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EXPERIMENTAL INVESTIGATION AND PERFORMANCE AND EMISSION ANALYSIS OF DIESEL ENGINE WITH MODIFIED INLET MANIFOLD

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Abstract - *An Investigation project done with the objective to analyse the emission and performance of single cylinder four stroke diesel engine at different load conditions .In this project inlet air manifold is modified using swirl enhancer to generate the swirl of air so that efficient combustion is achieved This experiment is done aiming to improve thermal efficiency and decrease harmful emissions by maximizing the use of air fuel during the combustion process .*

***Key Words*: Diesel engine, Swirl enhancer, Performance, Emissions, Combustion process**

1.INTRODUCTION

In todays world pollution is the major problem caused by emissions of harmful gases from different sources like automobiles and industries which pollutes the environment. The harmful gases may be CO,HC,CO_2 and NOx etc. NOx emissions are greatly reduced by generating swirling air. Swirling air causes rapid mixing of fuel and air. Swirl is the ordered rotation of air entering the engine cylinder. Swirl can be generated in different ways, in our experent it is generated using swirl enhancer installed in inlet air manifold.

1.1 Swirl enhancing device

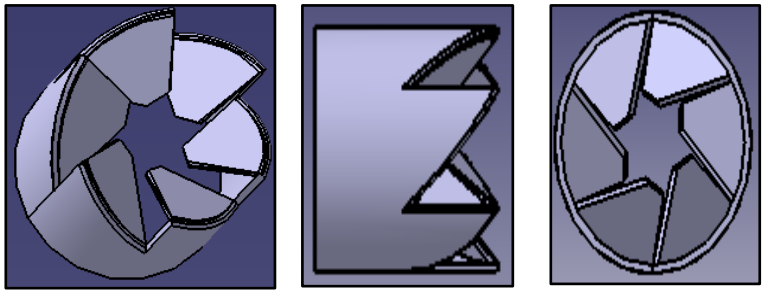

Fig-1: Modelling of swirl enhancer

Swirl Enhancer of 28mm diameter is inserted inside the Inlet air port of the engine head. The modification is done to create swirling. Its effect on performance and emission are discussed in the results section. It is made with sheet metal by cutting the blade on the front part which faces the combustion chamber.

1.2 Engine specification

1. Engine type: Computerized single cylinder four stroke diesel engine
2. Model: Make kirloskar, TV1
3. Cooling type: Water cooled
4. Speed:1500rpm
5. Stroke: 110mm
6. Bore:87.5mm
7. Compression ratio: 17.5
8. Fuel tank: 15lit capacity with metering column
9. Load sensor: Load cell type strain gauge, range 0-50

10. Load indicator: Digital, Range 0-50 kg
11. Rotameter: Calorie meter cooling 25-250 LPH; Engine 40-400 LPH.

1.3 Physical model preparation

1. Sheet metal is used for making swirl booster as it is deformable in nature.
2. It can easily take the shape of t he inlet air port.
3. Sheeet metal operations require less equipments and are easier than machining.

Swirl enhancer(Physical model)

Fig-2: Side view of the swirl enhancer

Fig-3: Top view of the swirl enhancer

2. METHODOLOGY

1. A 15x15 mm steel sheet metal is selected for making tapered swirl enhancer.
2. A sheet metal is selected because it is easy to perform operations while making a swirl enhancer.
3. Sheet metal working tools are used for making swirl enhancer.
4. A swirl enhancer made up of sheet metal can easily take the shape of the Inlet air port.
5. Initially a development of cone method is used to draw the development of tapered swirl enhancer.
6. The development is pasted on sheet metal and cutted accordingly.
7. The cutted sheet metal is rolled to form a tapered swirl booster.
8. The swirl enhancer is inserted inside the inlet air port of the cylinder head.

