Measurement of Black Smoke in Transport Vehicle for Corrective Action

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Abstract **:- The emission of fine carbonaceous particles in India is a serious threat to human health, ecological systems, and regional and global climate regimes. India is thought to release about 20 percent of the global black carbon through the combustion of coal and bio fuels without adequate particle controls. Diesel engines have high efficiency, durability, and reliability together with their low-operating cost. Many policies have been imposed worldwide in recent years to reduce negative effects of diesel engine emissions on human health and environment. Many researchers have been carried out on both diesel exhaust pollutant emissions and aftertreatment emission control technologies. In this paper, Measurement of black smoke in transport and their control systems are reviewed. Each type of emissions and control systems is comprehensively examined. At the same time, the legal restrictions on exhaust-gas emissions around the world and the effects of exhaust gas emissions on human health and environment are explained in this study.**

KEYWORDS:Diesel engine, Emission, Emission control system

INTRODUCTION:

The emission of black smoke by diesel engine trucks and buses is an everyday sight in many countries in the world. At best, it represents an unpleasant smell and more dirt to cover ourselves and surroundings at worst It can present a health hazard through the inhalation of particles containing hydrocarbons and is also a sign that the vehicle is operating inefficiently and wasting fuel. Many operators are reluctant to perform extra work on their vehicles during maintenance periods and will not do so unless it can be proved that they will save money. In addition. While there is no routine or random smoke, checks in many countries, there are also no outside incentives to improve this particular aspect of a vehicle's performance.The Overseas Centre of the Transport Research Laboratory in -the UK has been carrying out research into 'the problems of black smoke for some years now and has recently started a joint project with GIRT to measure black smoke emissions from two fleets of vehicles and to correlate the emissions with the fuel consumed by the same vehicles.This article describes the background to the project and the way in which it will be carried out. It is anticipated that the results will be published later. Any enquiries concerning the project should in the meantime be addressed to Shri PC Rao, Engineering Faculty of GIRIT. Pune.

WHAT IS SMOKE?

Smoke is a general term used to describe the cloudy, hazy, emanations that result from the burning of organic substances. It consists of solid and/or liquid particles or droplets that are so small that they tend to remain suspended in air for extended periods of time s varying from seconds to years. The smoke of the engine exhaust is a visible indicator of the combustion process in the engine. Opacity is a measure of light reduction/loss over a smoke column path usually expressed as a percentage. An opacity of 10% means that 90% of the source light power remains and 10% has been lost after passing through the measurement path. The 90% (0.9) term (the light remaining) is referred to as Transmittance.

THE MEASUREMENTOF BLACK SMOKE

There are two ways of obtaining black smoke emissions from a vehicle under test. The most complex is to mount the vehicle on a dynamometer or rolling rod, and, by altering the resistance to the driving wheels, the vehicle may be driven at a variety of speeds and loads to determine its' emissions of black smoke. The second way, and by far the easiest, is the Free Acceleration Smoke Test. In this test the vehicle's engine is run until normal operating temperature is achieved. Then the accelerator pedal is pressed down to its maximum extent and kept there until the engine reaches its' governed speed. By this action the engine is accelerated at its maximum possible rate against its' own inertia and hence is at full power through its operating speed range. This is repeated several times in order to obtain a mean reading of peak smoke level. The test is defined precisely in ECE Regulation 24 and is the method used in this project.

In order to measure the concentration of smoke a device called opacimeter is used. This has supplanted the older filter type devices -and measures the density of smoke by shining a beam of light across the exhaust plume. Smoke Meters are available in the U.K. market which sample either the entire plume or-part of it and it is the latter type that are commonly used today. A smoke test has recently become compulsory during the annual in-service inspection in the UK and a number of meters have been approved to comply with the requirements of the U.K.'s Vehicle Inspectorate

WHAT IS SMOKE METER?

An Instrument which determines the smoke density in exhaust gases emitted by engine systems. The term Smoke Meter generally refers to a smoke measuring instrument based on optical property measurements. A wide variety of approaches to such instruments exists. Many measure opacity directly through the smoke column. Others measure opacity through a sampled fraction of the column.

