

AUTOMOBILE EMISSIONS

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Abstract- The automobiles play an important role in the transport system. With an increase in population and living standard, the transport vehicles as well as car population is increasing day by day. In addition to this there is steep increase in the number of two wheelers during the last two decades. All these are increasing exhaust pollution and particularly in metros as density of these vehicles in metros are very high. The main pollutants contributed by I.C. engines are CO, NOX unburned hydro-carbons (HC) and other particulate emissions. Other sources such as Electric power stations industrial and domestic fuel consumers also add pollution like NOX, SO₂ and particulate matters. In addition to this, all fuel burning systems emit CO₂ in large quantities and this is more concerned with the Green House Effect which is going to decide the health of earth.

Index Terms- Exhaust pollution, Hydro-carbons, NO_x emission, Petrol engines, diesel engines, CO Emissions, SO₂ Emissions, CO₂ Emissions.

I. INTRODUCTION

Undesirable emissions in internal combustion engines are of major concern because of their negative impact on air quality, human health, and global warming. Therefore, there is a concerted effort by most governments to control them. Undesirable emissions include unburned hydrocarbons (HC), carbon monoxide (CO), nitrogen oxides (NO_x), and particulate matter (PM), we present the U.S. and European emissions standards, both for gasoline and diesel operated engines, and strategies to control the undesirable emissions. The role of engine design, vehicle operating variables, fuel quality, and emission control devices in minimizing the above-listed pollutants are also detailed.

II. CARS AND POLLUTION

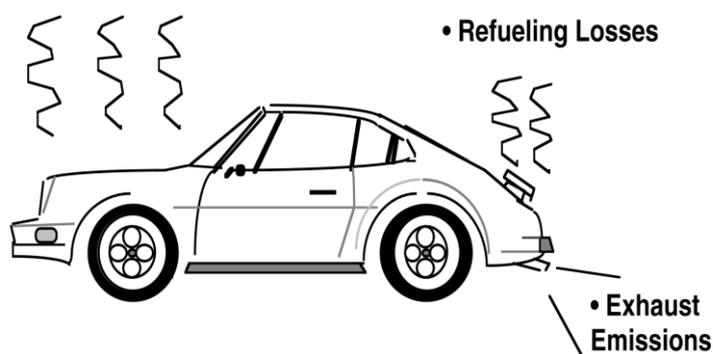
Emissions from an individual car are generally low, relative to the smokestack image many people associate with air pollution. But in numerous cities across the country, the personal automobile is the single greatest polluter, as emissions from millions of vehicles on the road

add up. Driving a private car is probably a typical citizen's most "polluting" daily activity.

III. SOURCES OF AUTO EMISSIONS

The power to move a car comes from burning fuel in an engine. Pollution from cars comes from by-products of this combustion process (exhaust) and from evaporation of the fuel itself.

• Evaporative Emissions



IV. THE COMBUSTION PROCESS

Gasoline and diesel fuels are mixtures of hydrocarbons, compounds which contain hydrogen and carbon atoms. In a "perfect" engine, oxygen in the air would convert all the hydrogen in the fuel to water and all the carbon in the fuel to carbon dioxide. Nitrogen in the air would remain unaffected. In reality, the combustion process cannot be "perfect," and automotive engines emit several types of pollutants.

"Perfect" Combustion

FUEL (hydrocarbons) + AIR (oxygen and nitrogen)

CARBON DIOXIDE +
 water + unaffected
 nitrogen

Typical Engine Combustion

FUEL + AIR UNBURNED
 HYDROCARBONS + NITROGEN OXIDES
 + CARBON MONOXIDE + CARBON
 DIOXIDE + water

V. EXHAUST POLLUTANTS

• HYDROCARBONS

Hydrocarbon emissions result when fuel molecules in the engine do not burn or burn only partially. 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. A number of exhaust hydrocarbons are also toxic, with the potential to cause cancer.

• NITROGEN OXIDES (NO_x)

Under the high pressure and temperature conditions in an engine, nitrogen and oxygen atoms in the air react to form various nitrogen oxides, collectively known as NO_x. Nitrogen oxides, like hydrocarbons, are precursors to the formation of ozone. They also contribute to the formation of acid rain.

• CARBON MONOXIDE

Carbon monoxide (CO) is a product of incomplete combustion and occurs when carbon in the fuel is partially oxidized rather than fully oxidized to carbon dioxide (CO₂). Carbon monoxide reduces the flow of oxygen in the bloodstream and is particularly dangerous to persons with heart disease.

