International Journal of Advance Research in Science and Engineering
Vol. No.6, Issue No. 04, April 2017
www.ijarse.com
IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

STUDY OF DIESEL EXHAUST PARTICLE REDUCTION USING ONE STAGE ELECTROSTATIC PRICIPITATOR

Dayanand Surse[1], Prof. Shivanad Karve[2], Shubham Thange[3], Sonali Pawar[4], Nitin Londhe[5]

[2]Professor: Department of Mechanical Engineering, GSMCOE Balewadi Pune, (India)

[1,3,4,5]Department of Mechanical Engineering, GSMCOE Balewadi Pune, (India)

ABSTRACT

Electrostatic precipitators (ESPs) are used to control polluted environment. Conventional ESPs have high collection efficiency but they have a problem that is their collection efficiency decreases due to particle reentrainment for collection of low resistive diesel particulates such as marine engines. In this study, the effect of electrode configuration on collection performance of diesel particulates was investigated using one-stage and two-stage ESPs. The particle concentration for the particle-size range of 30 to 5,000 nm was measured using a scanning mobility particle size and a particle counter .The collection efficiencies as a function of the electrode length and the particle diameter were estimated. As a result, the particle re-entrainment was suppressed with increasing number of discharge electrodes in the one-stage type ESP.

Keywords- diesel exhaust particle, Electrostatic precipitator, re-entrainment, collection efficiency

I. INTRODUCTION

ESPs are extensively used for cleaning of industrial flue gases, combustion flue gases, ventilation flue gases of road tunnels etc. Collection efficiency of convectional ESPs decreases due to particle re-entrainment .The collection of low resistive particles are detached from the collection plate because of electrostatic repulsion force exceeds particle adhesive force on the collection electrode' this phenomenon is particle re-entrainment. In this study, the fundamental collection characteristics under high dust-loading and high gas temperature conditions were investigated for one-stage ESP. The influences of the number of discharge electrodes, the collection electrode length and the engine load on the particle size–dependent collection efficiency were investigated.

II. EXPERIMENTAL SETUP

2.1 SPECIFICATIONS-

- Diesel engine generator(220cc)
- Max. electric o/p power 1.8KW
- Speed 3200 rpm

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

- high dust-loading and high gas temperature conditions in the ESPs.
- Dilution m/c to dilute flue gases approx.100 times.
- Scanning Mobility Particle Seizer and particle counter. For particle size dependent efficiency.
- Collected particle observer on Collection electrode by Scanning Electron Microscope
- Exhaust gas temp-135-220°c
- gas velocity in ESPs approx. 1.5 m/s.

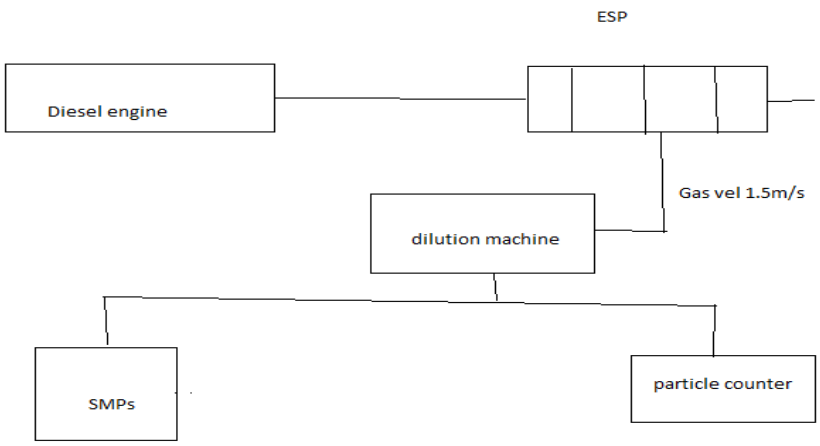

Fig: EXPERIMENTAL SETUP

Schematic diagram of the experimental system is shown in fig. Emissions from small diesel engine generator ,direct injection type for a single cylinder, displacement volume of220-cc, maximum electric power output of 1.8 kW) using light oil with 3200 rpm were used to create a high dust-loading and high gas temperature condition in the ESP. In order to determine the particle number density in the ESP, the flue gas was diluted approximately 100 times by the dilution machine. The particle size-dependent number densities before and after the ESPs were determined by the Scanning Mobility Particle Size for the particle size range of 30-300 nm and the Particle Counter for the particle-size range of 300-5,000 nm, respectively. The collected particles on the collection electrode were observed using a scanning electron microscope (SEM). The exhaust gas temperature was135-220 ^{0}C. The gas velocity in the ESP was approximately 1.5 m/s. The engine load was set to 30, 60and 90% The collection efficiency η was calculated by equation $\eta = (1 - \frac{Nd}{Nu})\times 100$

where

Nu is the particle concentration upstream of the ESP an

Nd is the particle concentration downstream of the ESP.