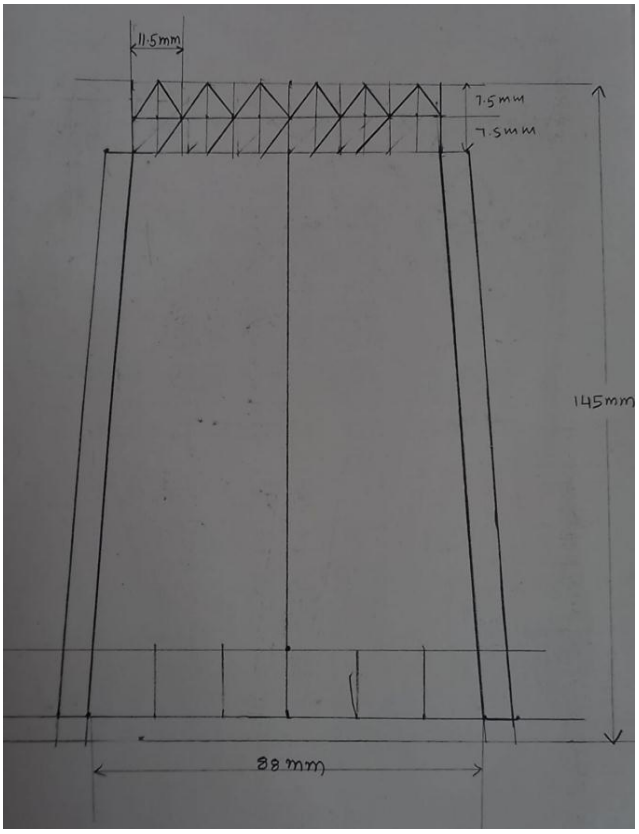

Fig-4: Devlopment sketch of swirl enhancer

Fig-5: Swirl enhancer inserted in a cylinder head

3. EXPERIMENTAL SETUP

Fig-6: Computerised diesel engine test rig

3.1 Construction

Test rig consists of

1. Single cylinder four stroke diesel engine(computerised).
2. Fuel tank and fuel measuring unit.
3. Rotameters for cooling measurement.
4. Transmitters for fuel flow and air flow measurementnts.
5. Eddy current dynamo meter for loading
6. Emission testing equipment.

3.2 Procedure

1. Initially engine is fueled with diesel.
2. Engine is checked for cooling water flow.
3. Ensuring it is at 0kg load.
4. Ensure power supply mains are on.
5. Ensure engine test rig is connected computer and emission checking device.
6. Start the engine with 0kg load and run for 20minutes and slowly rise the load.
7. Load is increased by 2 kg ,4kg.6kg,8kg and 12 kg and readings are tabulated.

