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DESIGN OF SMOKE FILTER TO DECREASE POLLUTANT EMISSIONS FROM DIESEL ENGINE

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ABSTRACT:

Diesel engines have high efficiency, durability, and reliability together with their low-operating cost. These important features make them the most preferred engines especially for heavy-duty vehicles. The interest in diesel engines has risen substantially day by day. In addition to the widespread use of these engines with many advantages, they play an important role in environmental pollution problems worldwide. Diesel engines are considered as one of the largest contributors to environmental pollution caused by exhaust emissions, and they are responsible for several health problems as well. The four main pollutant emissions from diesel engines (carbon monoxide-CO, hydrocarbons-HC, particulate matter-PM and nitrogen oxides-NO_x) and control systems for these emissions (diesel oxidation catalyst, diesel particulate filter and selective catalytic reduction) are discussed. Each type of emissions and control systems is comprehensively examined. The present project deals with the fabrication of filter type emission controller suitable for clamping to diesel engine for optimizing the control of emissions before and after usage.

Keywords: Diesel engine, Emission control system

INTRODUCTION

Diesel exhaust soot is the visible cloud of black carbon-containing smoke that appears on engine start-up and during normal diesel engine operation. Black carbon is hazardous to health and presents a range of other issues, including visible product contamination and soiling. It is also believed that black carbon is a contributory factor in climate change. This technical paper aims to clarify the issues surrounding exhaust soot and presents information designed to assist in the decision-making process of how best to reduce black carbon emissions from diesel exhausts.

1.1 PARTICULATE MATTER (PM):

In a theoretically perfect combustion, carbon dioxide, water and nitrogen are the end products. In reality, the incomplete combustion of diesel fuel results in emissions that include oxides of nitrogen (NOx), carbon monoxide (CO), carbon dioxide (CO2), water (H2O) and unburned hydrocarbons (HC). There are also unborn carbon particles, as well as engine oils, debris, soot and ash particulates, which are known as particulate matter (PM). This diesel particulate matter (DPM) is the visible cloud of black smoke that appears from engine start-up and continues to appear when the engine is running. DPMs can be categorized into two groups

- PM10 - Particles of 2.5 microns to 10 microns, and
- PM2.5 - Particles of less than 2.5 microns in size. Although most Diesel Particulates are very small, more than 99% are in the sub-micrometer range.

1.2 THE CONCERNS ASSOCIATED WITH DPM:

Climate change is something that directly affects us all and is just one of the concerns associated with diesel exhaust emissions. The main issues surrounding black carbon soot being:

• **Health** DPM has been identified by health experts as contributing to a variety of lung related illnesses. Exposure to DPM has been linked to acute short-term symptoms such as headaches, nausea, and irritation of the eyes, nose and throat. Long-term exposure can lead to chronic and more serious health problems such as cardiovascular disease and lung cancer.

•**Inhalation** The smallest particles have the worst health implications because of their ability to penetrate deep into lung tissue. They easily bind with other toxins in the environment, thereby increasing the hazards of particle inhalation.

• **Confined Spaces** Machinery operating in confined or enclosed spaces – for example in tunnels, mines, and quarries, or in factories and warehouses where ventilation is limited – pose a greater health risk to operatives and anyone in the vicinity of that equipment.

•**Air Quality** In addition to the health concerns mentioned above, the pollution emitted by diesel engines contributes greatly to air quality problems such as haze and smog, both of which restrict visibility and can cause irritation of the eyes, nose and throat. Furthermore, diesel exhaust fumes contribute to ozone formation, acid rain, and climate change.

• **Contamination DPM** can also contaminate products and packaging in factories and warehouses where DPMs are present in the atmosphere. In the wider environment DPM contaminates foliage and soils buildings, an all too common sight in urban areas.

LITARATURE REVIEW

Several techniques have been researched and developed to abate hazardous emission constituents from diesel engines at the source level. Some of such extensively investigated techniques are:

• Variations of Injection Pressure and Nozzle Geometry

• Pre-Mixed Combustion

• Water Injection or combinations of two or more of above.

