of modern industrialised world. Without the transportation performed by the millions of vehicles on road and at the sea, we would not have reached modern living standards. Petrol and Diesel are at the present principal fuels used for IC Engines. [1] The IC Engine is known as one of the major sources of air pollutants in the environment. The fuel oxidation process in the engine generates not only useful power, but also a considerable amount of pollutant emissions like carbon dioxide (CO<sub>2</sub>), carbon monoxide (CO), nitrogen oxide (NO<sub>x</sub>), unburned hydrocarbon (HC) and particulate matter (PM). CO<sub>2</sub> is mainly responsible for the global warming issues it creates a reflective layer in the atmosphere that reflects heat from the Earth back to the Earth's surface increasing the Earth's average temperature. Emission of many air pollutants from automobiles due to incomplete combustion of carbonaceous fuel have variety of negative

effects on health and environment. This continuously increasing emission of automobile exhausts, & industries is causing serious damage to the environment, causing harmful effects to human society. Automobile emission control techniques include all the technologies that help us reduce the air pollution causing emission. Various methodologies are implemented in order to control or reduce the automobile exhaust, and harmful gases. Recent inventions like Catalytic converter, Addition of various fuel additives, effective driving and road conditions, exhaust gases recirculation, etc. are implemented. There are many climate researchers who support the view that emissions of heat trapping gases (greenhouse gases) into the atmosphere, particularly CO<sub>2</sub>, from the combustion of fossil fuel, cause global warming. [6]. So in order to overcome or solve the problem of Global Warming some serious steps should be taken. Otherwise, we have to face serious environmental calamities in near future.

## 2. EXHAUST GASES AND THEIR CONSEQUENCES

### 2.1 Hydrocarbon (HC)

Hydrocarbon emissions result when fuel molecules in the engine do not burn or burn only partially. And they arise when vaporised unburned fuel or partially burned fuel products, leave the combustion region and are emitted with the exhaust. Unburned hydrocarbon emissions are independent of air/fuel rate.[7]Hydrocarbons react in the presence of nitrogen oxides and sunlight to form ground-level ozone, a major component of smog. Ozone irritates the eyes, damages the lungs, and aggravates respiratory problems. It is our most widespread and intractable urban air pollution problem. [3]

### 2.2 Nitrogen Oxides (NOx)

Under the high pressure and temperature conditions in an engine, nitrogen and oxygen atoms in the air undergoes reaction to form various nitrogen oxides, collectively known as NOx. (Nitrogen oxides). They also contribute to the formation of acid rain. [3]

In the combustion of near-stoichiometric fuel-air mixtures, the principal reactions governing the formation of NO from molecular nitrogen are: [7]

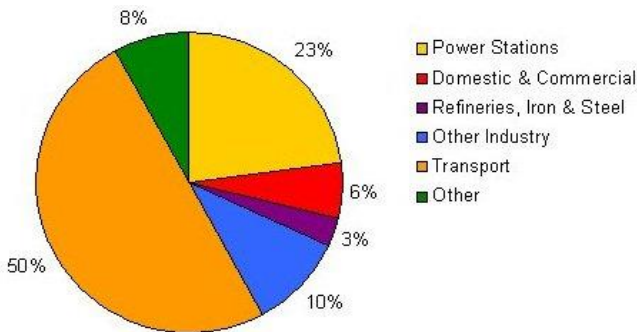


Fig-1:Sources of Nitrogen Oxides Pollution in the (2001)

### 2.3 Carbon Monoxide (CO)

This is one of the major pollutants present in the vehicle emission. The pollution due to CO is the main concern in areas with low population of modern three way catalyst gasoline vehicles. [4] Carbonmonoxide is a product of incomplete combustion and occurs when carbon in the fuel is partially oxidized rather than fully oxidized to carbon dioxide (CO). [3] Overexposure (carbon monoxide poisoning) may be fatal. (Carbon monoxide persistently binds to haemoglobin, the oxygen-carrying chemical in red blood cells, due to which blood circulation is affected. Carbon monoxide reduces the

flow of oxygen in the blood stream and is particularly dangerous to persons with heart disease. [3]

