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EXPERIMENTAL INVESTIGATION OF PREHEATING EGR IN DIESEL ENGIN

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Abstract

In an internal combustion engine, fuel combustion creates heat, with the bulk of the energy transformed into mechanical effort. The residual heat is excluded into the atmosphere. Only 50 to 60% of the heat energy is turned into work; the other 40-50% is squandered as heat, lowering engine efficiency by 20 to 30%. This heat is referred to as waste heat. The infection of the consume gas determines to quantity on heat recovered. EGR technology recovers this wasted heat, saving a large amount of gasoline. The methods include combustion air preheating, boiler feed water preheating, processing water preheating, and space heating. The current paper describes the experimental investigation of a CI engine fitted with an air-to-air warmth exchanger that serves as the air preheater, heating up air from the EGR to the cylinder inlet. The preheated air in the engine intake manifold impacts engine performance and emission control. The preheater boosts the temperature at the inlet by flowing exhaust gas through it. The higher the air flow temperature, the greater the thermal efficiency of the brakes and, consequently, the lower the specific fuel consumption, pollutants, and ignition delay. Preheating the inlet air causes uniform combustion, which minimises engine noise and defines the routine of CI engines and deprived of a preheater.

KEYWORDS: Air pre-heater, waste heat, noise, EGR....

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INTRODUCTION

The NOx, smoke, and particle releases from the automobile diesel machines have been topic to stern release guidelines over last few years . Diesel machines are recognized for their small fuel ingesting and minimal CO releases. Diesel engine NOx emissions, on the other hand, remain high. As a result, lowering the quantity of NOx in consume gas is extremely desirable for meeting environmental laws. Tractors, large trucks, and trucks are often powered by diesel engines. They consume proven gradually popular for reduced trucks as well as traveller's automobiles because to their low fuel consumption. However, greater NOx releases from diesel machines continue a key source of pollution.

1.1.1 GAS RECIRCULATION FOR EXHAUST

Exhaust gas recirculation (EGR) (HC), particularly nitrogen dioxide (NOX), carbon monoxide (CO) and hydrocarbons, is one of the best ways to reduce exhaust emissions and particulate matter (PM) emissions from diesel vehicles. A portion of the diesel engine's exhaust gas is often recirculated through the fresh air charge into the engine's combustion chamber for fuel injection combustion. Almost all types of diesel engines including light, medium and heavy duty engines, may dramatically reduce their NOX emissions by adopting an emission control method known as EGR. This saves petrol and also reduces engine emissions. Fuel volatility, density, viscosity, cetane number and sulfur concentration classifying diesel fuel. Air should be preheated to enhance these qualities. At the engine intake, an air preheater is fitted. The incoming air is heated using the waste heat of the engine exhaust. Better fuel combustion and increased intake temperature are ensured by preheating. Increased efficiency, torque, horsepower and fuel vaporization are the result of higher intake temperatures. Ignition delay is reduced and combustion rate is increased by preheating the air. NO, HC and CO emissions are produced by diesel engines. [Reduction of CO and HC emissions by preheating high temperature intake air]. Exhaust wastes 60 to 70 percent of energy, 30 to 40 percent to the environment and 30 to the engine's cooling system. The temperature of exhaust gas varies from 450 to 6000 degree Celsius. In the present study, an air preheater shell and tube heat exchanger.is used to recover this waste heat. It consists of a matrix material and a copper tube shell. More heat can be collected from the exhaust gas because the velocity of the exhaust gas decreases as it travels through the preheater. The copper pipes carry heat from the exhaust gas to the fresh air, thereby warming the air. The engine's intake manifold receives the next hot air.

2 MATERIALS AND METHODS

Several ERS systems, including a warm external breathing system, a cold external breathing system, a system with a reed valve and a pump, were investigated in the present study using an electrically driven system. Efficiency and emission characteristics of DI-CI engine may vary. Focus is on fuel economy at steady states circumstances. The reaction is investigated under a variety of situations, including ERS requirements and shifting torque. A diesel engine with and without EGR (cooling) was tested. The engine was accelerated at 10% EGR ratio using diesel to meet the study's goal. To get baseline readings, the engine is operated with diesel and 0% EGR. Finally, baseline data is employed in order to compare engine performance and emission metrics.

