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Research Article

Super Charging of IC Engines with the Thermoelectric Generator and Run Generator from the Waste Heat of IC Engines

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Abstract

Most of the times waste/or exhaust gases of IC engines utilise for turbo charging for to increase the performance of IC engines. In generally turbo charging used for increase the power output of the engine and increase the speed of the engine. Similarly super charging also utilise for improve the performance of the engine at same fuel consumption but increase the density of air. But supercharging need some from the engine so we try to run supercharging without power consumption from the engine in that place of power need we are introducing thermo electric generator. This generator producing power from the waste heat of exhaust/or emission gases. From the exhaust temperature and atmospheric temperature gradient with the peltier module producing power, its run the compressor for supercharging. Engine speed increases nearly 1000 to 1100-1200 rpm. And to the cause of high volume of air the combustion produces fewer emissions than the initial (mean) without super charging. While, BP increase nearly 9.75%. This experimentation result boost the BP and be in charge of emissions and to minimize the thermal/or heat losses and indirectly to control the atmospheric temperature through the hot gasses release directly in to the atmosphere.

Keywords: *IC Engine, peltier module*

NOMANCULTURE

BP- Brake Power; RPM- Revolution per Minute; V_{air}- Volume of air; T_{atm}- Atmospheric Temperature; TEG- Thermo Electric Generator; CO- Carbon monoxide; NO_{X}- oxides of nitrogen: HC- Hydro Carbons; P_{mi}- Mean Effective Pressure; EXG -Exhaust Gasses

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Introduction

Present utilization of fuel rate is very high, through this the global warming and emissions percentage also growing day by day. In this investigation we are trying to reduce emission and velocity of soot particles. And reduce the exhaust gas temperature release in the atmosphere. In IC engines heat losses mostly mislaid through the exhaust gasses (EXG). Practically in Morse test also we find majorly hear lost from the exhaust gasses. Cause of that heat loss we get less BTE. So we minimize/utilize the waste heat from the EXG to improve the BTE of an IC engines. Some of the cases the waste/exhaust gases used for turbo charging, for to increase the brake power and to increase the BTE. For a small change in this investigation the place of turbo using supercharging in SI engine. Power generated from the waste heat of EXG of SI engines for run the compressor of super charger. Thermo electric generator with peltier module used for producing power from the EXG temperature. In this process of EXGR (exhaust gas recirculation) not only for operate super charging and it also useful for control emissions .control emission with EXGR is one of the major content in this investigation.

ATAUER RAHMAN et al [1]; In this paper presents an innovative approach on power produced from the waste heat of - Ic engines .based on coolant and exhaust temperature difference in this work on thermo electric power generation .the performance of [$WeHS^e$] equipped engine has been investigated by using GT surface software for optimum engine speed 4000rpm.the result shows that specific fuel consumption of engine has improved by 3% due to reduction of HC formation. Engine BP about 7% by harvesting waste heat energy of the engine .And also prove reducing emission and reduce fuel consumption .TEG produced 200W and 20% of alternator output .Total of 15% waste heat energy of engine could recovered by effectively using the $WeHS^e$ .Engine BMEP and efficiency reduced by 15% and 10% respectively at We HS outlet air temperature reaches to 110^{o}c or more.

P.Naresh et al.[2] In this study discussing exhaust gas recirculation [EGR].EGR here a part of the exhaust gases is rerouted into the combustion chamber .This leads to a lower peak combustion temperature which in turn reduces the formation of NOX .In modern turbo charged engines it can be the problematic transient response of both the EGR-system and the engine, this work provides a simulative comparison of different EGR systems such as long -route EGR and short-route EGR ,hybrid EGR, a system with a read valve and a system with an EGR pump . Both the study state performance and transient performance the compared .They shown that using exhaust gas recirculation [EGRT] techniques in engines ,the emission are much controlled due to lesser amounts of NOX entering the atmosphere ,exhaust going lower the oxygen concentration in combustion chamber and increases the specific heat of the intake air mixture .It can be observed that 15% EGR rate is found to be effective to reduce NOX emissions substantially without deteriorating engine performance.