EQUIPMENT DESCRIPTION

The ASA 200 meter Is a compact unit that Is easily transported in a large briefcase or, when in use, the essential parts can be carried around a depot or workshop reducing the possibility of damage by being left on the workshop floor.The smoke meter uses a modulated light emitting diode (LED) as a light source and a solid state photodiode light receiver. Within the handset, electronics measure the light level received through that portion of the exhaust smoke passing through the meter,calculate the density of smoke and give the result in the form of the Smoke Absorption Coefficient, (k).The meter comprises a sensor unit inserted Into the vehicle exhaust, linked. via a cable that carries power and data, to a handset (Fig. 1). The handset can also be disconnected from the sensor and plugged into its base station which provides battery charging and a link to the printer for output of results. The printer is also battery powered and equipped with its own charger. Verification filters are also provided to enable calibration of the meter to be carried out at k =0 and a midpoint value (normally about k = 1.7).The operation of the meter Is controlled by the in-built computer that displays commands and options on the handset LCD display screen. A zero check is performed at the beginning and end of each test to ensure that the optics are not excessively dirty and to enable a correction to be made if not absolutely clean. When the test is started the handset Issues commands from the display to start accelerating, to release the throttle and when to start and stop the- engine. It also displays the individual peak smoke readings and the final result.The UK regulations permit the number of accelerations to vary between 4 and 10; a very clean vehicle may therefore pass within 4 accelerations while ‘a dirtier vehicle Is given up to 10 attempts to reach the limit. In all cases the result is obtained by taking the mean. of the last four values and subtracting the zero check reading. On completion of the test the handset Is connected to the printer and the full results are output. The entire test takes considerably less than five minutes once the vehicle has reached operating temperature.

WAY TO CONTROL SMOKE EXPOSURE:

Vehicle maintenance - Poorly serviced and/or badly tuned engines produce far more exhaust emissions than well maintained engines Check the crankcase for leaks. Regular basis check whether the head gasket blown? Are the rings and/or cylinder worn

Engine design- Manufacturers are improving the design of diesel engines all the time and modern engines are cleaner and produce far less exhaust emissions than older engines.

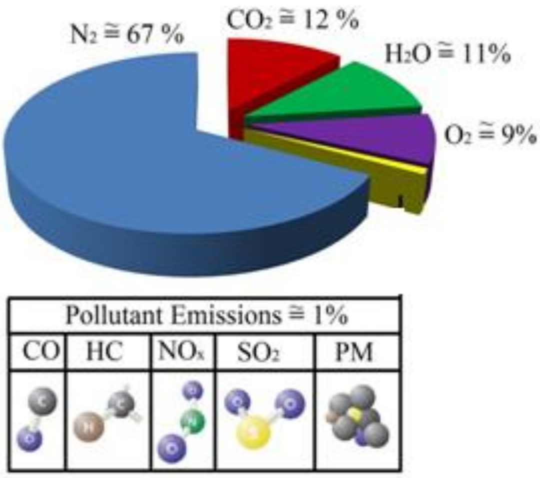
Filters -There are now available catalytic diesel exhaust filters that can both trap the particulate and, when exhaust temperature conditions are catalytically favorable, oxidize the particulate to carbon dioxide.

Ventilation- Good ventilation to dilute and disperse the exhaust emissions is possibly the most important factor for ensuring exposure is kept to a minimum.

Fuel- Diesel fuels are being improved all the time to make them cleaner burning and so reduce emissions. One major improvement has been the reduction in the sulphur content of diesel fuel.

THE EMISSIONS FROM DIESEL ENGINES

The diesel engine is an auto-ignition engine in which fuel and air are mixed inside the engine. The air required for combustion is highly compressed inside the combustion chamber. This generates high temperatures which are sufficient for the diesel fuel to ignite spontaneously when it is injected into the cylinder. Thus, the diesel engine uses heat to release the chemical energy contained in the diesel fuel and to convert it into mechanical force. For ideal thermodynamic equilibrium, the complete combustion of diesel fuel would only generate CO_2 and H_2O in combustion chambers of engine. However, many reasons (the air– fuel ratio, ignition timing, turbulence in the combustion chamber, combustion form, air–fuel concentration, combustion temperature, etc.)The most significant harmful products are CO, HC, NO_x, and PM.



Carbon monoxide (CO)

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Carbon monoxide results from the incomplete combustion where the oxidation process does not occur completely.This concentration is largely dependent on air/fuel mixture and it is highest where the excess-air factor (k) is less than 1.0 that is classified as rich mixture. It can be caused especially at the time of starting and instantaneous acceleration of engine where the rich mixtures are required. In the rich mixtures, due to air deficiency and reactant concentration, all the carbon cannot convert to CO_2 and be formed CO concentration. Although CO is produced during operation in rich mixtures, a small portion of CO is also emitted under lean conditions because of chemical kinetic effects.Carbon monoxide is an odorless and colorless gas. In humans, CO in the air is inhaled by the lungs and trans-mitted into the bloodstream. It binds to hemoglobin and inhibits its capacity to transfer oxygen. Depending on CO concentration in the air, as thus leading to asphyxiation, this can affect the function of different organs, resulting in impaired concentration, slow reflexes, and confusion.