4. EXPERIMENTAL ANALYSIS

4.1 Performance

1. **Load vs Brake thermal efficiency**

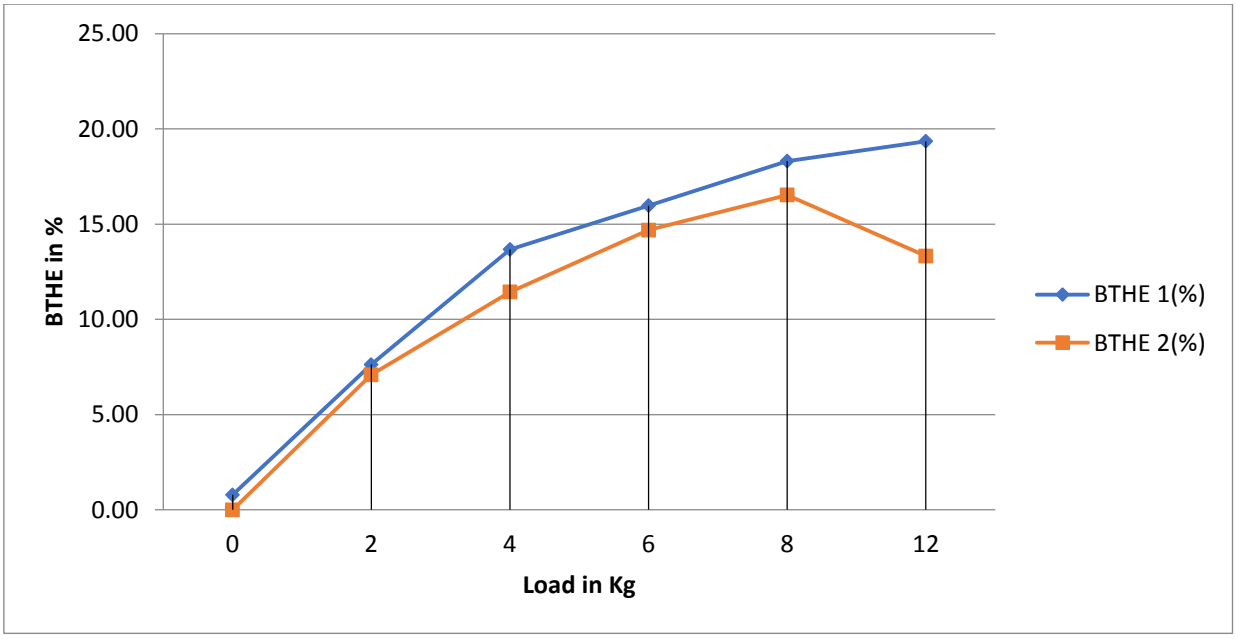

Chart-1: Load vs Brake thermal efficiency

Brake thermal efficiency depends on Brake power and specific fuel consumption. Here Specific fuel consumption is increasing in an engine with modified inlet manifold as the flow of fuel is more than air. Hence brake thermal efficiency is increasing with increasing load Brake thermal efficiency of an engine with an modified inet manifold is slighty less than conventiona diesel engine.

2. Load vs Specific fuel consumption

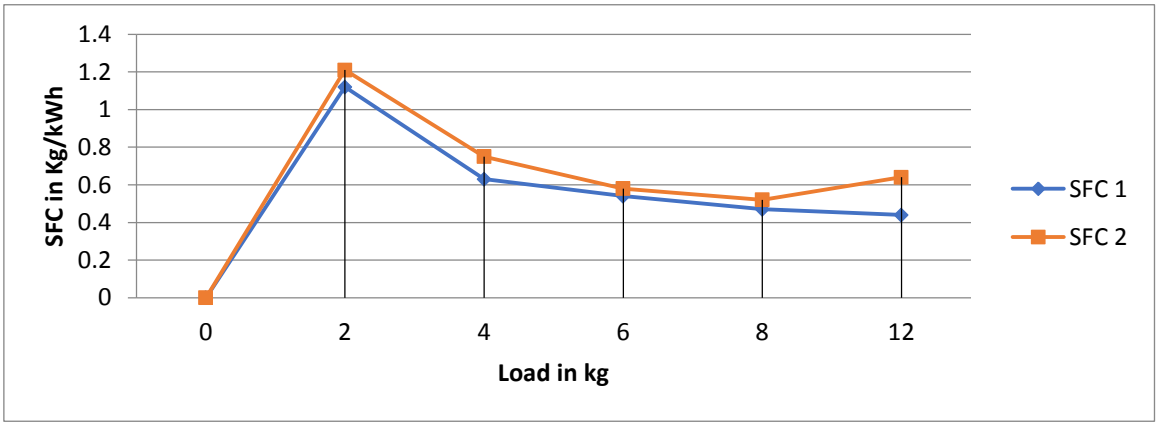

Chart-2: Load vs SFC

The specific fuel consumption of conventional diesel engine is lower than that of engine with modified inlet manifold. This is because of the disturbed air passage in the air inlet port .