III. ONE STAGE TYPE ESP

The one stage type ESP consisted of grounded plate electrodes and discharge electrodes. The length of the grounded plate electrode was 200, 400 and 550mm. The discharge electrode has saw-toothed edges on upstream and downstream sides to increase particle charge. The length of the discharge electrode was 150 mm. The spacing between the adjacent plates was 10 mm. -8 kV DC was applied to the one-stage type ESP. Aluminum foils were attached to the electrodes to observe collected particles using SEM

3.1 COLLECTION FOR ONE STAGE TYPE ESP

The collection efficiency for particle sizes lager than 1500nm increased with decreasing engine load. Collection efficiency for various engine loads. (The electrode length: 550mm). The collection efficiency within the particle size range of 300-5000 nm for high engine load decreased with increase in particle diameter. The collection of low resistive particles such as diesel exhaust particles are detached from the collection plate as particle re-entrainment occur .particle size dependent collection efficiency for various electrode length. (Engine load 90%) As 90% engine load is easy to re entrain The collection efficiency within the particle size 30-300nm was greater than almost 95% for all electrode length In the range of 300-5000nm for electrode length of 150mm decrease with increase in particle size The collection efficiency at particle sizes greater than 2,000 nm had negative values. The negative collection efficiency indicated that the downstream particle density was greater than upstream particle density due to particle re-entrainment the collection efficiency within the particle-size range of 300-5,000 nm increased with the electrode length. The collection efficiency at the electrode length greater than 300 mm had positive values due to the suppressed particle reentrainment.

The particle-size dependent collection efficiency for various electrode lengths in the one-stage type ESP, where the engines load was 90% which was easy to re-entrain. The collection efficiency within the particle-size range of 20-300 nm was greater than almost 90% for all electrode lengths. The collection efficiency within the particle-size range of 300-5,000 nm for the electrode length of 150 mm decreased with increasing particle size. The collection efficiency at particle sizes greater than 2,000 nm had negative values. The negative collection efficiency indicated that the downstream particle density was greater than upstream particle density due to particle re-entrainment. The collection efficiency within the particle-size range of 300-5,000 nm increased with the electrode length. The collection efficiency at the electrode length greater than 300 mm had positive values due to the suppressed particle reentrainment. The collected particles on the surface of electrodes were observed to investigate the mechanism of suppressing particle re-entrainment. Pieces of aluminum foil were attached on the grounded electrode surfaces to sample particles. The pieces were prepared for the SEM. Typical SEM images of the collected particles for various sampling locations a the collected particles on the surface of electrodes were observed to investigate the mechanism of suppressing particle re-entrainment. Pieces of aluminum foil were attached on the grounded electrode surfaces to sample particles The pieces were prepared for the SEM Many large agglomerations of particles were observed on the electrode surface under the saw-toothed edge. The particles were pressed down by wind pressure of corona wind. Therefore, the particles were spherical in shape, which increased the contact area between the particles and the electrodes and made the particles difficult to be reentrained from area under the saw-toothed edge. The particles at the middle position of the grounded electrode formed dendrite due to agglomeration in electrostatic The area under the saw-toothed edge, where the particles were difficult to be re-entrained, increased with the discharge electrode length, resulting in a further suppression of the re-entrainment

IV. CONCLUSION

The collection efficiency for one-stage ESPs is increase by suppressing particle re-entrainment by increasing the discharge electrode length.

REFERENCES

[1.] Journal on Diesel Exhaust Particle Reduction using Electrostatic Precipitator by Akinori Zukeran Presented at the 12th International Conference of Electrostatic Precipitation, ICESP, in May 2011 (Nuremberg, Germany)

[2.] "Influence on visibility index of re-entrainment phenomena in electrostatic precipitator," *Journal of Aerosol Science*, vol. 29.

[3.] "Two-Stage Type Electrostatic Precipitator Re-entrainment Phenomena under Diesel Flue Gases," *IEEE Transactions on Industrial Applications*, vol. 35

ACKNOWLEDGEMENT

The authors wish to thank **Prof. Shivanand karve** who had constantly supported, encouraged and guided us and gave us valuable suggestion on time The support of many individuals in challenging twork which have been completed here we extended my deep sense of gratitude towards **Prof. A KARYKARTE (H.O.D)** ,and all staff who provided the necessary facilities and requirements Last but not least We thank to all those who directly and indirectly helped me in completion of this study