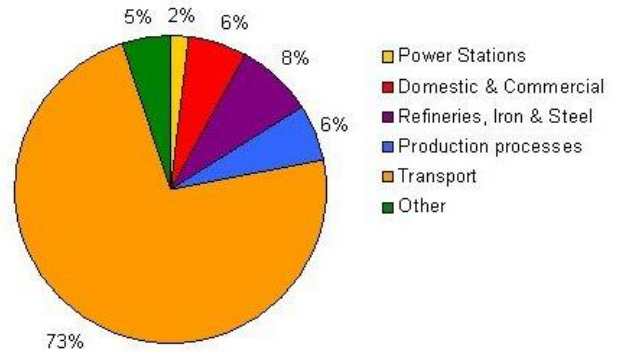
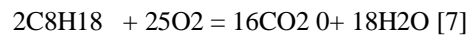


Fig-2:Sources of Nitrogen Oxides Pollution in the (2001)

### 2.4 Carbon Dioxide (CO<sub>2</sub>)

Carbon dioxide does not directly affect human health, it is not as lethal as carbon monoxide, but it is a “greenhouse gas” which traps radiation reflected from earth’s surface, and increases the temperature on earth, so contributes to the major problem to the nature that is “Global Warming”.

If a typical hydrocarbon octane, is taken to represent petrol, An equation may be written for the combustion occurring in the engine as follows: [7]



### 2.5 Photochemical Smog

The Components of automobile exhaust are particularly important in the formation of smog. Smog is a mixture of ozone, aldehydes, oxides of nitrogen and hydrocarbon.[7] It results from reaction of these compounds in the atmosphere through a complex chain mechanism requiring photolysis due to the action of sunlight. This Smog reduces the visibility on streets, during winter the visibility is almost restricted to about 1-2 m. This smog can cause various skin diseases. Photochemical smog causes severe irritation of the eyes, throat and respiratory system. In addition to this, it causes damage to some materials and is therefore, a major problem especially when it is held down in the local atmosphere of major cities by a temperature inversion. [7]

### 2.6 Lead Emissions.

One of the major source of lead is automobile emission. Just to increase the Octane number of fuel, tetra-ethyl lead is added and during combustion process in the engine, this lead is already present in fuel, we have:



**Issue**

The combustion of fuel (gasoline) containing lead (Pb) additives gives rise to large amounts of lead particulates, which are deposited downwind of highways. High lead levels from automobile exhaust are controlled by using unleaded gasoline.[7] Nowadays, Government is promoting lead free petrol in order to reduce pollution. Lead is highly dangerous to human health.

**2.7 Statistics of Exhaust Gases**

**Table-1: The table below shows how air pollution emissions have been declining since 1970.**

Pollutant	EMISSIONS Thousand Tones	Main Source
SO <sub>2</sub>	1127	Power stations
NO <sub>x</sub>	1685	Road transport
PM <sub>10</sub>	180	Construction, mining, quarrying / road transport
CO	3739	Road transport

**LITERATURE REVIEW**

**3.0 EMISSIONS CONTROL TECHNIQUES**

To increase engine efficiency we need improved engine design, more precise and accurate ignition timing and use of modern innovations of Engine management, innovation and implementation of new methodologies to minimize exhaust emissions and at the same time increase engine efficiency.

Advancements in engine design and vehicle technology continually reduce the toxic gases of exhaust leaving the engine, reducing toxicity is way more important than reducing the exhaust quantity. But only these things alone have generally been proved to be insufficient to meet emissions goals and standards. Therefore, new technologies to detoxify and reduce the quantity exhaust are an essential part of emissions control.