• Retarded and split fuel injection

• Exhaust Gas Recirculation (EGR)

Climate change is being counted as a global environmentalthreat caused by people. It is seen as the second mostserious issue that the world faces and has brought aboutresults that affect life adversely (European Commission2011). The major ones of these effects are average 0.8 _Cglobal warming above pre-industrial levels, 0.09 _Cwarming and acidifying of ocean since 1950s, 3.2 cm sea levelsrising per decade, an exceptional number of extremeheat waves in last decade, and drought affecting food cropgrowing areas (Levitus et al. 2012; Meyssignac and Cozenage2012; McKenzie and Wolf 2010; Li et al. 2009;

[1] Heyder et al. 2011; Dai Unless the current mitigation,commitments, and pledges are fully implemented, thenegative effects of climate change will go on. It is expectedthat a warming of 4 _C and sea-level rise of 0.5–1 m canoccur as early as 2060s (Huddleston 2012).The greenhouse effect is a natural process that plays amajor role in shaping the earth's climate. Human activities,especially burning fossil fuels, have contributed to theenhancement of the natural greenhouse effect. Thisenhanced greenhouse effect stems from an increase in theatmospheric concentrations called greenhouse gases (Jain1993; Saxena 2009). Greenhouse gases in the atmospherelead to climate change. The major greenhouse gasesemitted into the atmosphere through human activities arecarbon dioxide, methane, nitrous oxide, and fluorinatedgases (hydro fluorocarbons, per fluorocarbons, and sulfurhexafluoride) (Venkataraman et al. 2012; **[2] Wei et al. 2008**;Carbon dioxide (CO2) has the largest rate among thegreenhouse gases, and it is the main reason of globalwarming. The global emission of carbon dioxide hasreached 34 billion tons with an increase of 3 % in 2011(Olivier et al. 2012). Throughout the world, CO2 emissionsare currently about 35,000 million metric tons per year.Unless the urgent policies are put in action, CO2 emissionswill be projected to rise up 41,000 million metric tons peryear in 2020s. In addition to warming in climate systems,the rising of CO2 concentration in the atmosphere leadsocean acidification as a result of dissolutions (The PotsdamInstitute for Climate Impact Research and Climate 2012).

The Intergovernmental Panel on Climate Change(IPCC) stated in the Synthesis Report that, ''In the absenceof additional climate policies, an increase of baselineglobal greenhouse gas emissions from human sourceswould have become by a range from 25 to 90 % between2000 and 2030'' (IPCC 2007). In the Fourth AssessmentReport, IPCC has forecasted a global temperature risingbetween 1.1 and 6.4 _C, and a global sea level risingbetween 7 and 23 inches by 2100. According to the IPCC,global greenhouse gas emissions must be reduced to50–85 % below year 2000 levels by 2050 to limit warmingto 2–2.4 _C. To be able to reach this target, greenhouse gasemissions from all sectors must be reduced through amulti-generational effort (IPCC 2007).Transport is a main sector which causes the environmentalpollution and climate change. Emissions fromtransport, and especially motor vehicles, add considerablyto the levels of greenhouse gases in the atmosphere (OECD2002). Transport is the second-largest sector in producingglobal CO2 emissions with a range of 22 % (InternationalEnergy Agency 2012). Owing to the rapid increase ofmotor vehicles and very limited use of emission controltechnologies, transport emerges as the largest source ofurban air pollution, which is an important public healthproblem in most cities of the developing world. Air pollutionin developing countries accounts for tens of thousandsof excess deaths and billions of dollars in medicalcosts and loses productivity every year (Faiz et al. 1996;Sivaloganathan 1998). The World Health Organizationestimated that around 2.4 million people die every year dueto air pollution (WHO 2007).

In today's world, environmental protection, climatechange, and air pollution have become subjects of centralconcern. Many agencies, organizations (EPA, OECD,IPCC, IEA, EEA, etc.) worldwide were established andhave been working to prevent air pollution and climatechange caused by pollutant emissions. In their works, theyhave reported that approximately the 20–30 % of pollutantemissions originates from transport and these emissionshave an important impact upon global warming and climatechange. To prevent the effects of these pollutant emissions,they have emphasized on such issues as making severallegal arrangements, advancing the technological developments,creating several model structures, developing controlsystems, and organizing the structure of traffic (OECD2011; EPA 2012; IEA 2012; IPCC 2007; OECD 2002;EEA 2012).Diesel engines have extensive usage compared to gasolineengines on account of their low-operating costs,energy efficiency, high durability, and reliability.

PROBLEM STATEMENT:

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 after treatment emission control technologies. The emissions from diesel engines and their control systems are reviewed and there is a need to develop of pollutant filtration in a practical testing system to check the minimum emission rate.