3. Load vs Indicated thermal efficiency

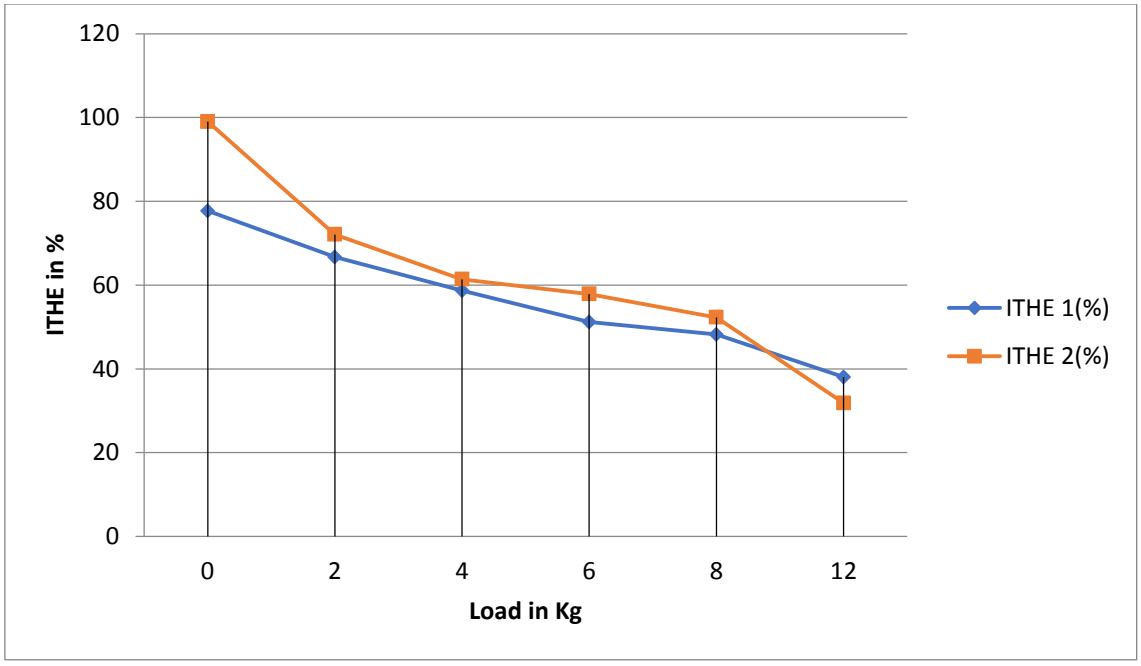

Chart-3: Load vs ITHE

Indicated thermal efficiency depends on the indicated power which inturn depends on the indicated mean effective pressure.Indicated mean effective pressure is the average pressure in the cylinder for a complete engine cycle. As indicated mean effective pressure is increasing for diesel engine with modified inlet manifold .The ITHE of diesel engine with modified inet manifold has slighty higher than conventiona diese engine.

4. Load vs Mechanical efficiency

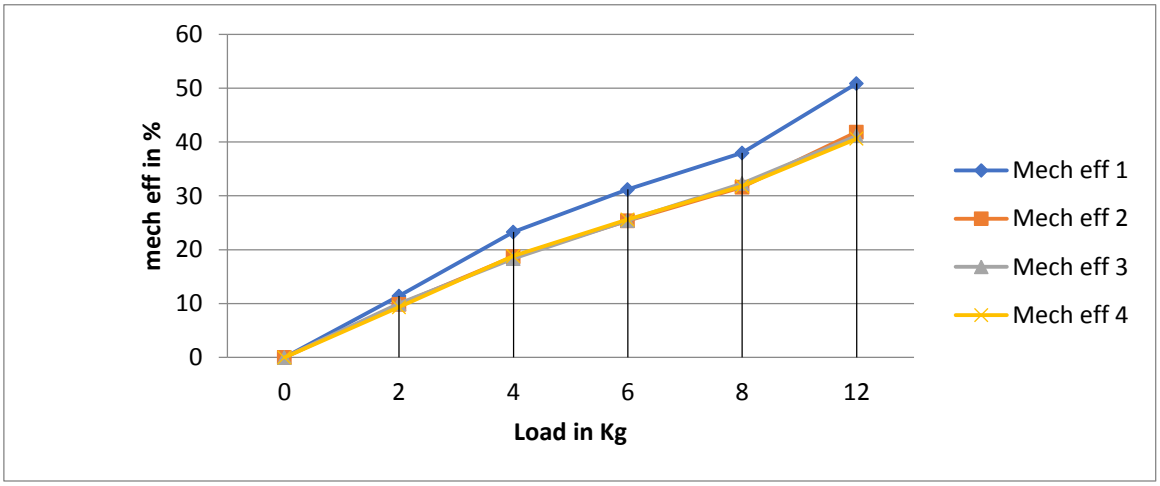

Chart-4: Load vs Mechanical efficiency

Mechanical efficiency is obtained by the ratio of brake power to the indicated power. As the indicated power is increasing in an engine with modified inlet manifold hence mechanical efficieny is decreasing.