• CARBON DIOXIDE

In recent years, the U.S. Environmental Protection Agency (EPA) has started to view carbon dioxide, a product of “perfect” combustion, as a pollution concern. Carbon dioxide does not directly impair human health, but it is a “greenhouse gas” that traps the earth’s heat and contributes to the potential for global warming

VI. EVAPORATIVE EMISSIONS

Hydrocarbon pollutants also escape into the air through fuel evaporation. With today’s efficient exhaust emission controls and today’s gasoline formulations, evaporative losses can account for a majority of the total hydrocarbon pollution from current model cars on hot days when ozone levels are highest. Evaporative emissions occur several ways:

DIURNAL: Gasoline evaporation increases as the temperature rises during the day, heating the fuel tank and venting gasoline vapors.

RUNNING LOSSES: The hot engine and exhaust system can vaporize gasoline when the car is running.

HOT SOAK: The engine remains hot for a period of time after the car is turned off, and gasoline evaporation continues when the car is parked.

REFUELING: Gasoline vapors are always present in fuel tanks. These vapors are forced out when the tank is filled with liquid fuel.

What Has Been Done to Control Automobile Emissions?

The Clean Air Act of 1970 gave EPA broad authority to regulate motor vehicle pollution, and the Agency’s emission control policies have become progressively more stringent since the early 1970’s.

EPA standards dictate how much pollution autos may emit but automakers decide how to achieve the pollution limits. The emission reductions of the 1970’s came about because of fundamental improvements in engine design, plus the addition of charcoal canisters to collect hydrocarbon vapors and exhaust gas recirculation valves to reduce nitrogen oxides.

The advent of “first generation” catalytic converters in 1975 significantly reduced hydrocarbon and carbon monoxide emissions. The use of converters provided a huge indirect benefit as well. Because lead inactivates the catalyst, 1975 saw the widespread introduction of unleaded gasoline. This resulted in dramatic reductions in ambient lead levels and alleviated many serious environmental and human health concerns associated with lead pollution.

The next major milestone in vehicle emission control technology came in 1980/81. In response to tighter standards, manufacturers equipped new cars with even more sophisticated emission control systems. These systems generally include a “three-way” catalyst (which converts carbon monoxide and hydrocarbons to carbon dioxide and water, and also helps reduce nitrogen oxides to elemental nitrogen and oxygen), plus an on-board computer and oxygen sensor.

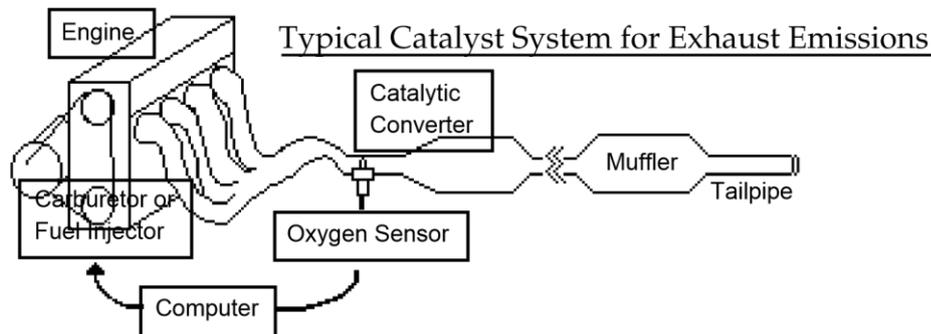
This equipment helps optimize the efficiency of the catalytic converter.

Vehicle emissions are being further reduced by provisions of the 1990 Clean Air Act. Mobile source provisions include even tighter tailpipe

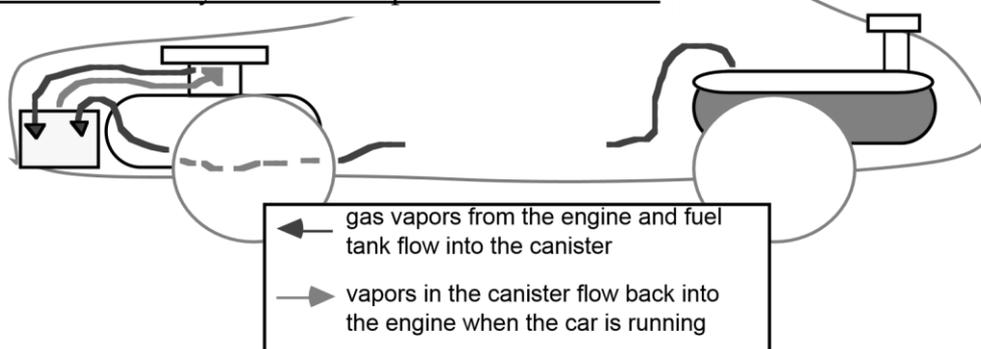
standards, increased durability, improved control of evaporative emissions, and computerized diagnostic systems that identify malfunctioning emission controls.