2.1 EXPERIMENTAL PROCEDURE SET UP

The performance parameters were tested using a diesel engine with variable compression. These machine parameters are provided. Four-stroke, single-cylinder, water-cooled diesel engine with the parameters listed in the table is used for testing. 1 A schematic design of the test rig for a diesel engine is shown in Figure 1. With the help of a rope brake dynamometer, the machine is loaded. An electric heater is installed in the fuel line between the fuel pump and the injector to heat the petrol.

Figure 1:EGR FULL SETUP

Exhaust gas recirculation (EGR) is an active plan for monitoring NOx secretions from diesel engines. EGR lessens NOx is reducing of the oxygen concentration in the ignition space and captivating hotness.

Based on its rated power and brake drum radius of 0.15 m, the engine's original full shipment weight was 16 kilograms. Throughout the test the engine was loaded at 0, 25%, 50% and 75% of its maximum capacity. Engine load is limited to 75% of its full capacity (12 kg) for safety and engine health. For each load, the fuel temperature rises to 250oC, which is 100oC to 175oC from room temperature (normal diesel). Thermocouple systems were used to manually adjust the fuel temperature. Variable injection timing studies are not included in this article as the constant injection timing was found to be 23o before TDC.

Figure 2: Electronically controlled external rebreathing unit

K-type thermocouples were used to measure the temperature of the cooling water intake, exit and exhaust gas. With provision for automatic room temperature regulation, digital indicator is used. Calibration of temperature gauges takes time into account. A flow meter was used to monitor water flow to calculate the flow rate in gallons per minute. Fuel consumption measured. Exhaust gas emissions were calculated using an exhaust gas analyzer.

2.2 RECIRCULATION SYSTEM

The recirculated exhaust gas is sometimes sent back into the combustion chamber along with the intake air. An exhaust gas by-pass is supplied in addition to the manually operated EGR valve because the quantity of EGR needs to be properly assessed and managed. During the exhaust stroke, the engine releases high-pressure exhaust gases. The natural pulse. The volumetric flow rate of the recycled gas must be determined., it is desirable to eliminate these pulses. Due to this, the EGR route includes a second tiny air box with a diaphragm. A meter with a strategically located orifice is used to measure the volumetric flow rate of EGR. The experimental EGR system is completely schematically depicted in the picture. Tools are available for gathering relevant data from diverse sources. Thermocouples are installed in the intake and exhaust manifolds, as well as at a number of spots throughout the EGR system. The smoke opacity of the exhaust gas is measured using an AVL smoke meter. The pressure difference across the orifice is used to calculate the EGR ratio. Using a matrix of experimental conditions, the effect of EGR on exhaust gas temperature and exhaust smoke opacity is investigated.

3 RESULT AND DISCUSSION

As the EGR percentage increases under continuous management (0–21%), exhaust gas pollution decreases. Figure 4 illustrates this. As stated earlier, extremely high temperatures are the primary cause of NOx construction in the ignition compartment. Since our experimental results show a reduction in consume temperature through growing EGR (Figure 4), we can securely conclude that the ignition chamber temperature too decreases, thereby reducing NOx formation.

EMISSIONS					
DIESEL		10% HOT		10% COLD	
0	78	0	76	0	66
0.71	170	0.76	105	0.8	93
1.5	320	1.3	210	1.42	197
2.18	552	2.22	389	2.2	375
2.94	831	2.86	620	2.92	599
3.57	1074	3.56	820	3.55	792

Table:1Emission

Thermal efficiency is unaffected by the drop in exhaust gas temperature, proving that EGR has no impact on it. According to Table 1, thermal efficiency somewhat declines with high loads and EGR rates higher than 15%. This could be the case since the conversion of consume petrol reduces the amount of regenerated oxygen needed for ignite.

As the amount of EGR increases, the exhaust gas becomes more opaque. As seen in Figure 4, the opacity increases rapidly with higher loads and higher EGR rates. The opacity growth rate for low tones is equal to the EGR growth rate. The brake was also shown to be fuel-specific. Consumption (BSFC) is mostly independent of EGR.

