Study of Cerium Silica as a catalyst in CI engine fuelled with plastic oil blend

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Abstract. Emissions from automobiles cause major damage to the environment NOx is one of those gases responsible for enhancing the greenhouse effect. To overcome these sorts, most vehicles are employed with catalytic converter. Cerium silica is used as a catalytic material to reduce the emissions from the CI engine. Two methods such as impregnation and co-precursor are employed in the preparation of ceria silica. Ceria silica is molded into solid by adding TMOS [Tetra methyl orthosilicate], Absolute ethanol, DI water, Propylene oxide, and cerium salt. The mould used in the exhaust gas as a catalytic material after-treatment system. The study is done to reduce various exhaust emissions. The engine that is employed is a 5.2kW single cylinder CI engine. Plastic oil blend is used in this process to run the engine which is being produced by pyrolysis process from waste plastic materials.

Keywords: CI engine, Ceria Silica, NOx emission, plastic oil, catalyst.

1. Introduction

Diesel engines were noted for their higher thermal potency and therefore they were usually utilized in industry. However, diesel engines are the main contributors to emissions like oxide. These emissions are abundantly harmful to persons and are accountable for respiratory disorder. SCR is employed in numerous applications. SCR is well-tried to be most effective emissions technology for NOx absorbent material. This method is widely used for all diesel engines.

In USA, Europe and Japan, NOx reduction system supported the SCR technology unit being developed for a variety of IC engine applications. SCR technology is approaching commercialization in Europe wherever a variety of industrial quality vehicle makers select urea-SCR for meeting unit v emissions [1]. In japan automotive were the primary use industrial urea-SCR system that was introduced on its Quon heavy-duty truck launched in 2004. An organic compound is injected through external supply into system to react with unburnt carbon materials and ammonia is reacting with SCR system for NOx emissions reduction. So, metallic element silicon oxide is that the material of the SCR system chosen because the best technology to withstand the heat throughout the testing method consistent with this SCR technology, AdBlue is employed to scale back the NOx emission [2].

Urea is the colourless liquid and ignitable that is injected into system to react with unburnt carbon and ammonia to urge react with selective chemical reactor. Organic compound that isn’t risky to health and surroundings and doesn’t need any special handling instrumentation is employed for precaution. In European country, serious duty ICE WITH capability of twelve litres is employed for testing the selective chemical reactor with organic compound appliance to manage the NOx emissions within the
steady state condition. Likewise ford tested the IC with capability of five litres engine with SCR for NOx emissions management. BSVI is that the sixth emission benchmark in reducing pollution levels when put next to the BSVI emission norms [3].

SCR technology is in the purpose of the nitrogen oxide emission reduction, which is known as “selective” catalyst for NOx level by using ammonia and urea as a reductant. SCR system converts the pollutant into nitrogen, CO2 and water in the exhaust system of the vehicles. SCR unit is major in the marine industries also. For reduction of stationary source emissions, SCR technology is used and it is being recognized as the emission technology in the diesel engine emission standards for all equipment. It is economically and environmental benefits in the technology. It is implemented in all passenger vehicles to control the NOx emission in the worldwide. This system is most important technology in all application for emission control and to protect the environment from the pollutants [4].

Measure of ammonia produced from a gear like electrostatic-precipitator, SCR this is known as NH3 slip. Ammonia slip is an industry term for ammonia going through the SCR unreacted. It is considered to be toxic gas thus should be controlled before the exit of tailpipe. Operational cost regarding to SCR technology is AdBlue solution. AdBlue is a diesel exhaust liquid utilized in vehicles with Selective Catalytic Reduction (SCR) innovation to diminish destructive gases being delivered into the climate [5]. Catalyst poisoning is said to be deactivation of chemicals, where thermal decomposition happens with regards to catalyst degradation. Sulphur in fuel causes Catalyst poisoning when the range of Sulphur is high. Countries with production of newer catalyst has the capability to reduce Catalyst poisoning.

2. Literature Survey

Under the CI pump, the NOx reductions and N2O discharges of urea Selective Catalytic Reduction frameworks with catalyst are tested. At higher temperatures, the fumes of the fuel motor used in this study display higher NOx. Furthermore, the proportion was significantly higher. The experiment was discovered with the NO2/NOx proportion & fume gas temperature had a significant impact on both catalysts. Because of the low NH3 stockpiling limit occurred on a fairly regular basis. Because of the side responses between smelling salts, NO2, and oxygen, the N2O production amount for the Fe-zeolite catalyst increased dramatically. In either case, the V2O5-WO3/TiO2 catalyst was not affected [6].

The action of the V2O5/TiO2 catalyst could be improved by either Nb or Sb doping. Increased Nb stacking resulted in increased N2 selectivity. When both are stacked on a catalyst, the NO shift is significantly higher than when either Sb or Nb is stacked on the catalyst. Sb oxides and Nb oxides have a strong collaborative effect, which can help the catalyst work better. Sb and Nb expansion would also help protect against K2O damage.Nb and Sb are mainly found in the form of Nb5+ and Sb5+ on the Sb and Nb stacked catalyst surface. Sb expansion increased the redox capacity of the catalyst surface and improved the feebly reinforced oxygen, both of which are essential for the SCR response. The expansion of Nb can actually promote the separation of water, resulting in the formation of surface hydroxyl species and an increase in surface corrosiveness. Sb and Nb combined can increase redox capability and surface corrosiveness, advancing SCR execution [7].