P. Naresh et al [3].In this paper deals with exhaust gas recirculation [EGR] here, a part of exhaust gases is rerouted into the combustion chamber. This leads to a lower peak combustion temperature which is turn reduces the formation of NOx .This work provides a simulative comparison of different EGR system ,such as long-route EGR ,short-route EGR a system with a reed valve and a system with an EGR pump. Using EGR technique in engines, the emissions are very much controlled due to lesser amounts of NOx entering the atmosphere .Thus the emission levels to be maintained are attained by the engines .It can be observed that 15% EGR rate is found to be effective to reduce NOx emission substantially without deteriorating engine performance.

SHIDA CHEN et al [4]; This study investigates the emission characteristics of toxic organic pollutants(PAHS,PCBS) generated by a heavy-duty diesel engine operating at various Exhaust gas recirculation [EGR] rates during steady-state cycles .Tests on the exhaust gas composition were conducted before and after changing the EGR ratio. The fuel used in the study [B_2Diesel] was a mixture of 2% biodiesel and 98%Diesel.The main focus was on the emission factors for the organic toxic pollutants in the exhaust gas after EGR ratio 0% and 5% were applied by an EGR ratio of 5% the total mass emission factors increased by 4.0 times and 4.8 times respectively .When the EGR ratio was increased from 0% to 5%,but those of PM(particulate matter) and carbon monoxide(co) increased by 60.5% and 66% respectively

MAROA SEMAKULA et al [5]; This paper investigation on EGR as a technique for controlling emissions of NOx, CO, CO2, HC and SOF in conjunction with other techniques discussed in this review when implemented will adequately address the underlying issues of the effects of EGR on diesel engine performance parameters and reduction in emissions as was seen during the studies that were reviewed here. EGR cooling will allow us to retain the benefits of low NOx emissions but without compromising engine efficiency .EGR cooling is necessary as it reduces soot and soluble organic fraction [SOF] emissions .That the preheating of the inlet air reduce CO emissions by the introduction of EGR in to the system through it is observed that Co emissions increased linearly as the rate of EGR %was being increased.

OSAMA GHAZAL et al [6]; in this study, the effect of exhaust gas recirculation [EGR] on performance and emission of 4-cylinders gasoline engine was investigated. A model was built using GT-power professional software .The model was equipped with catalytic converter and EGR controller .The EGR were varied from 0.2 to 0.05 fractions .The engine speed was 4000 rpm and kept constant for all simulation runs. The engine torque, power, efficiency, fuel consumption, and emission were calculated. The result showed that, the decrease of EGR ratio increase engine torque, power, and brake efficiency; While decrease fuel consumption. Moreover, the increase of EGR ratio resulting in decreased NO and HC and increased CO emission.

MESHACK HAWI et al [7]; In this research, a direct injection compression [DICI] engine was modified in to a dual- fuel engine that used biogas as the primary fuel and diesel as pilot fuel ,with the focus on reduction of harmful exhaust emission while maintaining high thermal as pilot fuel ,with the focus on reduction of harmful exhaust emissions while maintaining high efficiency. The effect of exhaust gas recirculation [EGR] on engine performance and emission characteristics was studied. The EGR system was developed and tested with different EGR percentages, i.e.0%,10%,20% and 30%. The effect of EGR on exhaust gas temperature and performance parameters like brake specific fuel consumption, brake power and thermal efficiency was studied .The results showed that EGR led to a decrease in specific fuel consumption and an increase in brake thermal efficiency. With increase in percent [%] of EGR, the percentage increase in brake thermal efficiency was up to 10.3% at quarter load and up to 14.5% at full load for single fuel operation while for dual-fuel operation an increase up to 9.5% at quarter load and up to 11.2% at full load was observed .The can be concluded from the fact the most important reasons for the formation of NOx in the combustion chamber is the high temperature of about 2000 K at the site of combustion .It was found that EGR reduced the exhaust gas temperature by up to 7.6% at minimum engine loading and up to 2.3% at maximum loading.

JAGADISH et al [8] this research work did to reduce NOx emissions of CI engine, by the effective utilize the EGR . 1-cylinder, 4-stroke water cooled diesel engine operated with by product of vegetable oil (Soybean Oil). In this work performance done with 5%EGR, 10%EGR and 15%EGR. The engine performance of BTE, BSFC, and emission analysis such as oxides of nitrogen, CO and HC. The observations show that when biodiesel blend work with EGR, NOx and HC formation were reduced.