Hydrocarbons (HC)

Hydrocarbon emissions are composed of unburned fuels as a result of insufficient temperature which occurs near the cylinder

wall. At this point, the air–fuel mixture temperature is significantly less than the center of the cylinder. Hydrocarbons consist of thousands of species, such as alkenes, alkenes, and aromatics. They are normally stated in terms of equivalent CH_4 content.Diesel engines normally emit low levels of hydrocarbons. Diesel hydrocarbon emissions occur principally at light loads. The major source of light-load hydrocarbon emissions is lean air–fuel mixing. In lean mixtures, flame speeds may be too low for combustion to be completed during the power stroke, or combustion may not occur, and these conditions cause high hydrocarbon emissions.

Particulate matter (PM)

Particulate matter emissions in the exhaust gas are resulted from combustion process. They may be originated from the agglomeration of very small particles of partly burned fuel, partly burned lube oil, ash content of fuel oil, and cylinder lube oil or sulfates and water. Most particulate matters are resulted from incomplete combustion of the hydrocarbons in the fuel and lube oil. In an experimental study, typical particle com-position of a heavy-duty diesel engine is classified as 41 % carbon, 7 % unburned fuel, 25 % unburned oil, 14 % sulfate and water, 13 % ash and other components. In another study, It is reported that PM consists ofelemental carbon (%31 %), sulfates and moisture (%14 %), unburnt fuel (%7 %), unburnt lubricating oil (%40 %) and remaining may be metals and others sub-stances .

Nitrogen oxides (NO_x)

Diesel engines use highly compressed hot air to ignite the fuel. Air, mainly composed of oxygen and nitrogen, is initially drawn into the combustion chamber. Then, it is compressed, and the fuel is injected directly into this compressed air at about the top of the compression stroke in the combustion chamber. The fuel is burned, and the heat is released. Normally in this process, the nitrogen in the air does not react with oxygen in the combustion chamber and it is emitted identically out of the engine. However, high temperatures above 1,600 LC in the cylinders cause the nitrogen to react with oxygen and generate NO_x emissions. So, it will not be wrong to say that the major influences of the formation of NOx are the temperature

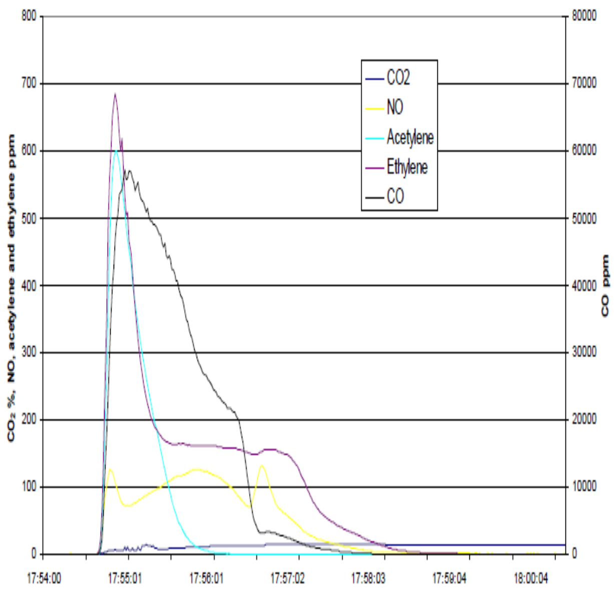


Table: EU emission standards for passenger cars

Standard	Year	Diesel cars (g/km)				Petrol cars (g/km)			
		CO	HC	NO_x	PM	CO	HC	NO_x	PM
Euro I	1995	2.72	0.97	–	0.14	2.72	–	0.97	–
Euro II	2000	1.00	0.90	–	0.10	2.20	–	0.50	–
Euro III	2010	0.64	0.56	0.50	0.05	2.30	0.20	–	0.15
Euro IV	2015	0.50	0.30	0.25	0.025	1.00	0.10	–	0.08

SMOKE TEST

A **smoke test** is a series of test cases that are run prior to commencing with full-scale testing of an application. Smoke testing is non-exhaustive testing, ascertaining that the most crucial functions of a program work, but not bothering with finer details.The idea is to test the high-level features of the application to ensure that the essential features work. If they do not work, there is no need to continue testing details of the application, so the testing team will refuse to do any additional testing until the smoke test suite passes. This puts pressure on the development team to ensure that the testing team does not waste valuable testing time with code that is not ready to be tested.Once smoke tests are implemented as part of your software development life cycle, you will see the overall quality of the product improve and the sensitivity to producing high quality software increased.