OBJECTIVES:

1. To study the present using emission control systems.
2. To study the process of making filter type emission control equipment.
3. To check the present emissions in diesel engine with chemical ratios.
4. To check the emissions after assembling new filter.
5. To compare both the emission ratios before and after.

MATERIALS, DESIGN AND ANALYSIS

MATERIALS:

STAINLESS STEEL 316

- Stain less steels are iron base alloys containing 10.5% or more chromium. they have used for many industrial architectural chemical and consumer applications for over a half century
- Currently there are being marketed a number of stain less steels originally recognized by the American iron and steel intuits (AISI) as standard alloys .also commercially available are property stain less steels with special characteristics
- A stainless steel in the singular sense as if it were one material .actually there are over fifty stain less steel alloys there are classification are used to identify stain less steels

There are:

1. Metallurgical structure
2. The AISI numbering system (Namely ‘’200,300,400. Series numbers)
3. The unified numbering system

- Stain less steel type 316 contain slightly more nickel than type 304, and 2-3% molybdenum giving it better resistance to corrosion than type 304 epically in chloride environments that tend to cause pitting type 316 was developed for use in sulfite pulp mills because it resists sulfuric acid compounds its use has been broadened however to handling many chemicals in the process industries
- Steel is unquestionably the primary industrial constructional material the dominant product from for stain less steels is cold rolled sheet the other products individually from only a third or less of the total amount of cold rolled sheet
- The most widely used stain less grades are the austenitic chromium-nickel 18-8 type steels

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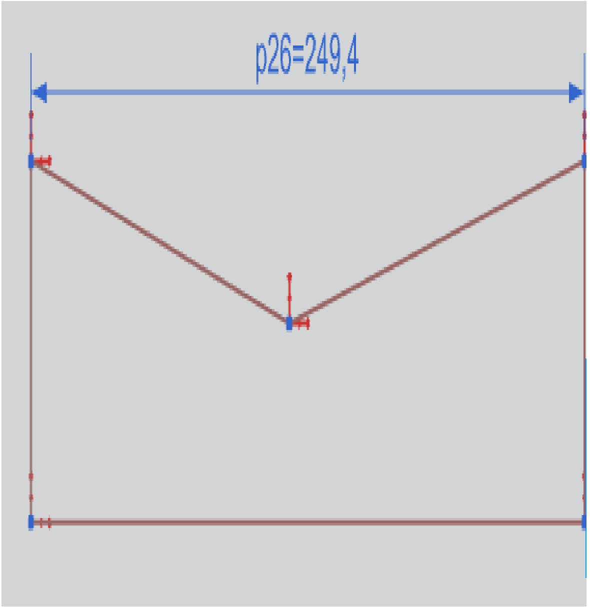
ie EN14301/1.4307 ,which from more than 50% of the global production of stain less steel

- Stainless steel stains less easily than other iron-based metals, but it's not literally "stainless". Just like standard steel, stainless can get marked up by fingerprints and grease, develop discoloration, and eventually rust. The difference is resilience. Stainless steel can withstand much more time and abuse before showing signs of wear.
- All steels have the same basic iron and carbon composition, but stainless steel also contains a healthy dose of chromium—the alloy that gives stainless steel its famous corrosion resistance.
- And this is where things get complicated. There are multiple grades under the stainless steel umbrella, each with slightly different alloy composition, and therefore slightly different physical characteristics.
- Stainless steel must contain at least 10.5 percent chromium. Depending on the grade, it may contain much higher chromium levels, and additional alloying ingredients like molybdenum, nickel, titanium, aluminum, copper, nitrogen, phosphorous and selenium.
- The two most common stainless steel grades are 304 and 316. The key difference is the addition of molybdenum an alloy which drastically enhances corrosion resistance, especially for more saline or chloride-exposed environments. 316 stainless steel contains molybdenum, but 304 don't. For outdoor furnishings like rails and bollards, stainless steel is an ideal corrosion-resistant material, but it will only withstand long-term exposure if the grade is appropriate for its environment. 304 is an economical and practical choice for most environments, but it doesn't have the chloride resistance of 316.
- The slightly higher price point of 316 is well worth it in areas with high chloride exposure, especially the coast and heavily salted roadways. Each application for stainless steel has its own unique demands, and needs a stainless steel that's up to the task.