Experımental Setup And Methodology

Thermoelectric peltier module is assembled with heat sink and cooling fan. The heat sink arranged in the muffler, where the exhaust gases directly contact. The combination of thermoelectric module and heat sink and muffler is called thermoelectric generator (TEG). 12V P/N module two modules connected in series to increase the voltage of TEG. The thermoelectric generator produces electricity by using the waste heat of exhaust gases. Generally the P-N module one side heat sink other side cooling fan. Through the seebeck affect the temperature difference convert in to electrical energy directly. When the EXG entered in to the muffler from the combustion chamber and it touches heat sink fins, the temperature passes to module.

Module hot junction attached to the heat sink, other side of peltier module had cold junction. The cold junction arranged cooling fan for the temperature difference. From the hot and cold temperature deference, with seeback effect produce some voltage. Nearly 12v produce each module, we are connecting 2 modules in parallel (24v) and two fans one for cooling side of module cooling fan (12v) and second compressor fan for supercharging are also connected parallel. The output total voltage connected with fans. Here the waste heat of IC engines used of producing power and, this power utilized for run supercharger. Supercharger compressor fan placed at in front of carburetor. It send tabulated air to carburetor and then, there mixed tabulated air and fuel in it. In the turbulence its produce homogeneous mixture and also produce air ratio in the place of same air-fuel mixture. So it’s possible to produce high combustion rate and produce more break power at same fuel consumption. And simultaneously its give high break thermal efficiency and decrease brake specific fuel consumption. The compressed air mixed with fuel and entered in to the cylinder at suction stroke. Here increasing the compression mean increase the volumetric efficiency.

The aim of thermoelectric generator producing electricity directly by temperature gradient. From the seebeck effect it works on the same principle. Fined plate contact with exhaust gas of the engine, plate outside stick the module and other side of this module stick with another finned plate with coolant fan. This combination or set of all these called as thermo electric generator. In this TEG P/N Fig.1 module play a key role peltier element comprises semiconductor pellets fabricated from n-type and p-type bismuth telluride materials.

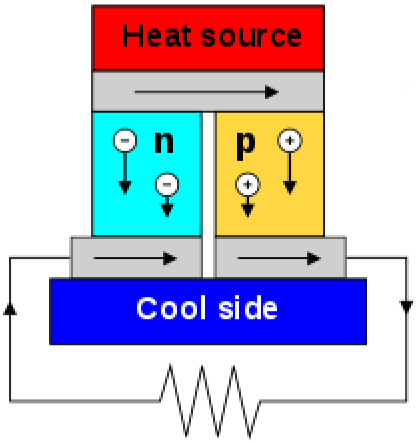


Fig.1. P-N module

From N-junction side electrons move to diffuse P-junction side and P-junction holes diffuse to N-junction side. From electrons diffusion produce positive ions and holes produce negative ions this exchange of ions produce current field. This module from this P-N junction produces voltage.

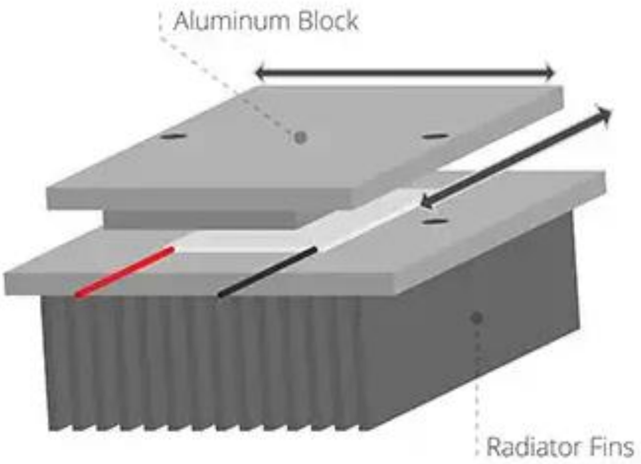


Fig.2 Thermoelectr ic generator

The schematic line diagram Fig.3 shows the experimental set up. From the air filter compressed air send to the carburettor. The air mixed with the petrol and send in to the inside the combustion chamber at suction stroke. For this turbulence in combustion chamber, combustion will happen effectively and produces more brake power. The temperature of exhaust gases will recover with the TEG. It produces power from the temperature difference through the module. Some temperature of the exhaust gasses will reduce. The emission soot particle release from the silencer in to open atmosphere. And the emission analyzer connected with exhaust pipe. And it show the emission values.