5. Load vs A/F Ratio

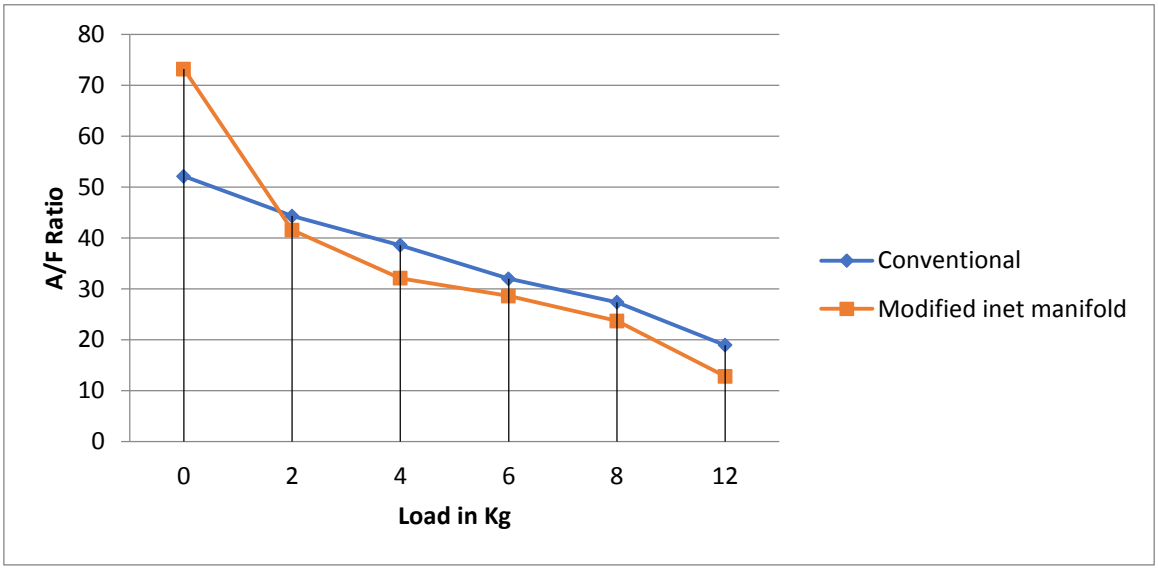

Chart-5: Load vs A/F Ratio

The air fuel ratio is more in conventional diesel engine and it is reducing in an engine with modified inlet manifold because of less air flow resulting in rich mixture.

