EMISSION AND ODOR CONTROL OF STATIONARY DI DIESEL ENGINE BY WATER SCRUBBING TECHNIQUE

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Abstract- A simple low-cost exhaust gas after treatment system called water-scrubbing and air-dilution is developed in this project. The water-scrubbing and air-dilution system is investigated on a stationary direct injection (DI) diesel engine to reduce exhaust odor and smoke to acceptable level under variable engine running conditions. Diesel exhaust is diluted with air and washed by sprayed water and passed through a silica gel-absorber.

Index Terms- Flue gases, Diesel Engine, scrubber, Emission control. Etc

I. INTRODUCTION

Today due to increasing use of automobiles and engine based applications and limited resources of fuel engine efficiency has become the greatest issue to discuss about. Today the scientists and many engine manufacturing companies highlight on the factors increasing the engine efficiency to cope up with the increasing demands and decreasing resources. To contribute to the requirement of companies the various methods are generated or implemented to increase the engine efficiency. One of such methods is the preheating the air before entering the engine. This increases the engine performance and increases the efficiency due to less power consumption.

We have used the similar technique on the stationary DI Diesel engine to increase the engine performance. In this technique we have preheated the air before letting it to enter the engine. This helps the engine to give greater efficiency than the normal one. Another fatal issue of the 20th Century is the environmental pollution. It is the greatest challenge on the engineers to develop the technology with less pollution. It is vital to look towards this issue with a greater concern. Engine pollution is the greatest resource that contributes a greater share in the air pollution. Considering the above issue we are developing a method to reduce the emissions of the stationary DI Diesel engine by using the water scrubbing technique. In this technique we have used the air dilution tunnel, water scrubber and the silica gel absorber in order to reduce the odor, emissions.

II. PRESENT PRACTICES

Control devices:-

The following items are commonly used as pollution control devices by industry or transportation devices. They can either destroy contaminants or remove them from an exhaust stream before it is emitted into the atmosphere.

Particulate control:-

1.Mechanical collectors:- (dust cyclones, multicyclones)

2.Electrostatic precipitators:- An electrostatic precipitator (ESP), or electrostatic air cleaner is a particulate collection device that removes particles from a flowing gas (such as air) using the force of an induced electrostatic charge. Electrostatic precipitators are highly efficient filtration devices that minimally impede the flow of gases through the device, and can easily remove fine particulates such as dust and smoke from the air stream.

3.Baghouses:- Designed to handle heavy dust loads, a dust collector consists of a blower, dust filter, a filter-cleaning system, and a dust receptacle or dust removal system (distinguished from air cleaners which utilize disposable filters to remove the dust).

4.Particulate scrubbers:- Wet scrubber is a form of pollution control technology. The term describes a variety of devices that use pollutants from a furnace flue gas or from other gas streams. In a wet scrubber, the polluted gas stream is brought into contact with the scrubbing liquid, by spraying it with the liquid, by forcing it through a pool of liquid, or by some other contact method, so as to remove the pollutants.

III. OBJECTIVE

These are the current engine performance parameters of the IC engine lab of our department, our main objective is to increase the performance and reduce the following emissions.-

(1) To reduce odor about 90% as compared to without system and went down to the level of 2 or lower which is acceptable for all human beings by using water-scrubbing and air-dilution system. Eye irritation by diesel exhaust was completely eliminated.

(2) To reduce smoke about 85% by the water scrubbing and air-dilution system than without system. This reliefs the public nuisance of diesel smoke when operated at a populated place.

(3) To reduce NOx, CO and CO2 upto more than 80% by the water-scrubbing and air-dilution system than without system.

(4) To prevent increase in engine back pressure and any fuel penalty by the water- scrubbing and air-dilution system than without system.

(5) To improve the engine performance as well as combustion parameters.

IV. METHDOLOGY

Method Adopted:-
Engine: Single Cylinder Stationary Diesel Engine
Engine Details:
IC Engine set up under test is Research Diesel having power 3.50 kW @ 1500 rpm which is 1 Cylinder, Four stroke , Constant Speed, Water Cooled, Diesel Engine, with Cylinder Bore 87.50(mm), Stroke Length 110.00(mm), Connecting Rod length 234.00(mm), Compression Ratio 18.00, Swept volume 661.45 (cc)
Combustion Parameters:
Specific Gas Const. (kJ/kgK): 1.00, Air Density (kg/m^3): 1.17, Adiabatic Index : 1.41, Polytrophic Index : -0.00, Number Of Cycles : 1, Cylinder Pressure Reference : 0, Smoothing 2, TDC Reference : 0
Performance Parameters:
Orifice Diameter (mm): 20.00, Orifice Coeff. Of Discharge: 0.60, Dynamometer Arm Length (mm): 185, Fuel Pipe dia.(mm): 12.40, Ambient Temp. (^oC): 27, Pulses Per revolution: 360, Fuel Type: Diesel, Fuel Density (Kg/m^3): 830, Calorific Value Of Fuel (kj/kg): 42000 Air Dilution System- Dilution Tunnel and Blower Water Washing System-Vertical Water Scrubber Moisture Absorbing System-Silica Gel Absorber

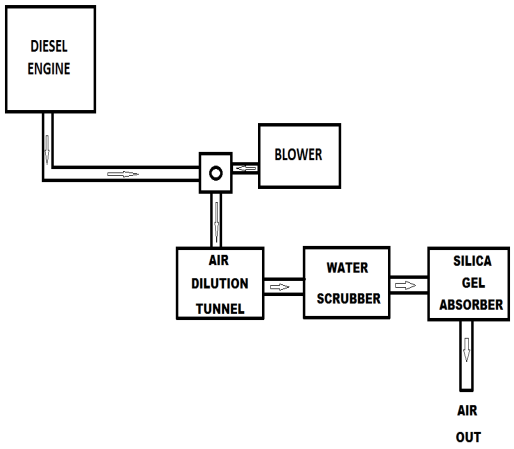


Fig. 1 showing block diagram of Method adopted.