Figure3.1 316 Stainless Steel Metal



Figureure 3.2 Plane View Of The Smoke Filter

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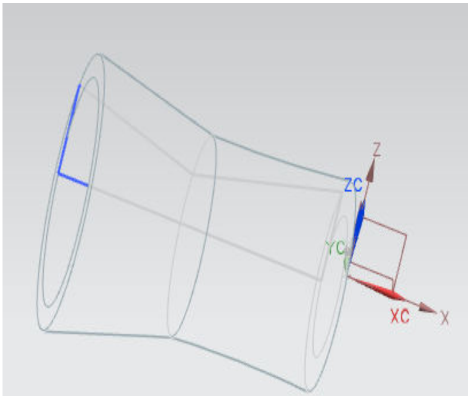
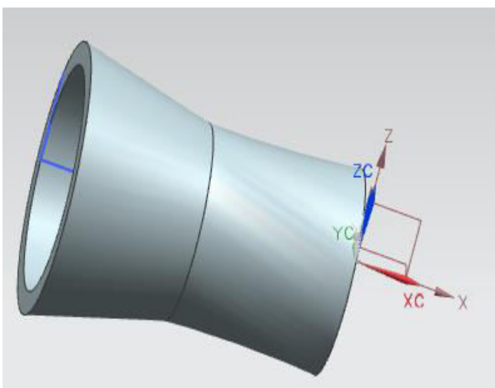


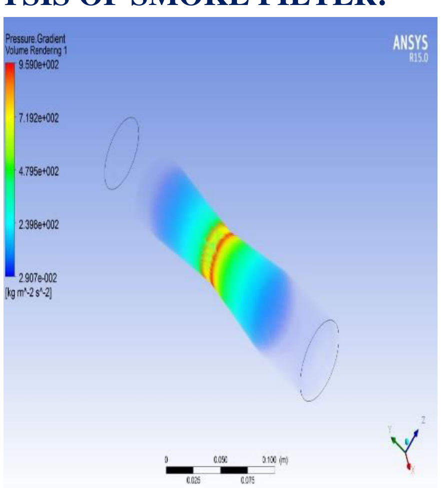
Figure 3.3shows That Smoke Wire Frame Model



The Figure3.4shows That Smoke Filter Of The Nx8.0model

RESULTS

ANALYSIS OF SMOKE FILTER:



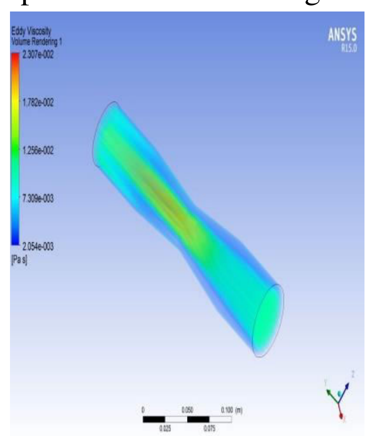
The Figure4.1pressure Gradeint Of The Smoke Filter

DISCUSSIONS:

The above FIGURE shows the pressure graident of the smoke done in ansys having rendring -1 shows the renderenc which has a maximum value at center postion indicated , and is getting varied with a difference 2 the next rendering is found in the next portion to the maximum value and while coming to end the value is getting decreased which can be clearly observed in above FIGUREure done by ansys.

The maximum value obtained at center portion for pressure $9.590e^{+002}$kg m^{a} -2 s^{L}-2.

The minimum value obtained at center portion for pressure 2.907e-002 kg m^{a} -2 s^{L} -2.



The Figure4.2 Shows That Velocity Gradient

DISCUSSIONS:

The above FIGURE shows the velocity gradient of the smoke done in ansys having rendering -1 shows the endurance which has a maximum value at center position indicated, and is getting varied with a difference the next rendering is found in the next portion to the maximum value and while coming to end the value is getting decreased which can be clearly observed in above FIGUREure done by ansys.
The maximum value obtained at center portion for velocity 2.307 e^{-002}Pa s.
The minimum value obtained at center portion for velocity 2.054e-003 Pa s.

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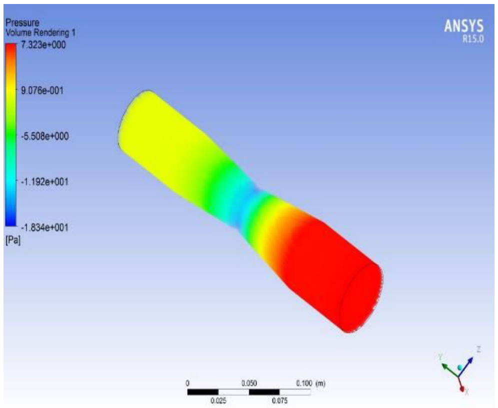