4.2 Emissions

1. **Load vs CO emission**

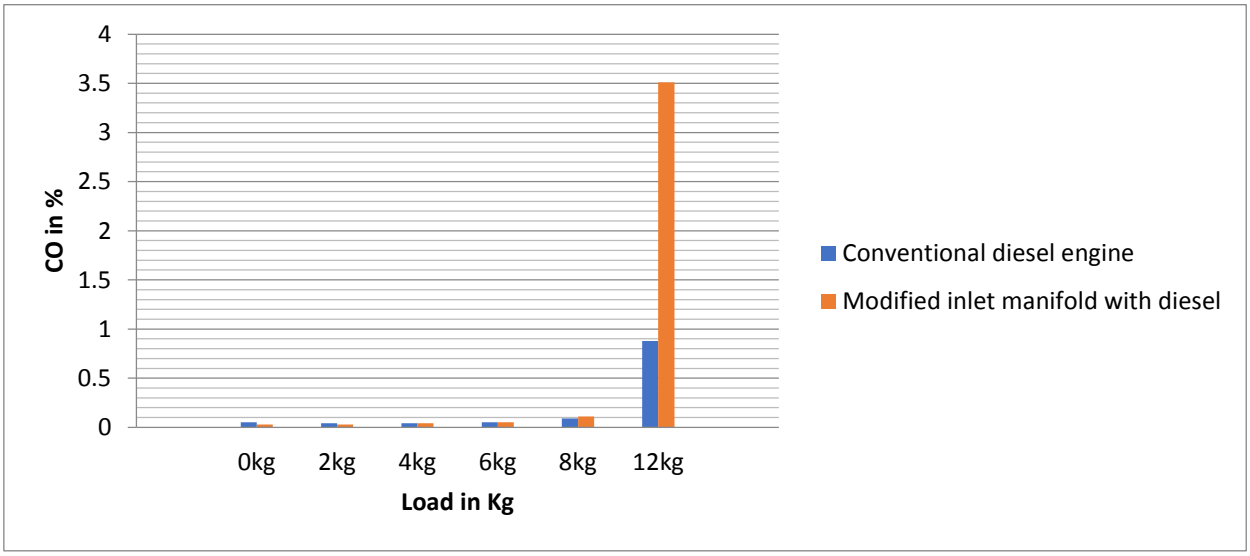

Chart-6: Load vs CO emission

2. **Load vs HC emission**

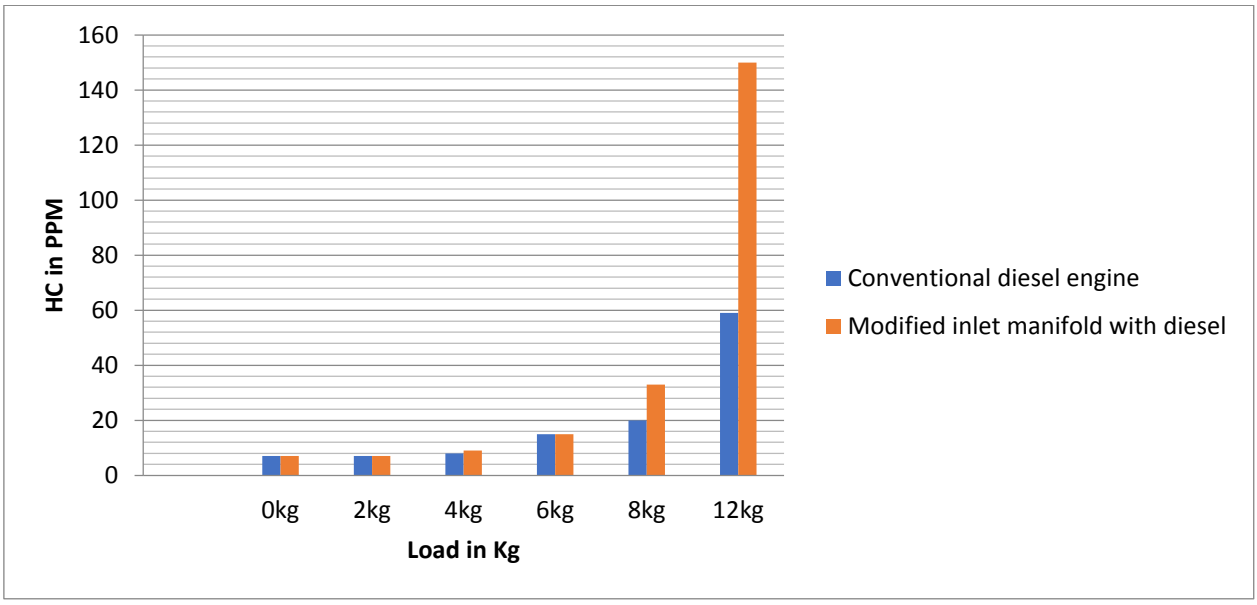

Chart-7: Load vs HC emission

Higher fuel/air ratio causes the emission of HC and CO. During the initial loads the CO and HC emissions are comparatively small and there is slight difference between difference between the two But at higher loads it is increasing because with increase in the load the fuel/air ratio increases and also there is disturbance for air flow due to modification if an inlet manifold. This causes rich fuel/air mixture hence resulting in Carbon monoxide and hydrocarbon emissions.

