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Experimental investigation on enhancing the engine performance by preheating the air in SI engine

Bilal Shaikh[1], Ravindra Navthar[2], Sachin Kardile[3]
[1] Research Scholar, GH Raisoni College of Engineering, Savitribai Phule Pune University, Ahemednagar, Maharashtra, India
[2] Dean of Mechanical Department, P.D.V.V.P. College of Engineering, Savitribai Phule Pune University, Ahemednagar, Maharashtra, India
[3] Professor, GH Raisoni College of Engineering, Savitribai Phule Pune University, Ahemednagar, Maharashtra, India

Abstract
Now a days we are facing a lot of problems with respect to fuel demand. A common problem is how to increase engine efficiency? and how to manage the fuel economy?. Etc...So, the objective of this project work was to gain a better understanding of the efficiency characteristics of engine with inlet air pre heater. For this purpose, the effect of inlet air pre heater orientations, no. of testing, types of sophisticated fuel, types of material used for the purpose of inlet air pre heater have been investigated. In this project, we modified the air intake into the cylinder of four stroke air cooled IC engine of 2 wheeler, to improve the fuel vaporization rate, proper combustion &increase the fuel efficiency. The preheating of intake air is achieved by introducing an air pre-heater in the exhaust pipe (silencer) of the vehicle. Fresh air takes heat from heated silencer and this heated air send at air chamber. Because of this heating of air fuel vaporization rate gets increases which results in above advantages.

Keywords: air preheating, heat exchanger, vaporization

1. Introduction
Given the importance of increasing energy conversion efficiency for reducing both the fuel consumption and emissions of engine, scientists and engineers have done lots of successful research aimed to improve engine thermal efficiency, including supercharge, lean mixture combustion, etc. However, in all the energy saving technologies studied. Engine exhaust heat recovery is considered to be one of the most effective. Many researchers recognize that Waste Heat Recovery from engine exhaust has the potential to decrease fuel consumption without increasing emissions, and recent technological advancements have made these systems viable and cost effective.
The improvement in efficiency of the engines of today may very well be one of the first steps towards further developments and revolutions in the field of energy management which may go from effective management of fossil fuels to the full-time usage of renewable resources leading us to a cleaner and greener future

1.1 Way of Increasing the Efficiency of Engine
1. Use of pure quality of fuel
2. Advanced design of piston and cylinder
3. Proper mixing of fuel and air in carburetor for complete combustion
4. Vaporized fuel at suction of cylinder

1.2 Importance of Vaporization of Fuel
1. The humidity in the atmospheric air affects the petrol vaporization in the carburetor. Therefore, by preheating the inlet to the carburetor for a considerable amount, the vaporization can be ease and in turn complete combustion is achieved
2. By reducing the water vapor to the engine, the steam formation in the engine can be reduced. This prevents the pitting of the engine, piston, inlet & exhaust pipe.

2 Literature Review
T. Endo *et al.* perform "Study on maximizing Exergy in Automobile Engines" in 2007. The use of waste heat of Automobile engine that applied Rankine cycle from the viewpoint of exergy (available energy) was researched. To verify the system, the Rankine cycle system was installed in hybrid vehicle. As the result of vehicle testing, thermal efficiency was increased from 28.9% to 32.7% at 100km/h constant vehicle speed. In this paper, it is concluded that Rankine cycle using waste heat was very effective to maximize exergy in automobile engine [1].
V. Pandiyarajan *et al.* perform "Experimental Investigation waste heat recovery from diesel engine exhaust using shell& tube type Heat exchanger & TES" in 2011. According to them nearly about 10-15% of fuel power is stored as a heat in the combined storage system, which is available at reasonably higher temperature for suitable application [2].
Frank Will studied the "Fuel conservation & emission reduction through novel waste heat recovery for IC engine" in 2011. According to them Lubrication system of CI engine offer large potential for energy conservation and reduction of emissions. Exhaust gas/oil heat exchanger can reduces usage of fuel over 7%. Nox & CO emissions are also reduced by such a system [3].
Mr. Janak Rathavi *et al.* studied the "Experimental Study of