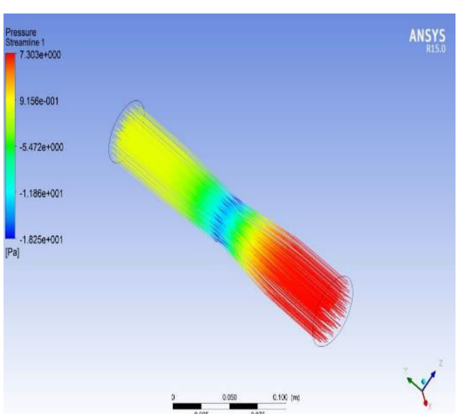
The Figure4.3 Shows That Pressure Volume Rendering Of The Filter

DISCUSSIONS:

The above FIGURE shows the mixture of pressure volume the smoke done in ansys having rendering -1 shows the endurance which has a maximum value at end position indicated, and is getting varied at different and with a difference the next rendering is found in the next portion to the maximum value and while coming to end the value is getting decreased which can be clearly observed in above FIGUREure done by Ansys.

The maximum value obtained at end portion for pressure emission is $7.323e^{+000}$ Pa

The minimum value obtained at end portion for volume emission is $1.834e^{+001}$ Pa.



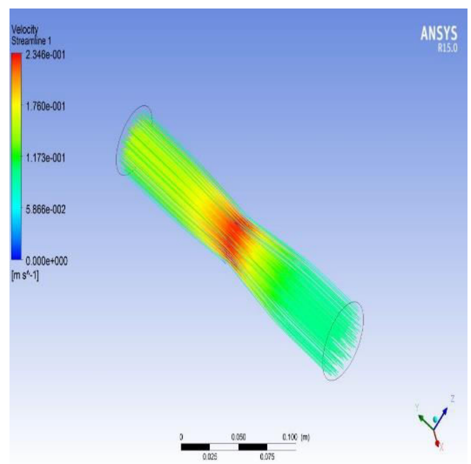
The FIGURE4.4shows that Pressure streamline

DISCUSSIONS:

The above FIGURE shows the mixture of pressure steam line for smoke filter done in ansys having endurance and emission of pressure at both ends and which has a maximum value at end positions indicated, and is getting varied at different and with a difference the next rendering is found in the middle portion to the minimum value.

The maximum value obtained at end portion for pressure steam line is $7.303e^{+000}$ Pa

The minimum value obtained at the end portion for pressure steam line is $1.825e^{+001}$ Pa



The FIGURE 4.5 shows that filter velocity steam line

DISCUSSIONS:

The above FIGURE shows the mixture of steam line for smoke filter done in ansys having endurance and emission of pressure at both ends velocity which has a maximum value at end positions indicated, and is getting varied at different and with a difference the next rendering is found in the middle portion to the minimum value.

The maximum value obtained at end portion for velocity steam line is 2.346e-001 ms^{L-2}

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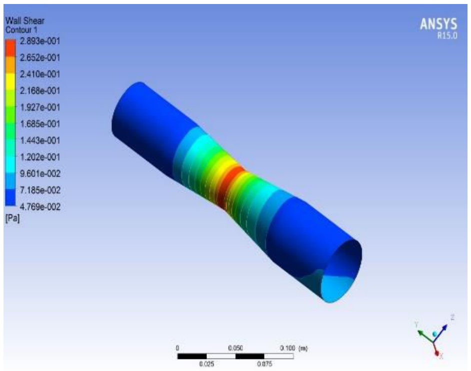
The minimum value obtained at the end portion for velocity steam line is 0.00e+000 ms^{L-2}



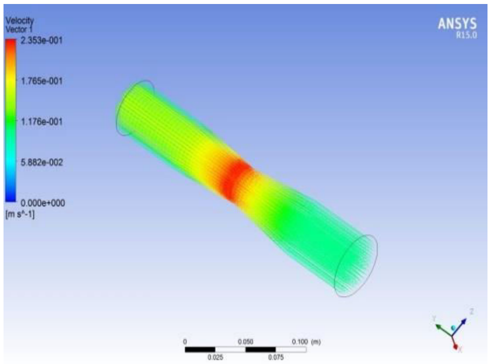
The FIGURE 4.6shows that filter wall stressing model

DISCUSSIONS: The above FIGURE shows the mixture of for smoke filter done in Ansys having endurance and emission of pressure at both ends and which has a maximum value filter wall stressing model at end positions indicated, and is getting varied at different and with a difference the next rendering is found in the middle portion to the minimum value.