Basic Controls for Exhaust and Evaporative Emissions

2. To reduce the formation of pollutants in the emission by redesigning the engine system, fuel system, cooling system and ignition system.
3. By destroying the pollutants after these have been formed.



Typical Canister System for Evaporative Emissions



What Has Emission Control Meant for Air Quality?

Efforts by government and industry since 1970 have greatly reduced typical vehicle emissions. In those same years, however, the number of miles we drive has more than doubled. The increase in travel has offset much of the emission control progress. The net result is a modest reduction in each automotive pollutant except lead, for which aggregate emissions have dropped by more than 95 percent.

With ozone continuing to present a persistent urban air pollution problem, future vehicle emission control programs will emphasize hydrocarbon and nitrogen oxide reductions. Carbon monoxide control will remain critical in many cities, and limits on vehicle-generated carbon dioxide may become important in the future.

VII. CONTROL OF EMISSION FROM SI ENGINES

1. To reduce atmospheric pollution, two different approaches are followed:

In petrol engines, the main pollutants which are objectionable and are to be reduced are HC, CO and NO_x. The methods used are Si engine control are-

- Crankcase Emission Control (PCV System)
- Evaporative Emission Control
- Exhaust Gas Recirculation
- Water Injection
- Crankcase Emission Control (PCV System)

VIII. CONCLUSION

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REFERENCES

- [1] Al-Hasan, M., “Effect of Ethanol-Unleaded Gasoline Blends on Engine Performance and Exhaust Emission”, *Energy Conversion and Management*, Vol. 44, (2003), 1547-1561.
- [2] Desoky, A. A. and El-Emam, S. H., “A Study on the Combustion of Alternative Fuels in Spark-Ignition Engines”, *International Journal of Hydrogen Energy*, Vol. 10, Issue 8, (1985).
- [3] Jamal, Y. and Wyszynski M. L., “OnBoard Generation of Hydrogen-Rich Gaseous Fuel-A Review”, *International Journal of Hydrogen Energy*, Vol. 19, No. 7, (1994), 557-572.
- [4] Al-Baghdadi M. A. S. and Al-Janabi, H. A. S., “Improvement of Performance and Reduction of Pollutant Emission of a Four Stroke Spark Ignition Engine Fueled with Hydrogen-Gasoline Fuel Mixture”, *Energy Conversion Management Journal*, Vol. 41, No. 1, (2000), 77-91.
- [5] Das, L. M., “Exhaust Emission Characterization of Hydrogen Operated Engine System”, *International Journal of Hydrogen Energy*, Vol. 15, (1990), 815- 833.
- [6] Mathur, H. B., Khajuria, P. R., “Performance and Emission Characteristics of Hydrogen Fuelled Spark Ignition Engine”, *International Journal of Hydrogen Energy*, Vol. 9, No. 8, (1984) , 729-735.
- [7] Mclean, W. J. and Homan, H. S., “Performance and Emissions of Hydrogen Fuelled Internal Combustion Engines”, *International Journal of Hydrogen Energy*, Vol. 1, (1976), 153-172.
- [8] Varde, K. S., “Combustion Characteristics of Small Spark Ignition Engines using Hydrogen Supplemented Fuel Mixtures”, *SAE Paper*, No. 810921, (1981), 1-7
- [9] Tsunoda, A. et al., Newly-Developed Diesel Engines for Generator Set, Mitsubishi Juko Giho Vol.40 No.4 (2003)
- [10] Sakaguchi, K. et al., Environmental Friendly Diesel Engine "UEC EcoEngine", Mitsubishi Heavy Industries Technical Review Vol.41 No.1 (2004)
- [11] Tsunoda, A. et al., MITSUBISHI Leanburn Gas Engine with World's Highest Thermal Efficiency, Mitsubishi Heavy Industries Technical Review Vol.40 No.4 (2003)
- [12] ASTM D86-07 Standard test method for distillation of petroleum products at atmospheric pressure, vol. 05.01.