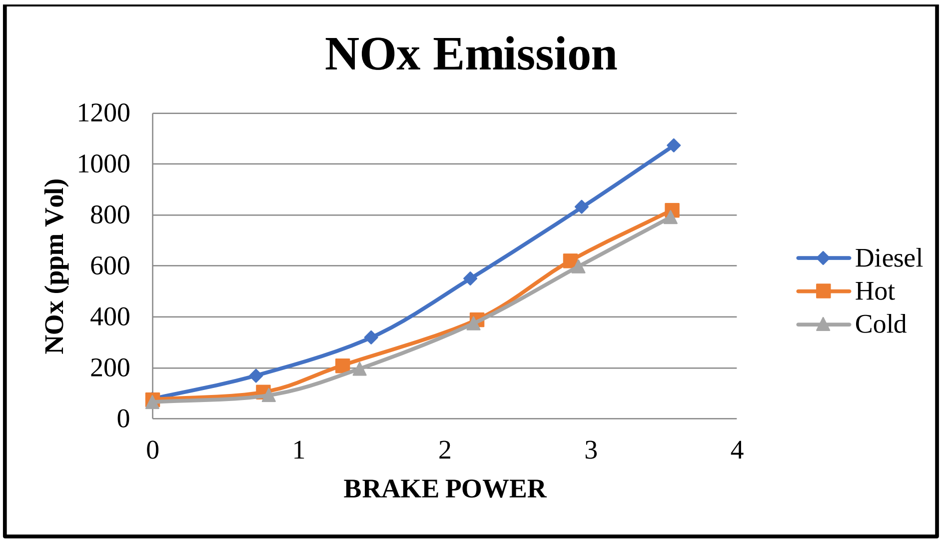

Figure:3 NOX EMISSION

RESULT

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POWER	EFF	EFFI	EFF
0	0	0	0
0.74	15.7	13	16.2
1.48	23	22	23.9
2.22	28.3	27	29.7
2.9	30	29.8	31
3.7	32	31.7	32.9

TABLE :2 Break Thermal Efficiency VS Brake Power

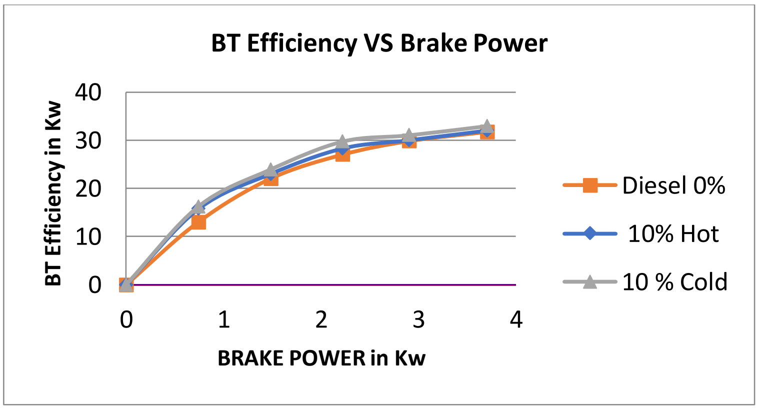

FIGURE:4 BT Efficiency VS Brake Power

Figure.4 Demonstrated step-by-step studies of single-cylinder, 4-stroke,3.7kW braking power diesel engine. Test procedures include specified injection pressures and times. The following graphs show the conformance findings of practical tests that examined the effect of electrically controlled heat and cold. Complete engine performance sequences are generated using 0% EGR to estimate, 10% hot EGR and 10% cold EGR engine characteristics and emission values. Properties and emission values for

smoke opacity, nitrogen oxide, hydrocarbon, CO and CO2 are determined.
Compared to 0% EGR, HC emissions increased marginally at 10% hot and cold EGR. This is This is due to the heterogeneous composition of the inner cylinder having limited access to O2. This combination burns very slowly, increasing the level of HC emissions.

Diesel		Hot	Cold
BP	HC	HC	HC
0	40	38	35
0.74	35	32	30
1.48	35	33	30
2.22	32	30	28
2.9	33	33	30
3.7	57	51	49