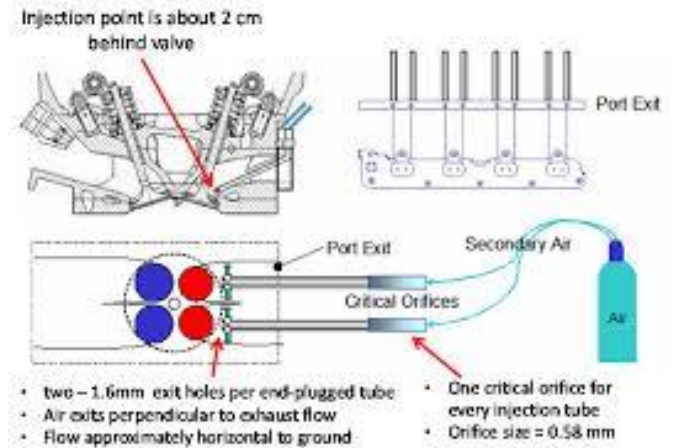
Following are the techniques to reduce the exhaust toxicity and proportions.

**3.1 Air Injection**

There was significant unburned and partially burned fuel in the exhaust of 1960s and early 1970s vehicles, this fuel was getting wasted and it also resulted in increasing toxicity of exhaust. As the automobile research advanced, so secondary air injection significantly reduced tailpipe emissions. Air injection systems provides oxygen via air to oxidize (burn) unburned and partially burned fuel in the exhaust before its ejection from the tailpipe.[10]The mechanism by which exhaust emissions are controlled depends on the method of injection and the point at which air enters the exhaust system, and varies during the development of the technology. This method is useful not only in reducing the wastage of fuel, (The unburnt fuel). The air so injected helps in combustion of unburnt fuel.[12][13] Combustion process requires fuel,

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oxygen and heat. Combustion cannot occur without any one of the three. Inside the exhaust manifold there is enough heat to support combustion process, so if we introduce some oxygen then any unburned fuel will ignite. This combustion will not produce any power, but it will reduce excessive hydrocarbon emissions. [9] And thus will reduce the exhaust gas toxicity, alternatively, helps in better fuel combustion and exhaust control.

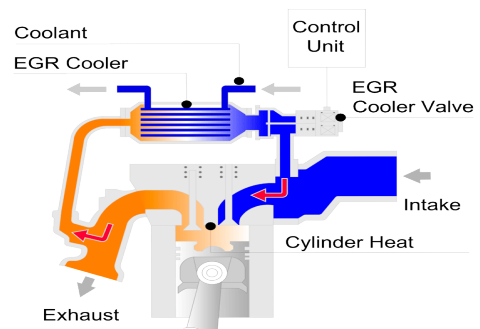


**Fig-3: Air Injection[11]**

**3.2 Exhaust Gas Recirculation (EGR)**

Exhaust gas recirculation valve (EGR) valve meters a small amount of exhaust gas into the intake system; due this the air/fuel mixture gets diluted, so as to lower the combustion chamber temperature.[9] EGR process involves by passing a calculated and specified volume (mass) of engine out exhaust back to engine to mix with fresh intake charge. Exhaust gases mainly consists of CO<sub>2</sub> and H<sub>2</sub>O, which are already combusted during previous cycle, they do not burn again when they are recirculate.[1] However, Effect of addition of these diluents to the intake charge for lowering of combustion temperatures and consequently reducing the formation of NO<sub>x</sub> [3](Heywood 1988). EGR is defined as a mass per cent of total intake flow, Since EGR process reduces performance of engine by diluting the air /fuel mixture, the system does not allow EGR action when the engine is cold or when the engine needs full power. [9]

$EGR = \frac{m_{EGR}}{m_i} \times 100 \%$ , Where “i” is the total mass flow into the engine. [1]



**Fig-4: EGR**

### 3.3 Evaporative Emissions Control

Gasoline evaporates quite easily. In the uncontrolled vehicles, fuel vapors from the fuel tank and carburetor were vented into the atmosphere that constituted about 20% of all hydrocarbon emissions from a gasoline passenger car. [3] In 1970 a legislation was passed, to prohibit venting of gas tank fumes into the atmosphere. A system was developed to eliminate this source of pollution called evaporative control system [3]. The working of this fuel evaporative control system is to trap and store evaporative emissions from the gas tank and carburetor [9]. The vapours produced in the fuel tank normally collect in the fuel tank itself, and are transferred via vent to the charcoal canister. When fuel vapour pressure becomes excessive. The fuel vapours from the tank and carburetor led to and adsorbed into the charcoal [3]. The fuel vapors adhere to the charcoal, until the engine is started, and engine vacuum can be used to draw the vapors into the engine, so that they can be burned along with the fuel/air mixture. A sealed gas tank filler cap is required in this system. This cap is so important to the operation of the system, that a test of the cap is now being integrated into many state emission inspection programs. [9] RTO offices used to check the cap. And proper maintenance of the tank and the cap should be maintained.