3. Load vs CO_2 emission

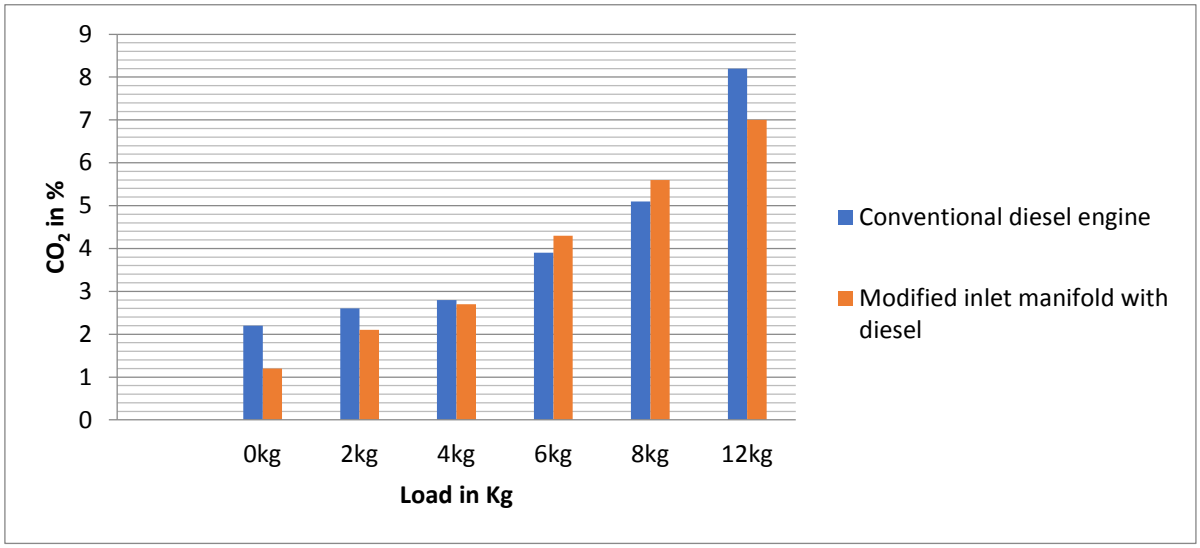

Chart-8: Load vs CO_2 emissions

The combustion process causes a mixing of carbon with oxygen in air resulting in the formation of carbon dioxide.The change of CO2 emission is slighty reduced in an engine with modified inlet manifold at maximum load.

4. Load vs NOx emission

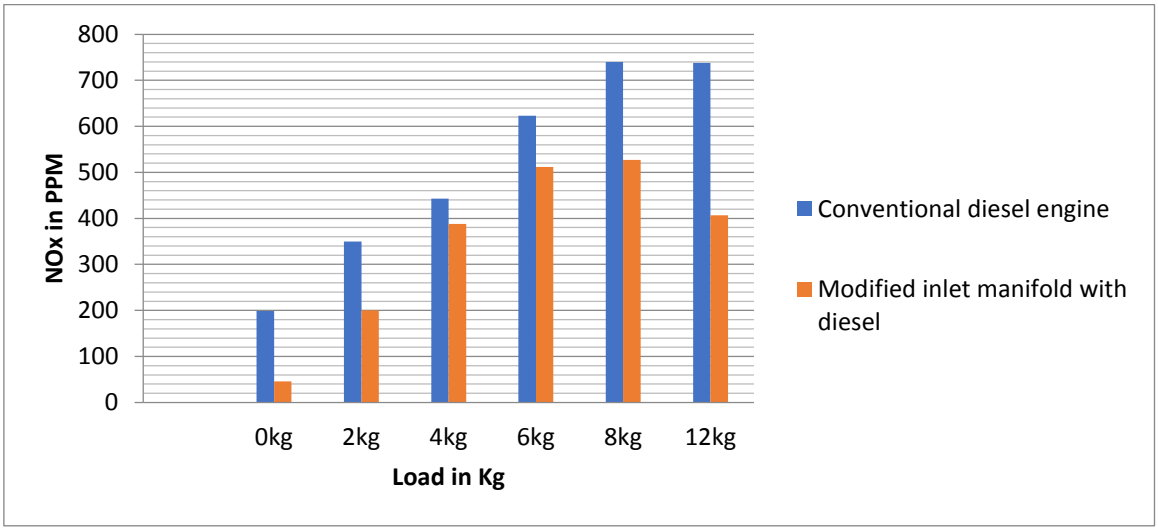

Chart-9: Load vs NOx emission

NOx emissions increases with increase in load because it causes increased fuel supply resulting in longer combustion duration causing increase in temperature hence it causes NOx formation. The NOx emissions are decreasing in an engine with modified inlet manifold because of rich mixture burning.