PROCESS OF SMOKE TESTING

Identify Smoke Test Cases

Smoke test cases are subset of total test cases. To create a smoke, we need to identify the minimum number of test cases, to cover the crucial functionality of the product so that they could be executed in least amount of time. This is a very important step of the smoke testing. If we create large set of smoke test cases then it may take more time in execution and if we create small set of smoke test cases then it may not be effective in covering the crucial functionality.

Create Smoke Test Cases

Once the smoke test cases have been identified, the next step is to create test cases. We write smoke test cases and automate them if required. But as discussed in 'V. Techniques of Smoke Testing', it's not always possible to automate the smoke test cases.

Run and Analyze the Results

Once the smoke test cases are ready then whenever there is a new build, smoke is run on the build and results are analyzed to take the decision of accepting or rejecting the build.

Maintenance

Maintenance is used to maintain the value of smoke test cases over the period of time. Whenever new crucial functionality is added, we need to create new smoke test cases. Similarly whenever there are changes which affect the smoke scripts, we have to fix them.

Process of Smoke testing

ALTERNATIVE DRIVELINES TO CONTROL BLACK SMOKE

Electric vehicles

Electric vehicles offer a number of advantages, such as low noise levels and virtually no toxic emissions during operation. Emissions occur elsewhere, however: for instance, during the production of the batteries and the electricity needed to recharge them. Still, extensive use of such vehicles has been inhibited by the current limitations of battery technology, such as limited driving range, and by high costs, restricting their use to special niche applications. A breakthrough for battery-powered vehicles seems unlikely in the near future, even though batteries are constantly becoming cheaper and more efficient. It would be better if the electricity were produced aboard the vehicle, which is one of the reasons why many automakers appear to be focusing instead on hybrid electric vehicles or on fuel cells.

Hybrid electric vehicles

Hybrid electric vehicles combine the internal combustion engine of a conventional vehicle with the battery and electric motor of an electric vehicle. A hybrid is more expensive and heavier than the corresponding conventional vehicle, but might cut fuel consumption and toxic emissions by about half in urban driving. Some hybrid vehicles can recover energy when they slow down during braking. Vehicles that use a smaller engine in combination with an electric motor are sometimes called light hybrids, while full hybrids also have a battery pack that enables the car to be driven at low speeds with the engine off.

Fuel cells

A fuel cell converts the chemical energy of the fuel directly to electricity. A fuel-cell vehicle can therefore be seen as an electric vehicle in which a fuel cell has replaced the battery. Many see fuel cells as a future option for motor vehicles, especially passenger cars and buses, and the level of research and development in this field has increased in recent years.Fuel cells consist of a solid polymer membrane covered by thin layers of electrode material on each side. Electricity is produced when hydrogen is fed to one side of the cell (anode) and oxygen or air to the other side (cathode). Several types of fuel cells, including proton exchange membrane fuel cells, produce electricity with high efficiency from gaseous hydrogen.

Automotive gas turbines

Gas turbines for lorries and buses have a long history. One company in the United States, for instance, presented a prototype lorry as early as 1964. Since then, various projects have tried to optimize the performance of the system by changing such factors as the turbine-inlet temperature, the compressor-inlet temperature and pressures. Advanced materials (such as ceramics) have also been developed to cope with higher turbine-inlet temperatures, thus increasing the thermal efficiency of gas turbine engines. Gas turbines have also been used in hybrid drive trains.Automotive gas turbines are highly reliable (the turbine is simple, with the rotor as the only moving part), can potentially produce low levels of emissions of nitrogen oxides and PM and can run on a variety of fuels. Because of these qualities, they have been under development, particularly in Japan. On the other hand, they are expensive to manufacture, do not perform well during acceleration and deceleration, and are inefficient when idling and under low load conditions. For the time being, the technical challenges involved appear to limit the automotive industry's interest in gas turbines.