Waste Heat Recovery Technique to Increase Efficiency and to Decrease Hazardous Emissions in CI Engine" in Jan.2012. They analyzed from study that the large amount waste heat is through exhaust which has high temperature is utilized to vaporizing the diesel fuel and mixed with intake air thus mixture getting homogeneity. This homogenous charge in compression ignition engine increases the combustion response and reducing the physical delay period so getting increment in combustion pressure develops more power [4].

Lies Aisyah *et al.* analyze the "analysis of the Effect of Preheating system to improve Efficiency in LPG fuelled Small Industrial Burner" in 2014. Results shows that increasing initial Temp. of LPG from 28ºC to 50ºC would raise efficiency of the burner up to 6.75% while CO emission decreased 49.06%. Furthermore, if the the burner Temperature increased upto 100 ºC the burner efficiency would raise significantly and CO emission considerably decreased [5].

Dr. R. Sudhakaran *et al.* performed the "Enhancing the IC Engine Performance by Using the Electrolysis and Preheating Process" in May-Jun 2014. From the investigation it has been informed that the efficiency of single cylinder four stroke petrol engines is increased by 2-3% using the hydrogen gas along with the petroleum. Hence SFC is decreased by 0.03kg/kw-hr. Here is a reduction in fuel consumption. Hence there is an potential to use hydrogen gas as a motive power in petrol engines which results in conservation of energy [6].

Pradip G. Karale *et al.* theoretically studied the "Waste Heat Recovery from Engine Exhaust by using Heat Wheel in 2015.

It has been observed that there is a large amount heat is waste from the engine. Approximately heat lost by exhaust as is same to useful work produced by engine. It is identified that there is large potential of energy saving through the use of waste heat recovery technologies. The recovery and utilization of waste heat not only conserves fuel but also reduces the green house gases and waste heat by increasing efficiency of engine. The new concept of Heat wheel can be used for exhaust gas heat recovery for intake air preheating of Diesel engine [7].

Chirtravelan. M *et al.* studied the "Design and Fabrication of Air Pre Heater for Diesel Engine" in Feb 2015.

From the test it is clear that the fuel consumption reduces and brake thermal efficiency increase with increase intake air temperature. The carbon dioxide and oxygen content remains unaltered in the exhaust gas. Carbon monoxide content in the exhaust gas slightly reduces with increase in intake air temperature. Whereas NOx content in the exhaust gas slightly increases with increase in intake air temperature. Hence the test results indicated that the advantages gained are more with increase intake air temperature though there are few disadvantages [8].

Krishna Perumal *et al.* studied the "Reduction of hydrocarbon by preheating Air-Fuel Mixture by flue gas in S.I. Engines" in 2015. In that the main pollutants contributed by S.I. engines are CO, NOX and unburned hydro-carbons. Dangerous hydrocarbon smokes from internal combustion(IC) Petrol engine is due to incomplete combustion of fuel. For maximum combustion of fuel in engine and to avoid dangerous harmful gases from exhaust, we propose a new concept of pre heating a fuel-oxygen mixture, before fed into the S.I. engine. This preheating of fuel makes the expansion in fuel. This preheating and expansion of fuel is done in separate expansion chamber by exhaust gas from engine. Preheating of fuel is done at constant pressure which expands the fuel volume as the ratio of increasing in temperature. Hence this makes the reduction of hydrocarbon and increase the thermal efficiency of the engine [9].