The Main parts of the project are as follows:-

1. Air Dilution System.
2. Water Scrubber.
3. Silica Gel Absorber.

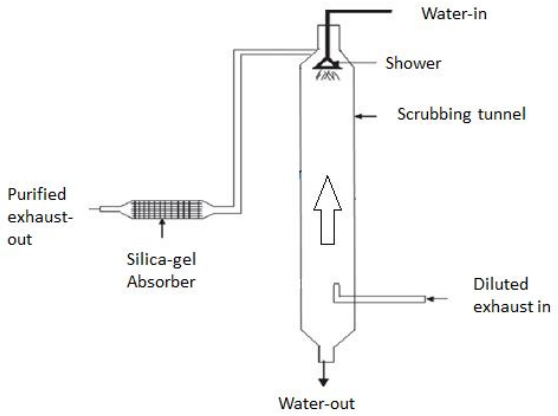


Fig. 2 showing Water scrubber & Silica gel absorber

Assembly:
The assembly of all the above devices is attached to the engine to serve the purpose. The specific material for each part which is to be used in our project in shown in following table. The dimensions of the parts needed in the assembly are also important from project point of view. The dimensions selected are also stated in the following table as shown:-

Material used:

Device	Material
Air Dilution Tunnel(Structure)	GP Sheet
Air Dilution Tunnel (Baffles)_	GP Sheet
Spray Tower	GP Sheet
Shower System	PVC Piping
Silica Gel	Silica
Absorber Box	Fibre
Valves	MS

Table 1. Showing Device & its specific material

Dimensions:

Device	Dimensions
Air Dilution Tunnel	Dia: 15 cm Length: 2.3 m
Water Scrubber (Spray Tower)	Dia: 15 cm Length: 2.7 m
Silica Gel Absorber	15cm x 15cm x 35 cm

Table 2. Showing Dimensions of devices

These dimensions are standard dimensions for a particular Diesel Engine according to the research of the author. We can alter the dimension required as per the capacity of engine used in the process used. The above mentioned dimensions are as per our requirement and the engine specifications.

V. TESTING

1) Odor Testing (Human Assessment Technique):-
Human assessment is one technique used to check odor intensity of exhaust gases. In this method, the nose is used as a detector of smell and an odor intensity scale is used to evaluate the discomfort level of exhaust gases. A difference of one point has been reported as being equivalent to a tenfold change in the concentration of odorous gases. Therefore, a one-point improvement in the odor scale is a significant improvement in exhaust odor. There is a significant scatter in the results recorded by human assessors when the test personnel are inexperienced, but reliable results can be obtained with experienced test personnel.

In Ref., a validation experiment has been reported to prove the reliability of the human assessors where ten assessors were used, of whom six were inexperienced and four experienced. Although the results were very scattered in the case of inexperienced assessors, very close results were obtained from the experienced assessors. This study used three experienced assessors, and the average value of odor ratings from these three assessors has been used throughout the study.

The range (maximum difference) of odor rating is about 0.25 points among the assessors for a data point or for replication of data and the standard deviation is about 0.2 points. In human assessment, usually assessment is done at the exhaust manifold or at the tail pipe. In this study, the assessment was performed at the tail pipe (about 1 m from the tail pipe end). The assessors checked the odor rating directly by exposing their nose to the exhaust stream at the tail pipe. The assessed gas speed (exhaust gas speed at which the odor levels are examined) was about 2.5–3 m/s. The maximum exhaust temperature at the checking point was about 40–45^{o}C when no attachment was used.

However, with different attachments the exhaust temperatures were only about 30–35^{o}C. Exposure time for odor assessment is about 2–3 s. This investigation includes eye irritation of exhaust gases, because eye irritation is also a great concern in the areas such as mines, tunnels, hospital, or other public gatherings where diesel engines are used. Irritation was expressed by the term ‘‘eye irritation time,’’ which is measured by the time required to irritate the eyes when the eyes are exposed to the exhaust. The longer time required to irritate the eyes indicates that there are less irritants in the exhaust and vice versa.

2) Flue Gas Analysis:
Flue gas analyzer is a electronic device which gives the complete content of the gases. Flue gas analyzer gives the complete numerical values of the contents in the emissions.

3) Smoke Testing:
Smoke level can be tested by visual inspection. There are a few smoke levels as shown below which gives a provision to decide the smoke level depending upon the colour of the smoke.

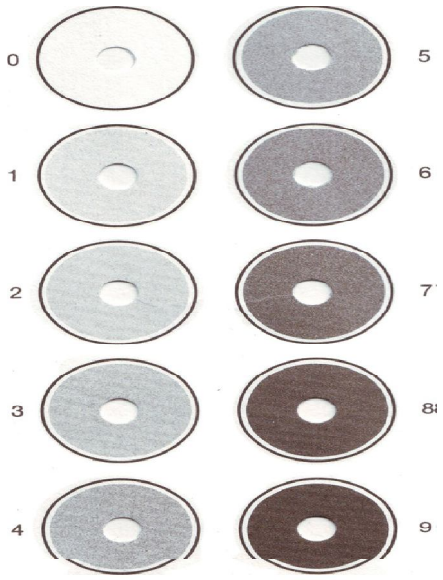


Fig. 3 showing different colour levels of smoke

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