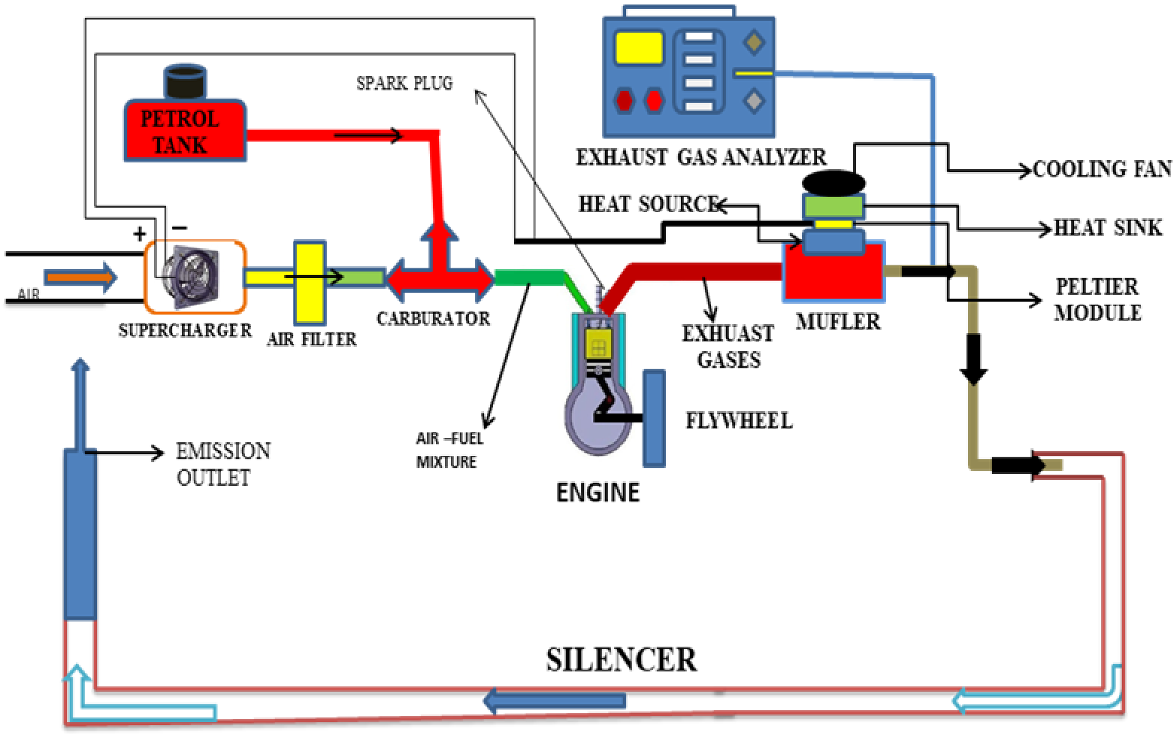


Fig.3. schematic of the experimental setup for the engine

SUPER CHARGER

In actual working of super charger the compressor run with crank shaft power. Compressor fan coupled with shaft, this shaft coupled with engine crankshaft with the help of belt. The super charger utilise the engine power.

But in my experiment the compressor run with electric motor. This motor run with the power generated from the waste heat, for this power generation I am using thermoelectric generator. The main purpose of this supercharger to increase the volume of air increased and creates turbulence in the combustion chamber. For this turbulence the mixture is homogeneous.

