PERFORMANCE AND EMISSION ANALYSIS OF DIESEL ENGINE BY COPPER COATING OVER PISTON CROWN AND CYLINDER HEAD

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Abstract: The major toxins emitted from SI engine are carbon monoxide (CO) and unburnt hydrocarbons (UHC). These are harmful and create health problems to human beings, and hence control of these pollutants calls for instant attention. It has been recognized from the literature review that copper coating inside the cylinder head and over the piston crown will reduce the emission and increase the overall performance. Hence, in this Project work piston crown and engine head are coated using copper and experiment are conducted. A Kirloskar AV1 engine is used for conducting experiment. The copper coated piston crown and engine head is used to reduce the emission (HC, CO, O₂, and CO₂). The performance and characteristics of the copper coated engine has been studied.

1. Introduction

Exhaust gas or flue gas is produced as a result of the combustion of fuels such as natural gas, gasoline, petrol, biodiesel mixtures, diesel fuel, fuel oil, or coal. According to the type of engine, it is discharged into the atmosphere through tail pipe, flue gas stack, or propulsive nozzle. It usually disperses downwind in a pattern called an exhaust plume. It is a main component of motor vehicle emissions (and from stationary internal combustion engines), which can also include:
- Crankcase blow-by
- Evaporation of unused gasoline

Motor vehicle emissions contribute to pollution and area unit a significant ingredient within the creation of smogginess in some giant cities. A 2013 study by MIT indicates that fifty 3000 early deaths occur per annum within the us alone due to vehicle emissions, in keeping with another study from identical university, traffic fumes alone cause the death of 5000 folks per annum simply within the UK. Over the past 3 decades, application of composite materials is incessantly increasing from ancient application. the most important a part of most combustion gas is gas (N2), water vapor (H₂O) (except with pure-carbon fuels), and greenhouse gas (CO₂) (except for fuels while not carbon); these aren't venomous or pestilent (although greenhouse gas may be a greenhouse emission that contributes to world warming). a comparatively tiny a part of combustion gas is undesirable pestilent or venemous substances, appreciate CO (CO) from incomplete combustion, hydrocarbons (properly indicated as CₓHᵧ, however usually shown merely as "HC" on emissions-test slips) from unburnt fuel, gas oxides (NOₓ) from excessive combustion temperatures, and particulate (mostly soot). When a chilly engine is started, the fuel doesn't
vaporize fully, making higher emissions of hydrocarbons, nitrogen oxides and monoxide, that diminishes solely because the engine reaches operation temperature. The length of this start-up section has been reduced by advances in materials and technology, along with computer-controlled mechanical system, shorter intake lengths, and pre-heating of fuel and/or inducted air. Catalytic converters square measure terribly inefficient till up to their in operation temperature. This point has been a lot of reduced by moving the device nearer to the manifold and even additional therefore inserting a little nonetheless quick-to-heat-up device directly at the manifold. The little device handles the start-up emissions that permit enough time for the larger main device to heat up. Additional enhancements are often complete in some ways, as well as electrical heating, thermal battery, chemical process preheating, flame heating and superinsulation.

2. Coating
Copper could be a substance with image copper metallic element (from Latin: cuprum) and number 29. It’s a soft, malleable and ductile metal with terribly high thermal and electrical conduction. A freshly exposed surface of pure copper features a reddish-orange color. It’s used as a conductor of warmth and electricity, as an artifact, and as a constituent of assorted metal alloys. Copper is found as a pure metal in nature, and this was the supply of the primary metal to be employed by humans, ca. 8,000 BC; it absolutely was the primary metal to be smelted from its ore, ca. 5,000 BC; it absolutely was the primary metal to be solid into a form in an exceedingly mould, ca. 4,000 BC; and it absolutely was the primary metal to be purposefully alloyed with another metal, tin, to make bronze, ca. 3,500. Copper was mined as Cyprus in the Roman era. The name originated from aes cyprium (metal of Cyprus), later transferred to cuprum, from that to copper (English), Koper (Dutch), cuivre (French), and Kupfer (German) got derived. Its compounds area unit unremarkably encountered as copper (II) salts, which regularly impart blue or inexperienced colors to minerals like azurite, mineral and turquoise and are wide used traditionally as pigments. Bailiwick structures engineered with copper corrode to convey inexperienced verdigris (or patina). Orna wants art conspicuously options copper, each by itself and within the style of pigments.