TABLE:3 Break thermal power vs Exhaust Emission

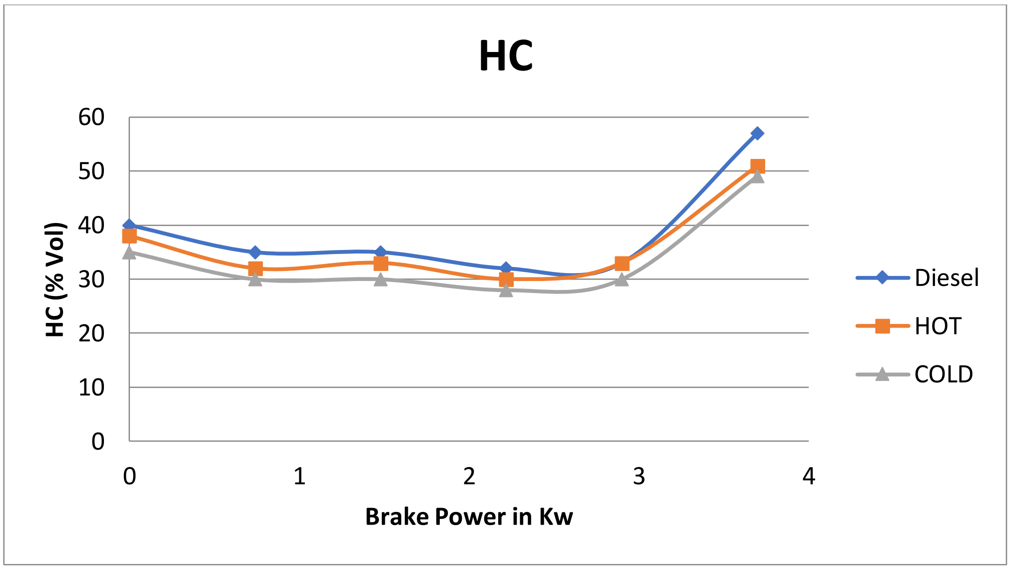

Figure:5 HC Vs Brake Power in Kw

Figure. 5 shows the Difference between hydrocarbon emissions from diesel engines with and without EGR and brake force. Due to lack of oxygen in the combustion chamber, hydrocarbon emissions increase as incomplete combustion load increases. The diesel hydrocarbon emission rate is 49%, the hot EGR rate is 51%, and the cold EGR rate is 57% at maximum load.

Diesel		Hot	Cold
BP	CO	CO	CO
0	0.11	0.09	0.08
0.74	0.1	0.09	0.08
1.48	0.09	0.08	0.07
2.22	0.07	0.06	0.06
2.9	0.07	0.06	0.06
3.7	0.08	0.07	0.07

TABLE :4 Break power VS Carbon Monoxide

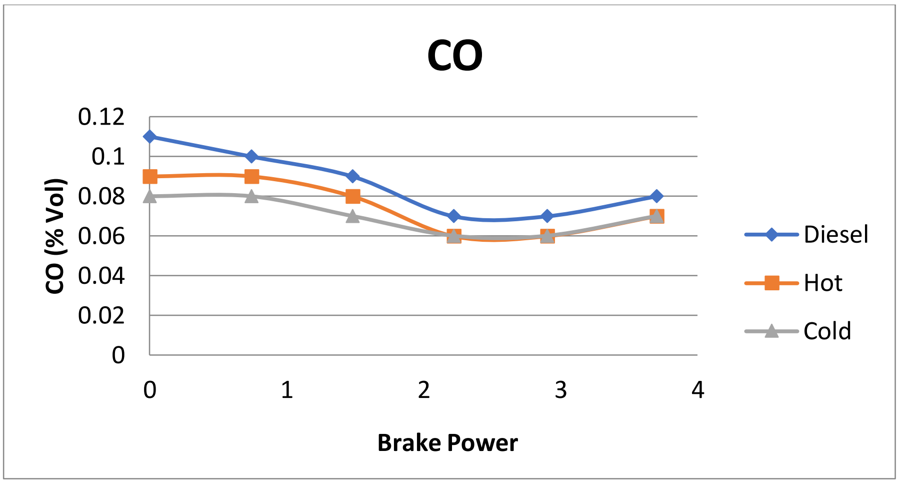

FIGURE :6 CO VS Brake power

Figure. 6 shows the Different levels of carbon monoxide emissions and braking efficiency. Diesel emits 0.06% carbon monoxide when operating at full capacity compared to 0.07% and 0.08% for cold and hot EGR respectively. Emissions are higher for both cold and hot EGR as opposed to no-EGR conditions. This is brought about by reducing the availability of plenty of oxygen for ignition. A richer air-fuel mixture is produced by oxygen emphasis, although low burning increases CO emissions.