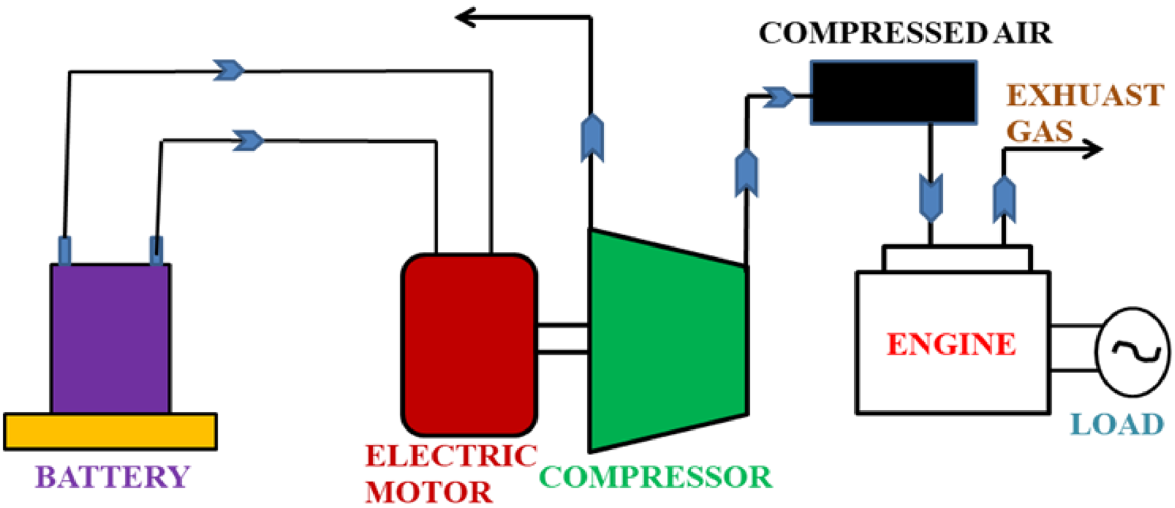


Fig.4. supercharger

Results And Dıscussıon

Brake Power Produced

In the experiment we are using compressor for super charging. The amount of air increases then the air ratio provides more oxygen content at the same fuel ratio. To the combustion this mixture produces more power output. Initially at normal ratio without supercharging the speed of the engine at constant accelerate is 1000, 1200, 1400 r.p.m, at maximum torque the brake power is

Brake power= (2*π*N*T)/60000 KW

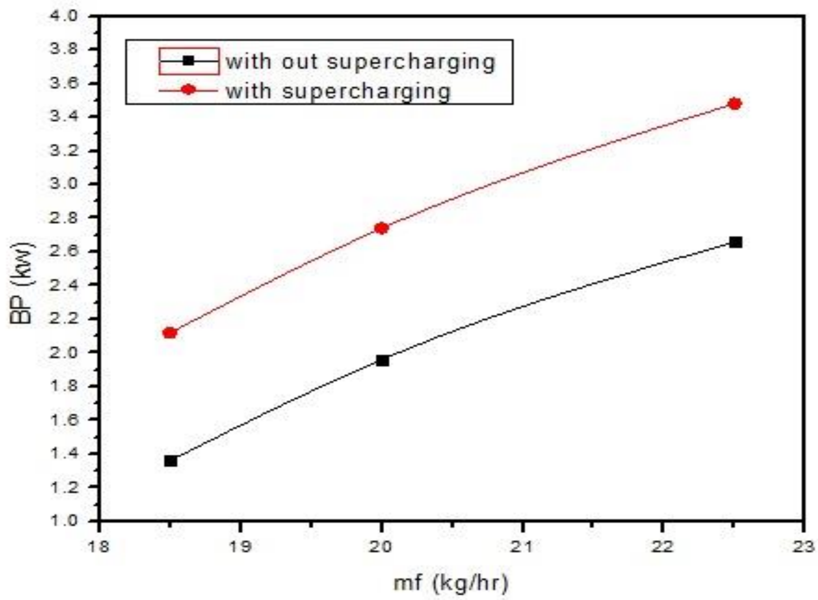
Brake power	Brake power	Brake power
= (2*π*N*T)/60000 KW = (2*π*1000*13)/60000 =1.36 KW	= (2*π*N*T)/60000 KW = (2*π*1200*15.6)/60000 =1.96 KW	= (2*π*N*T)/60000 KW = (2*π*1400*18.2)/60000 =2.66 KW