Most diesel vehicles have been furnished with comparative after-treatment gadgets. Be that as it may, NOx discharges shift extensively under genuine driving conditions relying upon the vehicle. The variety can be credited to the distinction in the methods of SCR control, yet the impact of DOC and DPF can't be disregarded. This examination was completed as a component of the advancement of PM and NOx decrease framework for the retrofit market of old diesel vehicles. Changes in NO, NO2 and N2O emissions owing to DOC, DPF, and SCR frameworks were explored. The accompanying ends can be drawn [8].
The expansion of methanol to the HC-SCR response results in a striking improvement in the low-temperature movement of an Ag/Al₂O₃ catalyst, notwithstanding the way that methanol all alone isn't dynamic for the HC-SCR response. The utilization of a quick transient exchanging framework showed that the expansion of methanol improves the transformations of both NOₓ and octane and the creation of N₂ with high selectivity in examination with those saw with octane and toluene all alone. This phenomenon is like the H₂ effect and it is noted that hydrogen and alkali were recognized during the methanol transient tests. Drift analysis has uncovered that NCO species are framed while adding methanol into the octane-SCR feed while CN species are taken out/burned-through from the outside of the Ag. These NCO species may assume an imperative part in advancing the synergist movement of NOₓ decrease however maybe more significantly the methanol can additionally eliminate cyanide species from the silver. Regardless of whether this happens through methanol-inferred animal groups or by means of the arrangement of hydrogen isn't yet clear [9].

This paper shows the best approach to limit the CO₂ emission in the air. This accounting of the CO₂ causes the climate into the catastrophic event which it means annihilated the world slowly. By these issues, greenhouse gas emanation causes to transmit the carbon dioxide (CO₂) particles in the climate. Despite the fact that numerous advancements created to control the CO₂ emissions into the air, CCS is the basic strategy what's more, better path for controlling the CO₂ outflow in the climate. Tentatively, single chamber with 4 cycle motor determination, diesel with 5kW appraised power. For this reason, rather than carbon dioxide capture (CCS) to ingest the CO₂ which is emitted from the fume’s framework is constrained by the wooden. Thus, the capability of the CCS is depicted by the exhibition and attributes of the diesel motor discharge. By these 15 experimentations on account of B20 fuel, results uncovered 19% CO₂ emissions is decreased by utilizing charcoal and 32% of CO₂ emissions is decreased with actuated carbon. This B20 fuel is contrasted and without CCS. In any case, in brake warm productivity around 2% tune is decreased with negligible backpressure utilizing CCS [10].

3. Experimentation

Investigation on NOₓ reduction technology using SCR- silica based catalyst complying with BSVI emission diesel engine is shown in figure 4. The SCR unit is placed far away from the engine. The swirl mixer increases the mixing ratio of the unburnt gases and AdBlue solution to form a uniform flow. SCR performance is investigated on computerized single cylinder four-stroke diesel engines.
Figure 2 shows the Gas Analyser which can be used to measure volume of various gas constituents in the exhaust gas of automobiles. These gases are CO, HC, NOx. The air-fuel ratio $\lambda$ can be calculated from the emission constituents and displayed in the analyzer. Figure 3 shows the Smoke Meter that can be used for getting the opacity value of the exhaust in the AVL 437C Smoke Meter. The Smoke Meter is used to estimate the opacity of polluted air, specifically diesel exhaust emissions.

With each passing day, the production and use of plastics increases. After their utility, all plastics must be disposed of as waste. The need to control plastic waste is becoming more evident. Thus, the problems caused by rising plastic waste and, as a result, rising fuel prices are frequently solved by devising a mechanism that reduces emissions caused by plastic while increasing the supply of renewable fuels. This was accomplished by turning waste plastic into a viable alternative oil. This
technology compendium seeks to provide a comprehensive overview of the solutions available for recycling waste plastics.

Plastics are polymeric structures made up of long chains of molecules that replicate themselves. Plastics have been a very significant and durable class of materials for product design as a result of developments in plastic manufacturing since then. Plastics have been an indispensable part of our lives, and they are a miracle of polymer chemistry. But, in addition to being a general annoyance, repeated reprocessing and dumping of plastic waste causes environmental issues and poses health risks. Environmental issues, such as contaminants, greenhouse emissions, non-biodegradable landfill effects are likely to be the most significant current danger to the standard sector.
Polymers come in a wide variety of shapes and sizes, and their properties are versatile enough to provide a wide range of materials that support society in terms of clinical and scientific improvement, energy conservation, and other ways. As a result, plastic assembly has grown significantly. The sector employs 1.6 million employees in Europe and has a turnover of more than 300 million euros. There’s a lot of hope for brand-new plastic applications that can help the world. Except for the denseness of polyethylene used in this analysis, some plastic resin, among others. Frequently found scattered in our surroundings' Polyethylene is a fantastic hydrocarbon oil source. Warmth leads to a lack of selectivity, an increase in secondary reactions, the formation of coke, and a reduction of catalyst longevity. Figure 5 depicts the pre-mould preparation process, SCR setup with the mould inserted and the Adblue solution sprayed, while Figure 6 depicts the post-mould operation. Figure 7 depicts the procedure of Precursor Method and Figure 8 depicts the procedure of Impregnation Method.
4. Results and Discussion