### 3.4 Modification in Engine Design

#### Modification in SI engine to reduce emission.

- ❖ Multi-port fuel injection systems, which can completely replace carburetors
- ❖ 4- Stroke engine to replace 2-stroke system, improved combustion chamber design and improved inlet manifold design for axial stratification of charge.
- ❖ Use of Electronic system for engine management to accurately regulate the amount of fuel supply to cylinders by sensing various engine parameters.
- ❖ Turbo-charged (TC) and Turbo-charged After Cooled (TCAC) engines.
- ❖ In research, Turbo-compounded engines are found to be up to 18 per cent better than the conventional engines, because turbochargers provides additional air for combustion process.
- ❖ After treatment, catalytic converter and exhaust gas recycling. [9]

### 3.5 PCV Valve (Positive Crankcase Ventilation)

To avoid crank case blow by phenomenon, a proper positive ventilation must be provided in crank case.

PCV valve is used to recover the vapours in the crankcase chamber, hence increases efficiency of the engine. The purpose of the positive crankcase ventilation (PCV) system, is to take the vapours produced in the crankcase of the engine during the normal combustion process, and redirecting them into the air/fuel intake system to be burned during combustion process. But there is a twist, these vapours dilute the air/fuel mixture so

they have to be carefully controlled and metered in order to not affect the performance of the engine. So, in order to maintain engine efficiency these vapours must be handled carefully. This is the job of the positive crankcase ventilation (PCV) valve.

### 3.6 Alternative Fuel

#### 3.6.1 Compressed Natural Gas (CNG) And Liquefied Petroleum Gas (LPG):

CNG is a clean fuel for vehicles with remarkable potential to reduce fine particles from the vehicular emission. [4] At present condition Compressed Natural Gas (CNG) is used widely as an alternative to gasoline and diesel

### 3.7 Biodiesel

Biodiesel is an alternative fuel similar to conventional or 'fossil' diesel. Biodiesel can be produced from straight vegetable oil, animal oil/fats, tallow and waste cooking oil. The process used to convert these oils to Biodiesel is called trans-esterification. Rapeseed represents the greatest potential for biodiesel production. Biodiesel has many environmentally beneficial properties. The main benefit of biodiesel is that it can be described as 'carbon neutral'. This means that the fuel produces no net output of carbon in the form of carbon dioxide (CO<sub>2</sub>). This effect occurs because when the oil crop grows it absorbs the same amount of CO<sub>2</sub> as is released when the fuel is combusted.

## 4. CONCLUSION

In this age of rapid advancement air pollution due to automobiles has become a critical concern for the environment. Today, in almost every country the majority of population is exposed to the poor quality of environment. The human beings have become exposed to different disease starting from a headache to serious diseases such as lungs cancer any many more. This indirectly leads to the economic loss of our country as financial resources are need to be spent for providing required medical facilities as well as effective measures to the affected public. Many environmental problems have been arising due to increasing pollution like Global Warming etc. Electric Cars is the best solution for this, we have to shift to battery powered vehicles, as the fossil fuel is constantly on the way of extinction, so we have to shift towards Renewable Energy Sources. Hybrid Electric Vehicles (HEVs) can be another best way. It uses the combination of engine of a conventional vehicle with electric motor powered by traction batteries and/or fuel cell. This combination helps in achieving both the energy and environmental goals. The deployment of a large number of this type of vehicles would help us in terms of environmental benefits, reduction of oil consumption and reduction in harmful emissions & pollution levels. Several methods of effective control of automobile emissions to meet current and future environmental demands are also analysed and effectively implemented for a peaceful and Nature friendly tomorrow.

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