Table.1. Brake Power at Various mass flow rates without Supercharging

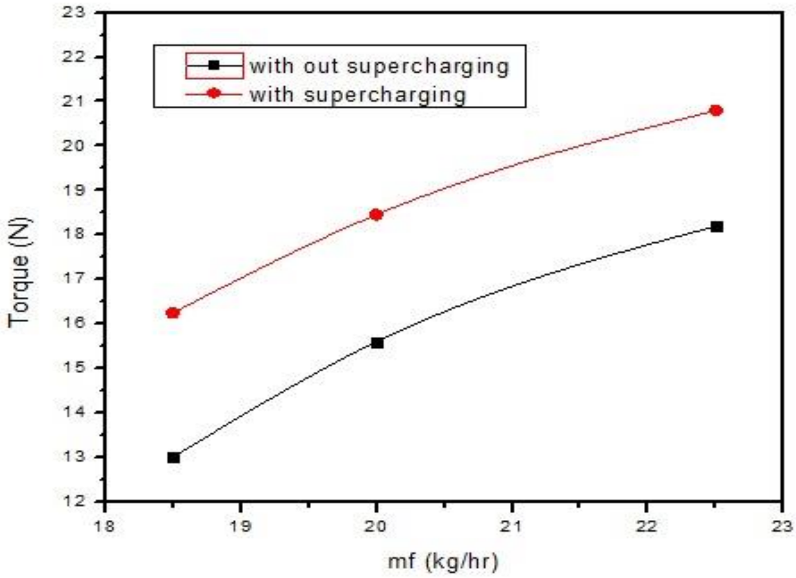
Brake power	Brake power	Brake power
= (2*π*N*T)/60000 KW = (2*π*1250*16.2)/60000 =2.12 KW	= (2*π*N*T)/60000 KW = (2*π*1420*16.25)/60000 =2.74 KW	= (2*π*N*T)/60000 KW = (2*π*1600*1)/60000 =3.48 KW

Table.2. Brake Power at Various mass flow rates with Supercharging

At the same accelerate by using supercharger 1250, 1420, 1600 rpm through considering same mass flow rate, then the BP also increase 23% more than the BP of super charger compare with without supercharger.



Graph.1. Mass Flow Rate Vs Brake Power



Graph.2. Mass Flow Rate vs Torque

Mean Effective Pressure

In actual practice the IC engines work and power rate depending on internal pressure. Some times its loss power because of pressure drop. In this project we are increasing internal pressure with creation of turbulence with the supercharging compressor. The pressure increasing rate without supercharging the speed of the engine at constant accelerate is 1000, 1200, 1400 r.p.m, at maximum torque the p_{mi} is

Mean effective pressure (P_{mi}) = (B.P*6)/ (L*A*N/2*K*10)

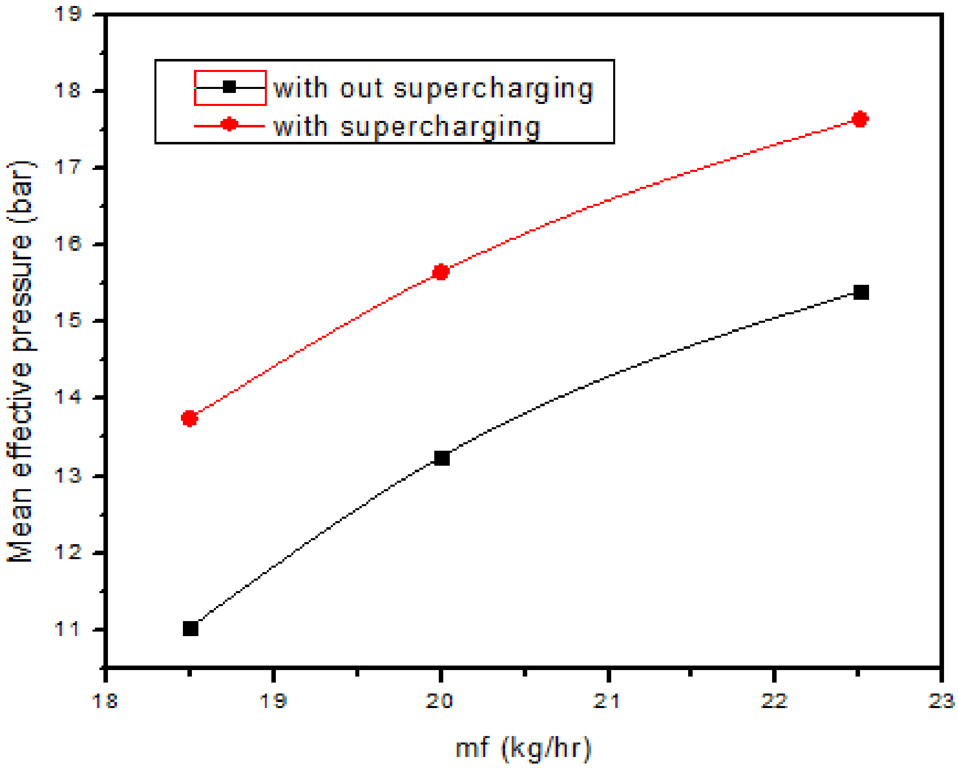
Mean effective pressure	Mean effective pressure	Mean effective pressure
= (B.P*6)/(L*A*N/2*K*10) =(1.36*6)/(0.058*2.55*10^-3*500*10) =11.03 bar	= (B.P*6)/(L*A*N/2*K*10) =(1.96*6)/(0.058*2.55*10^-3*600*10) =13.25 bar	= (B.P*6)/(L*A*N/2*K*10) =(2.66*6)/(0.058*2.55*10^-3*700*10) =15.4 bar