V. Pram Kumar *et al.* practically studied the "Air Preheating in Two Wheelers" in Dec. 2015. In this project paper, they modified the air intake into the cylinder in a single cylinder, two stroke aircooled engine (two-wheeler TVS-50XL 50 cc bike) to increase the fuel efficiency. At normal condition, the vehicle which is taken for our project, gives 45 to 50 Km, per liter of petrol. The fuel economy can be achieved up to 50 to 65 Km per liter by pre-heating of air to a particular temperature causes an increase of 10 Km per liter of petrol [10].

A. Rameshbabu *et al.* done the experiment on **"**Increase 0Engine Efficiency by Using Inlet Air Preheating Method through Exhaust Gas Temperature with Convective Mode of Heat Transfer" in April 2016. In the sample preparation the experimental setup designed with IAP. Results shows that efficiency properties in terms, of mechanical efficiency, brake thermal efficiency, indicated thermal efficiencies are increased mainly depending upon the IAP orientations followed by the number of trails. Hence compared to without IAP the difference were not highly significant [11].

Manikandan. G *et al.* done "Performance Test on SI engine by Peltier Air preheating along with Exhaust Gas Heat Recovery system" in May 2016. They have done this project with great effortwith the exposures and resources we had and completed the project successfully. Due to the air preheating air fuel mixture is expanded thus complete combustion is being achieved thus the carbon content is reduced by this method, high mixing of air and fuel is being obtained this leads to better burning of air fuel mixture thus leading to efficient use of fuel these were found by using engine run test and load test [12].

R. Vishal perform experiment on "Enhancing the efficiency of an IC engine using the concept of preheating" in may 2016. The experimental results obtained show that there is an increase in mileage and therefore, the thermal efficiency of the IC engine. Although this increase only corresponds to around 2-3 %, it can be increased a little further by using other techniques like variable valve timing, charge exchange work etc [13].

Vijay VS. *et al.* done "Design and Fabrication of Heat Exchanger for Waste Heat Recovery from Exhaust Gas of Diesel Engine" in Jun 2016. In this work it is found that use of heat exchanger is a useful and simple method to utilize the waste heat energy available in the exhaust gas of diesel engine. Here shell and tube heat exchanger design is used with both counter and parallel flow arrangements [14].

2.1 Research Gap

There is lack of study regarding study of all results of mileage, power output, brake thermal efficiency, BSFC, Exhaust

emission testing and effect on volumetric efficiency by air preheating technology.
Also there is some complicated techniques are performed for increasing the effect of air preheating by using complicated heat exchanger. Bur no research done for analyzing the parameter by adding fins in heat exchanger.

3. Problem Statement

Given the importance of increasing energy conversion efficiency for reducing both the fuel consumption and emissions of engine, scientists and engineers have done lots of successful research aimed to improve engine thermal efficiency, including supercharge, lean mixture combustion, etc. However, in all the energy saving technologies studied. Engine exhaust heat recovery is considered to be one of the most effective. Many researchers recognize that Waste Heat Recovery from engine exhaust has the potential to decrease fuel consumption without increasing emissions, and recent technological advancements have made these systems viable and cost effective.

3.1 Scope of Project

The humidity in the atmospheric air affects the petrol vaporization in the carburetor. Also low temperature of air affects the petrol vaporization in the carburetor. Therefore, by preheating the inlet air to the carburetor for a considerable amount, the vaporization can be ease which help for making homogeneous mixture of petrol and air. Non homogeneous mixture of air & petrol cause incomplete combustion of charge in the cylinder during working cycle. Incomplete combustion cause less power generation in engine which lowers the efficiency of engine. Also incomplete combustion of fuel results into production of harmful exhaust gases.
By reducing the water vapor to the engine, the steam formation in the engine can be reduced. This prevents the pitting of the engine, piston, inlet & exhaust pipe.

3.2 Objectives of Project

Hence by making air preheating arrangement in petrol engine following things can be achieved-

1. Leads To Complete Combustion Of Fuel
2. Increases Efficiency Of Engine
3. Avoid Pitting Failure Of Engine Parts From Moist Air
4. Production of Exhaust Gas Like Nox is Reduced Due To Low Temp. Of Exhaust Pipe.
5. Reduction in Hydrocarbon from the engine exhaust.