5. Load vs O_2 emission

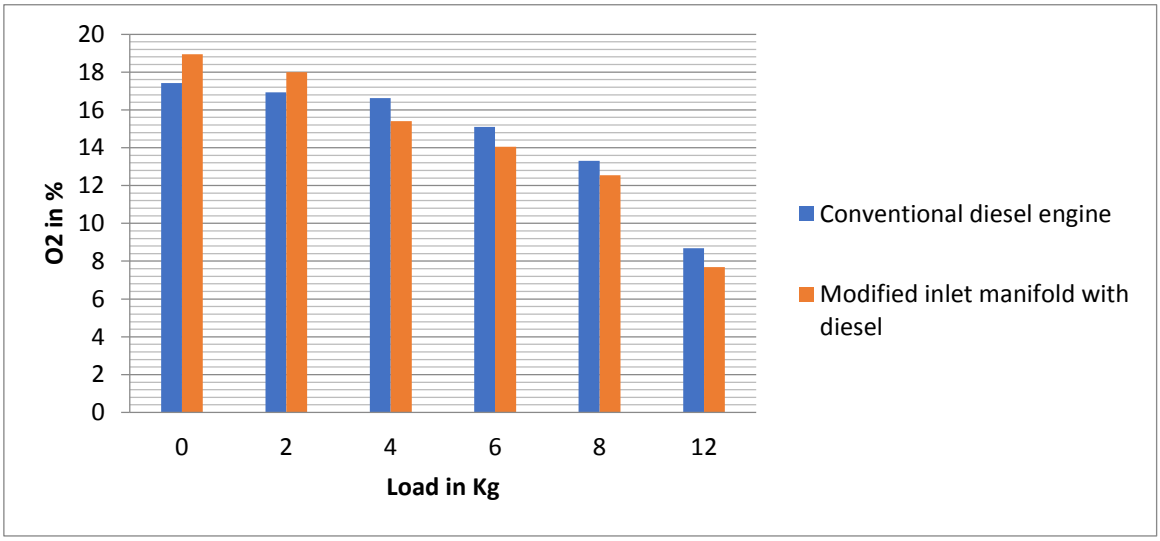

Chart-10: Load vs O_2 emission

With increasing load oxygen emission is reducing in different setups which results in good combustion of fuel O2 emission is also nearly same for different setups and fuels.

6. Load vs smoke emission

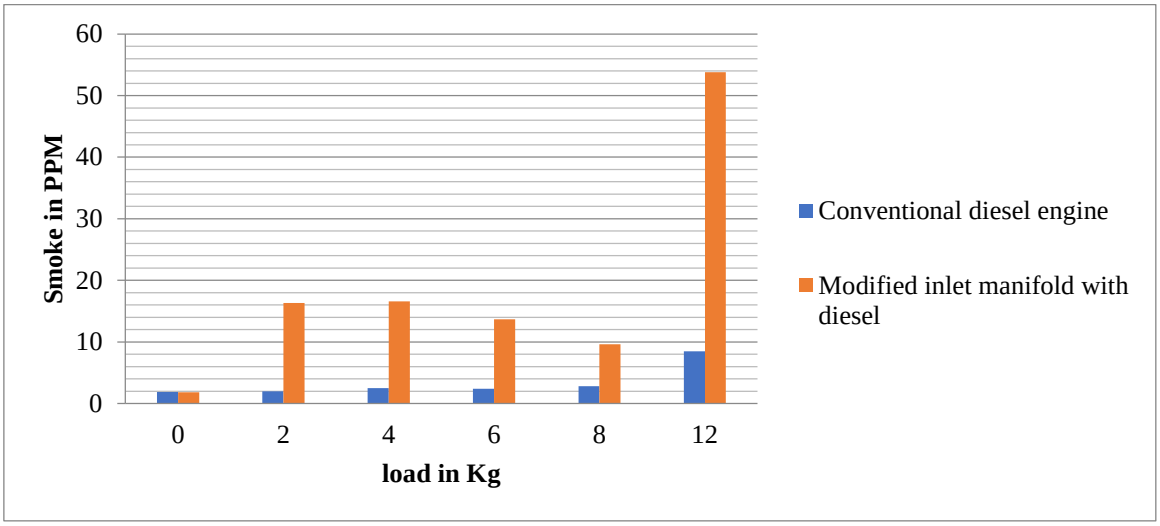

Chart-11: Load vs Smoke emission

Smoke emission is the part of combustion process.Smoke is increasing with increasing load because of rich fuel mixture burning.

5. CONCLUSIONS

1. Inlet air swirl is created by using modified inlet manifold.
2. It concludes that small reduction in Brake thermal efficiency and sight increase in specific fuel consumption.

3. Carbon monoxide and hydrocarbon emissions are slighty decreasing at the initial loads and increasing at the higher loads due to rich mixture.

4. Nitrogen oxide, carbon dioxide and oxygen are decresing in an engine with modified inlet manifold.

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