Table.3. Mean Effective Pressure at Various mass flow rates without Supercharging

Mean effective pressure	Mean effective pressure	Mean effective pressure
=(B.P*6)/(L*A*N/2*K*10) =(2.12*6)/(0.058*2.55*10^-3*625*10) =13.76 bar	= (B.P*6)/(L*A*N/2*K*10) =(2.74*6)/(0.058*2.55*10^-3*710*10) =15.65 bar	= (B.P*6)/(L*A*N/2*K*10) =(3.48*6)/(0.058*2.55*10^-3*800*10) =17.64 bar

Table.4. Mean Effective Pressure at Various mass flow rates with Supercharging

At the same accelerate by using supercharger 1250, 1420, 1600 rpm through considering. The same engine at maximum brake torque using supercharging to increase the combustion rate and internal pressure. Increase its P_{mi} 12% more than the P_{mi} of without supercharger. When the mass flow increases, the P_{mi} are 15%, 13%.



Graph.3. Mass Flow Rate Vs Mean Effective Pressure

Emission Results

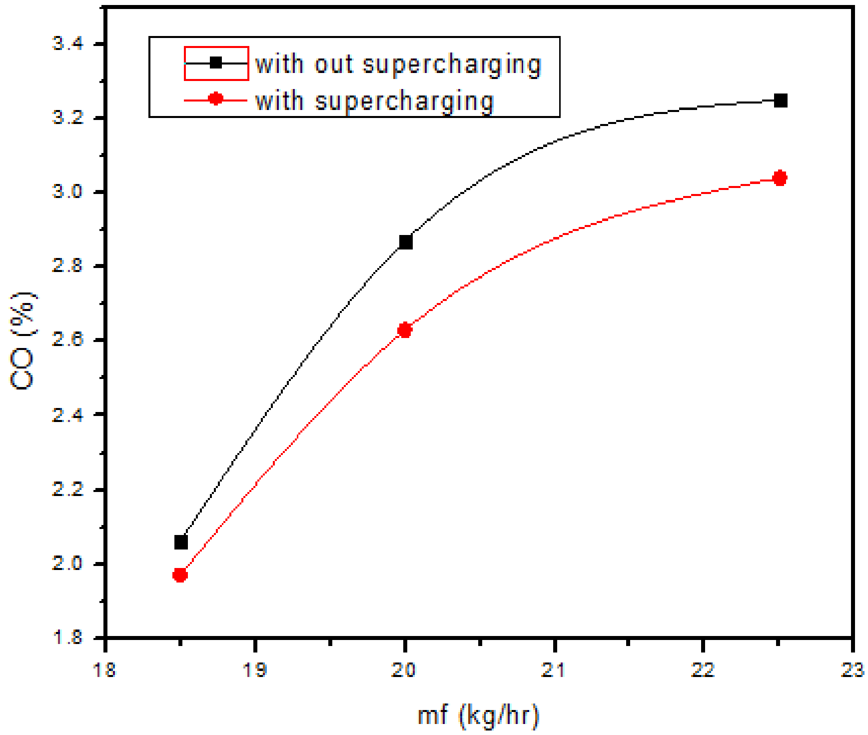
In this investigation we observe the decreasing of harmful emissions. We hope this possibility of decreasing emissions because of for the supercharging we send more air from this oxygen content is more.