4. Working Principle

As this is one type of heat exchanger means one body shares energy with other body. Here energy of exhaust gases which coming out of the engine through silencer pipe is shared with atmospheric fresh air which coming in from the holes on pipe from front side. This cool atmospheric air becomes hot at the end of heat exchanger because it takes energy of exhaust gases. This preheated air then supplied to air intake chamber then it forwarded to carburetor. In carburetor this air mix with petrol while mixing petrol droplet evaporates at fast rate due to high temperature air. This help in complete combustion of fresh charge in engine cylinder.

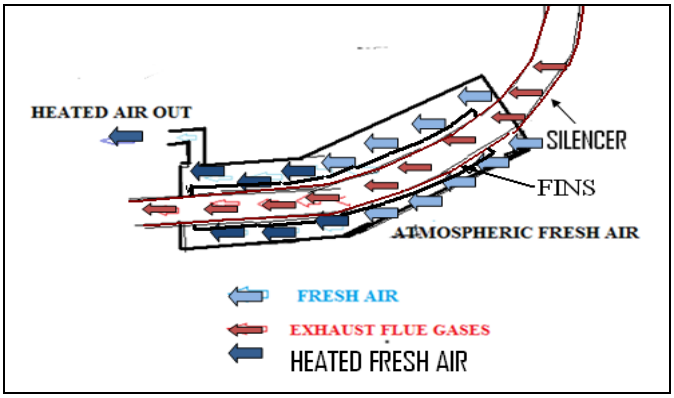

Fig 1: Schematic diagram of air preheater

5. Experimental Setup Layout

For investigating the Engine performance by preheating the air on SI engine purposes we have to make setup as shown in Air preheater is applied over the silencer and heat the atmospheric air and send it into carburetor for increasing the evaporation rate of petrol fuel. To measure the BP of engine Dynamometer is coupled to engine shaft which measures the power available at the shaft. To measure the exhaust emission Exhaust gas Analyzer is used which measures the concentration of various exhaust gases. To measure the volumetric efficiency of an engine we have to use orifice meter in the passage of preheated air. Location of orifice meter still not decided.

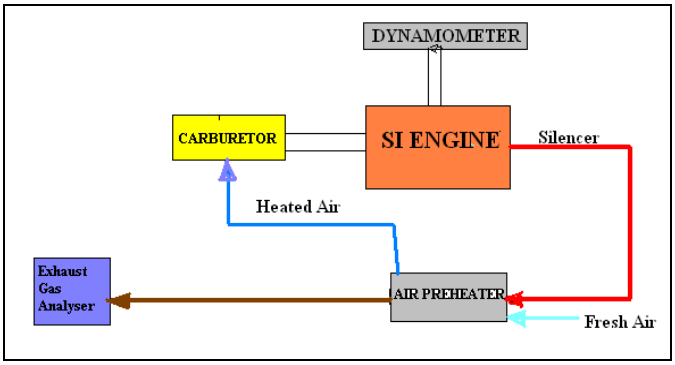

Fig 2: Layout of Experimental Set up

The above layout shows us experimental setup for determining the engine performance in terms of following parameter.

1. Brake Thermal Efficiency
2. BSFC
3. volumetric efficiency
4. Emission testing.

6. Conclusions

Here conclude your finding to with object of your studies. In this way we have seen the work related to enhancing engine efficiency by method of preheating the air by various research paper. We come to know that there is some research gap related to this study. So we are now take this task to overcome this research gap. For this purposes in our project we have to introduce fin on silencer and with the help of heat exchanger

on silencer we have to heat the atmospheric air and after passing through this heat exchanger the preheated air enters in carburetor for homogeneous mixing. With this homogeneous charge combustions we have to study various parameter related to engine performance

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