The figure 9 indicates the distinguishing of oxides of nitrogen range along the reference to independent loads. The values lows down in NO emission range when 10% plastic oil is blended with 90% diesel with single mould using SCR setup. The test was carried out by gas analyser. During the engine running the emission, particularly NO emission was absorbed with single mould SCR. Therefore, the emissions may be reduced at higher loads. The reading has been taken by using diesel, diesel-plastic oil blend with and without Selective Catalytic Reduction. The test was carried out by using two moulds which helps in reducing NO emissions drastically. Compared to the single mould the double mould showed more reduction for emissions. The values increase in NO for full load of 1153ppm with pure ordinary diesel. There is decrease in NO without SCR using diesel plastic blend of 890ppm (single mould) and 546ppm (double mould). There is comparative decrease in NO at full load of 746ppm with single mould SCR when 10% plastic oil is blended with 90% diesel. There is decrease in NO at full load of 510ppm with double mould SCR when 10% plastic oil is blended with 90% diesel. Therefore, the emissions is reduced at higher loads with respect to different mould.

![Figure 9. Comparison of NO emission with different moulds](image)

The figure 10 indicates the distinguishing of Hydro Carbon emission, oil blend with SCR and oil blend without SCR with reference to different loads of the engine. The values lows down in HC
emission range when 10% plastic oil is blended with 90% diesel with single mould using SCR setup. Therefore, the emissions may be reduced at higher loads. During the engine running the emission, particularly HC emission was absorbed with single mould SCR. Therefore, the emissions may be reduced at higher loads. The test was carried out by using two moulds which helps in reducing HC emissions drastically. Compared to the single mould the double mould showed more reduction with respect to HC emissions. The reading has been taken by using diesel, diesel plastic oil blend with and without Selective Catalytic Reduction. We prepared cerium silica for the reduction of HC reduction. The values increase in HC at full load of 39ppm with pure ordinary diesel. There is decrease in HC without SCR using diesel blend of 30ppm (single mould) and 15ppm (double mould). There is comparative decrease in HC at full load of 28ppm with single mould SCR when 10% plastic oil is blended with 90% diesel. There is decrease in HC at full load of 15ppm with double mould SCR when 10% plastic oil is blended with 90% diesel. Therefore, the emissions is reduced at higher loads with respect to different mould.

The figure 11 indicates the distinguishing of CO emission, diesel plastic oil blend with SCR and diesel-plastic oil blend without SCR with reference to different loads of the engine. The values lows down in Carbon Monoxide emission range when 10% plastic oil is blended with 90% diesel with single mould using SCR setup. The test was carried out by gas analyser. During the engine running the emission, particularly CO emission was absorbed with single mould SCR. The value lows down in Carbon Monoxide emission range when 10% plastic oil is blended with 90% diesel with double mould using SCR setup. The test was carried out by gas analyser. During the engine running the emission, particularly CO emission was absorbed more with double mould SCR. The values increase in CO at full load of 0.07ppm with pure ordinary diesel. Then there is decrease in HC without SCR using diesel blend of 0.20ppm (single mould) and 0.10ppm (double mould). There is comparative decrease in CO at full load of 0.13ppm with single mould SCR when 10% plastic oil is blended with 90% diesel. There is decrease in CO at full load of 0.10ppm with double mould SCR when 10% plastic oil is blended with 90% diesel. Therefore, the emissions is reduced at higher loads with respect to different mould.

5. Conclusion

1. There is increase in NOx at full load of 1153ppm and reduces to certain value with addition to catalyst as single mould 746ppm & double mould 510ppm.
2. There is decrease in NOx using diesel blend without SCR at full load of 890ppm in single mould and reduces to 546ppm in double mould.
3. There is increase in HC at full load of 39ppm and reduces to certain value with addition to catalyst as single mould 28ppm & double mould 15ppm.

4. There is decrease in HC using diesel blend without SCR at full load of 30ppm in single mould and reduces to 15ppm in double mould.

5. There is increase in CO at full load of 0.07ppm and reduces to certain value with addition to catalyst as single mould 0.13ppm & double mould 0.10ppm.

6. There is decrease in CO using diesel blend without SCR at full load of 0.20ppm in single mould and reduces to 0.10ppm in double mould.

7. There is increase in smoke value of 65.4ppm in pure diesel and reduces to 48ppm on SCR.

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