Diesel		10%Hot	10%
BP	CO2	CO2	CO2
0	2.6	2.4	2.3
0.74	3.4	3.3	3.3
1.48	5.2	5	4.9
2.22	6.5	6.3	6.1
2.9	7.9	7.4	7.7
3.7	9.8	9.4	9.2

TABLE:5Break power VS Carbon dioxide

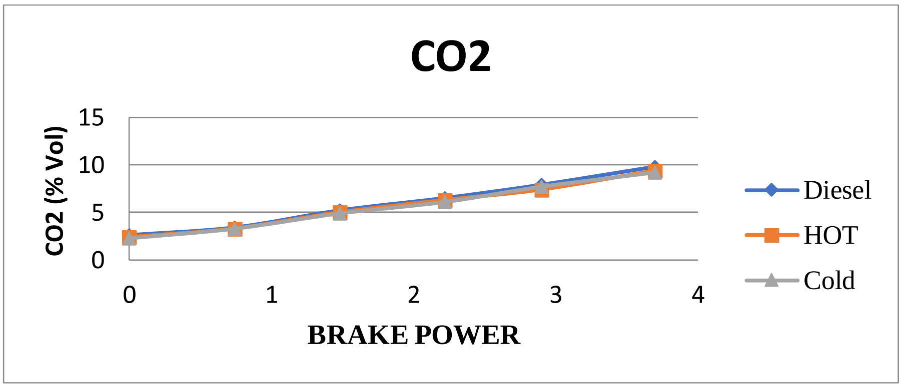

FIGURE:7 CO2 VS Brake power

Figure.7 shows the difference in CO2 emissions compared to BP. An increase in load conditions leads to an increase in carbon dioxide. Diesel emits 9.8% of its total volume as CO, compared to 9.2% and 9.5% for cold and hot EGR, respectively. Because less O2 is available, it leads to incomplete combustion, which reduces CO2 levels

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Diesel		10%Hot	10%Cold
BP	Smoke	Smoke	Smoke
0	5.7	5.5	11.2
0.71	10.9	11.3	16.2
1.5	18	19.8	25.4
2.18	27	30.3	31.8
2.94	44	45	47.3
3.57	54.1	57.6	59.7

TABLE:6 Break power VS Smoke

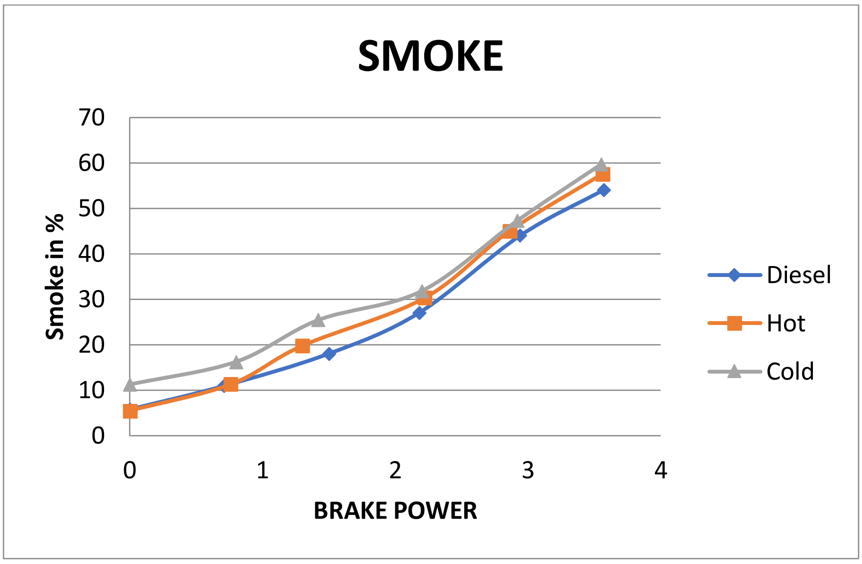

FIGURE:8 CO2 VS Brake power

Figure. 8 shows the Diesel exhaust with and without EGR. Smoke worsened as load conditions increased. Diesel emits 54.1% of smoke at full load compared to 59.7% for cold EGR and 55.3% for hot EGR. This is because the external rebreathing mechanism reduces Amount of oxygen required for complete fuel combustion. This leads to sufficient ignition, which increases the smoke output

CONCLUSION

According to test results, increasing air intake reduces fuel consumption, while increasing brake hot air efficiency. The amount of carbon monoxide in the coating gas decreases somewhat as the intake air temperature rises while the levels of gaseous carbon dioxide and oxygen remain the same. The NOx content of the exhaust gases increases slightly as the intake air temperature rises. Despite some drawbacks, the results show that the benefits increase with increasing intake air temperature. In areas of excellence such Even if NOx emissions are reduced, such as fuel consumption and CO emissions. EGR is still a successful NOx reduction technique for diesel engines. By using particulate matter traps and proper regeneration processes, the increase in particulate emissions from EGR can be minimized.

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