Carbon monoxide

Most of the IC engines produce CO because of unburned fuel or sometimes cause of less oxygen content in the combustion process. In this experiment we are using supercharger, its send more air percentage in the air-fuel mixture. Without supercharger the CO is 2.06 by using supercharger at same mass of fuel CO is 1.97%. CO decreased 4.3%. Similarly increasing mass flow rate the CO percentages are 8.36%, 6.46%.

SL. NO	MASS FLOW RATE (kg/hr)	CARBON MONOXIDE(CO)%	
		WITHOUT SUPERCHARGER	WITH SUPERCHARGER
1	18.5	2.06	1.97
2	20	2.87	2.63
3	22.5	3.25	3.04

Table.5. mean effective pressure at various mass flow rates without supercharging



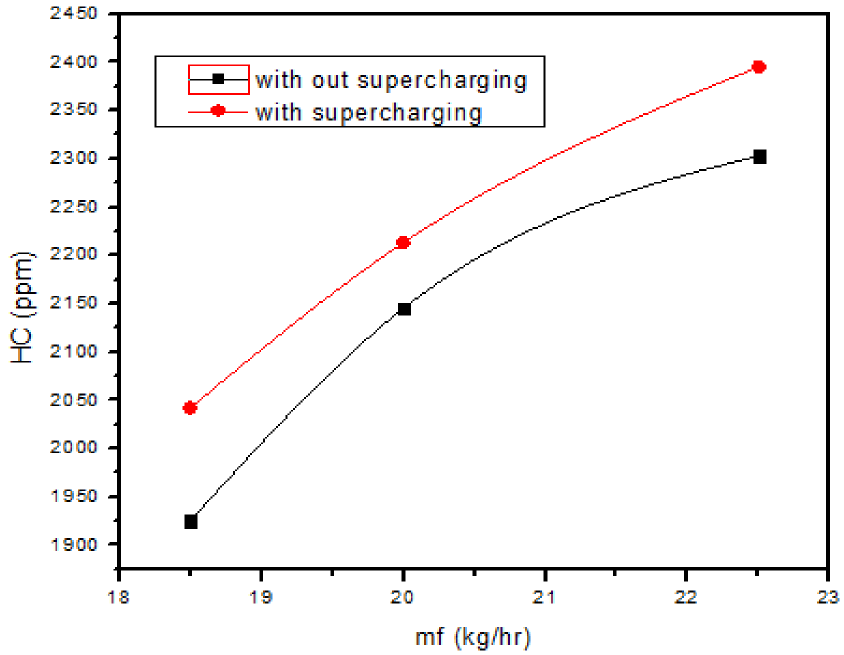
Graph.4. Mass Flow Rate Vs CO

Hydrocarbon

Most of the IC engines released HC because of unburned fuel or sometimes cause of high hydrogen and oxygen content in the combustion process. In this experiment we are using supercharger, its send more air percentage in the air-fuel mixture. Without supercharger the HC is 1925ppm by using supercharger at same mass of fuel HC is 2042ppm. HC increased 5.7 %. Similarly HC decreasing mass flow rate the HC percentages are 3.07%, 3.84%.

SL. NO	MASS FLOW RATE (kg/hr)	HYDROCARBON(HC)ppm	
		WITHOUT SUPERCHARGER	WITH SUPERCHARGER
1	18.5	1925	2042
2	20	2145	2213
3	22.5	2303	2395

Table.6. mean effective pressure at various mass flow rates with supercharging



Graph.5. Mass Flow Rate Vs HC

Finally the combustion rate high usually the unburned fuel particles and CO and NO_X were decreased. This more percentage of oxygen fuel burns completely its releases more CO_2 and slightly increase the HC.

Conclusıon

- In this investigation finally we concluded that, with the use of supercharger increase the speed and torque and proportionally increases Brake Power is nearly 23%.
- From the IC engines work mostly based on the internal mean effective pressure, increasing internal pressure one of main cause is using supercharger. From this increases P_{mi} 12% than the normal without supercharger.
- This supercharger supplies more oxygen content then it increasing combustion rate and also decreases the harmful gasses CO and NO_X. The CO decreased with supercharger at same mass flow rate of fuel 4.3%.
- Co_2 increases and also slightly increases the HC also nearly 3.07%.

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