ALTERNATIVE FUELS, FUEL BLENDS AND ADDITIVES

S.No	Vehicle No	Emission in co_2 (Black)	Km runs	KMPL	Engine oil KMPL
1	TN30N1177	81	1000335	5.81	11558
2	TN30N1450	81	243083	5.68	11216
3	TN30N1391	79	300268	5.70	10176
4	TN30N1176	79	1016858	5.67	9663
5	TN30N0798	78	134775	5.89	6674
6	TN30N1158	78	892648	5.94	8713
7	TN30N0870	77	85538	5.64	8361
8	TN30N0837	77	207072	5.06	7689
9	TN30N1334	77	773698	5.77	7766
10	TN30N1185	77	1006783	5.76	10209

The Auto-Oil II program provided an overview of the advantages and disadvantages of several fuels and fuel blends (Auto-Oil II, 2000).

Compressed natural gas

Compressed natural gas has a number of advantages. It has a low carbon-to-hydrogen ratio, is nearly free of sulfur and contains no toxic components. Also, it results in low emissions of PM, lower emissions of carbon dioxide per gigajoule of fuel, low cold-start emissions, and lower emissions of nitrogen oxides, and has a very low summer smog potential. On the other hand, it results in relatively high emissions of methane.

Liquefied petroleum gas

Liquefied petroleum gas can optimize the emission performance of passenger cars by reducing the emissions of nitrogen oxides, hydrocarbon and carbon monoxide by 80–95% relative to a petrol-fuelled vehicle. It has low sulfur content and a negligible amount of toxic components. Emissions of benzene, toluene and xylene and summer-smog potential are lower than for petrol-powered cars, and emissions of PM, PAHs, aldehydes and formaldehyde, and winter smog formation potential are lower than those of diesel-powered vehicles.

Diethyl ether

Diethyl ether can be produced from a variety of feedstocks, including natural gas, heavy crude oil, coal, waste and biomass. Emissions of nitrogen oxides and PM engines powered by diethyl ether are comparable to those of lean-burn heavy-duty engines using liquefied petroleum gas and natural gas or to light-duty Otto engines equipped with three-way catalysts. Diethyl ether is non-toxic and, because of the absence of carbon–carbon bonds, emissions of hydrocarbons (such as PAHs and benzene) are very unlikely (Verbeek & Van Der Weide, 1997). Diethyl ether can be used as fuel in dedicated engines or as an additive to biofuels.

Biodiesel

Biodiesel (fatty acid methyl ester), mainly produced from rapeseed oil, and used in up to 30% blends with normal diesel, is biodegradable and non-toxic. It contains almost no sulfur and no PAHs. As a result, it gives lower emissions of PM and reduced PAH content of exhaust particles. Its cold-start behavior, however, is inferior, and the relatively higher level of nitrogen oxide emissions would require some engine adjustments. Its biggest disadvantage is a high level of aldehydes emissions.

Bioethanol

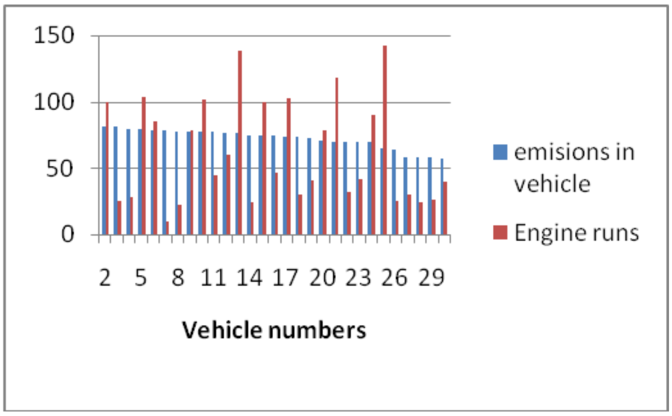
Ethanol can be fermented and distilled from biomass (such as sugar cane, cereals, sugar beet and wood). Bioethanol contains no sulfur, is biodegradable and is less toxic than methanol.

RESULT AND DISCUSSION

We discussed the Measurement of black smoke in various Transport vehicles and we have measured the emissions ofvehicles using the smoke meter.

Black smokes from transport vehicle

Graph: Emissions in vehicle



CONCLUSION:

The emission in exhaust rate depends upon the distance covered by the automobile and the maintenance carried out. So, In order to reduce the emission, proper maintenance of the vehicle must be kept up. Simultaneously, the usage of alternative fuels such as biodiesel, hybrid vehicle can be encouraged. The central pollution control board an environment ministry organization that sets guidelines on monitoring and controlling pollution says international studies linking air quality in India to disease and death are flawed because “the ethologic, personnel immunity and demography of India are incomparable with international practices.

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