3. Methodology

| Problem identification |
|------------------------|
| piston and engine head coating |
| Assembling in engine |
| Experimental analysis |
| Result |
Figure 1. Piston of Kirloskar AV1 after copper coating

Figure 2. Engine Head of Kirloskar AV1 after copper coating

4. Experimental Setup
The experimental setups were dispensed on single cylinder four stroke diesel (Kirloskar 500cc).
- The Exhaust emission like (HC, CO, dioxide & O2) was measured by exploitation Automotive Emission Gas analyzer.
- The main pollutants that are objectionable and are to be reduced are HC, CO & dioxide by exploitation chemical action coating together of the techniques wide accustomed cut back emission and improve performance

| Table 1. Engine Specifications |
|-------------------------------|
| Make | Kirloskar |
| Model | AV1 |
| No. of Cylinders | 1 |
| Cubic capacity (ltr) | 0.553 |
| Rated Speed (rpm) | 1500 |
| Bore Diameter | 80 mm |
| Stroke length | 100 mm |
| BHP | 5 |
| Orifice Diameter | 14 mm |
| Fuel | Diesel |
The AVL Smoke Meter could be a filter-type smoke meters for measurement the soot content within the exhaust of diesel and GDI engines. The variable sampling volume and thermal exhaust learning assures large applications vary, e.g. measurements throughout engine development or DPF standardization. AVL Di gas analyzer moveable Emission Measuring System for measure the HC, NO/NO₂, CO, CO₂ and O₂ concentrations among the exhaust gas of diesel and gasoline vehicles.

5. Performance and emission characteristics

The experimental were conducted on Single cylinder four stroke diesel standard engine and copper coated engine with varying load and the results are tabulated in the table. Emission of HC, CO₂, O₂ and CO was also noted. Standard engine and copper coated engine emissions readings are tabulated

| Gases        | Before coating | After coating |
|--------------|----------------|---------------|
| HC (in PPM)  | 13.2           | 11.41         |
| CO (% of volume) | 0.05       | 0.046         |
| CO₂ (% of volume) | 1.42       | 1.33          |
| O₂ (% of volume) | 18.66      | 16.45         |

| S.No. | FP (kw) | BP (kw) | \(\tau\) (Nm) | IP (kw) | TFC | SFC | \(\eta_{mech}\) |
|-------|---------|---------|---------------|---------|-----|-----|----------------|
| 1.    | 3       | 0       | 0             | 3       | 0.504 | -   | 0              |
| 2.    | 3       | 0.741   | 4.74          | 3.741   | 0.572 | 0.771| 19.80          |
| 3.    | 3       | 1.482   | 9.56          | 4.482   | 0.677 | 0.456| 33.06          |
| 4.    | 3       | 2.223   | 14.42         | 5.223   | 0.851 | 0.382| 42.56          |
| 5.    | 3       | 2.964   | 19.37         | 5.964   | 0.960 | 0.323| 49.69          |
From the above graph, the emission level of the Hydro Carbon gas with the standard and the copper coated engine was observed with various loads. The emission level of hydrocarbon is reduced 1.7% after the copper coating.

From the above graph, the emission level of the Carbon Monoxide gas with the standard and the copper coated engine was observed with various loads. The emission level of carbon monoxide is reduced 2.2% after the copper coating.
From the above graph, the emission level of the Carbon monoxide gas with the standard and the copper coated engine was observed with various loads. The emission level of carbon monoxide is reduced 2.3% after the copper coating

![Figure 6. CO vs Load](image)

From the below graph, the emission level of the Oxygen (O2) gas with the standard and the copper coated engine was observed with various loads. The emission level of oxygen is reduced 2.4% after the copper coating.

6. Results and discussion

From the above calculation and the emission analysis test of the engine with the piston crown and the engine head coated with copper shows that the variation in emission level of the HC, CO, CO2, O2 from the copper coated engine.

From the experimental investigation of copper coated engine the following conclusion could be arrived:

- From the experimental results at constant speed with various loads, the average HC emission standard engine is 13.2 ppm, whereas HC emission for copper coated engine is 11.41 ppm. (i.e.) 13.56 % of emission is reduced for copper coated engine compared to standard engine. It is represented in graph 3.
- From Graph 4. CO emission standard engine is 0.05 % of volume whereas copper coated engine gives 0.046 % of volume. From the results the average amount is 8 % of emission is reduced in copper coated engine at idle speed with various load condition.
- From the Graph 5. CO2 emission in standard engine is 1.42 % of volume whereas copper coated engine gives 1.33 % of volume. From the results is 6.33 % of emission is reduced in copper coated engine with various load at idle speed condition
- From the Graph 6. O2 emission in standard engine is 18.66 % of volume whereas copper coated engine gives 16.45 % of volume. From the results is 11.84 % of emission is reduced in copper coated engine with various load at idle speed condition.

Thus, the emission of the exhaust gases namely HC, CO, CO2 and O2 have been reduced to 11.41 ppm, 0.046 %, 1.33 % and 16.45 % respectively using Automotive Emission Gas Analyzer. This can be further reduced by implementing further additional technologies.
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