The maximum value obtained at end portion for is wall stressing model 2.893e-001 Pa

The minimum value obtained at the end portion for pressure steam line is 4.96 e-002Pa

The minimum value obtained at the end portion for filter Pressure vector is $1.834e^{+001}$ Pa



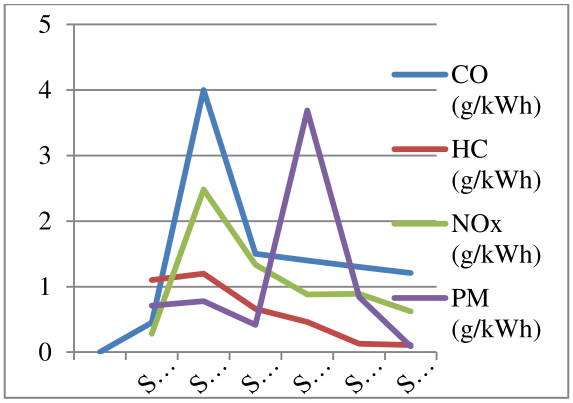
The 4.8 shows that Smoke filter velocity vector

DISCUSSIONS:

The above FIGURE shows the mixture of filter velocity vector for smoke filter done in ansys having endurance and emission of pressure at both ends and which has a maximum value at end positions indicated, and is getting varied at different and with a difference the next rendering is found in the middle portion to the minimum value.

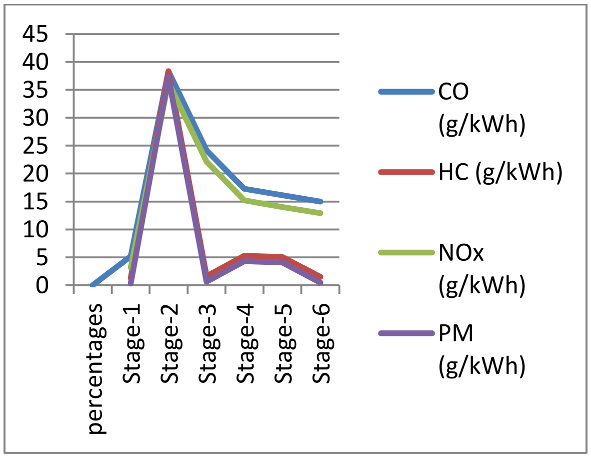
The maximum value obtained at end portion for filter velocity vector is 2.353e-001ms^{L-1}

The minimum value obtained at the end portion for filter velocity vector is 0.000+000 ms^{L-1}



The Graph 4.2 Shows That Practical Values Of Normal Diesel Engine Cold Shot Emissions

The Table 4.3 Shows That Practical Values Of Normal Diesel Engine Hot Shot Emissions



The Graph 4.3 Shows That Practical Values Of Normal Diesel Engine Hot Shot Emissions

CONCLUSION

- The smoke filter characteristics of main pollutant emissions (CO, HC, PM, and NO_x) from diesel engines and control technologies of these pollutant emissions with standards and regulations. Among these pollutant emission, CO and HC are emitted because of incomplete combustion and unburned fuel while NO_x emissions are caused because of high combustion temperatures above 1,600 °C. As for PM emissions, the reasons of PM emissions are 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.
- These pollutant emissions have harmful effects on environment and human health. Even though many applications have been implemented on diesel engines to prevent harmful effects of these pollutant emissions and to meet stringent emission regulations, only after treatment emission control systems are of the potential to eliminate the pollutant emissions from diesel exhaust gas.
- To control these pollutant emissions as desired is only possible with after treatment systems. Diesel exhaust after treatment systems include DOC, DPF, and SCR. These systems are the most requested components especially for heavy-duty diesel engines and usually a combination of DOC, DPF, and SCR has been respectively used for the simultaneous removal of main pollutant emissions from diesel engine exhaust.
- The temperature of diesel exhaust gas has an important effect on reducing pollutant emissions. Besides catalyst type, space velocity of exhaust gas, and emission form are the other parameters affecting the efficiency. With the after treatment emission control systems, it is possible to reduce the damage of the pollutant emissions on air pollution, to meet emission standards and requirements, and to prevent the harmful effects of pollutant emissions on environment and human health. Due to these missions, emission control systems are utmost importance worldwide. For the complete destruction of polluting emissions from diesel engines, further studies and researches on the after treatment emission control systems should be intensified and continued.

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