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# "Design and Fabrication of Air Preheater for Spark Ignition Engine for Determining Engine Performance"

Darshan Singh Tomar
*M.Tech Scholar*
*ME Thermal Engineering*
*Truba Institute of Engineering and Information Technology, Bhopal, Madhya pradesh, India*

Prof. Shamir Daniel
*Assistant Professor*
*ME Thermal Engineering*
*Truba Institute of Engineering and Information Technology, Bhopal, Madhya Pradesh, India*

Prof. Amit Khare
*Assistant Professor*
*ME Thermal Engineering*
*Truba Institute of Engineering and Information Technology, Bhopal, Madhya Pradesh, India*

***Abstract-****This paper presents the experimental results of a comparative investigation of an engine's spark-ignition system. During the road testing and laboratory tests, the efficacy of the ignition systems utilized was assessed based on the fuel consumption and the composition of the exhaust gases. Results are examined based on estimates of the combustion products' equilibrium and an analytical assessment of the flame extinguishing layer's thickness close to the combustion chamber's cylinder walls. This study examines how preheating the inlet air temperature can improve the performance of a SI engine that is air-cooled. By exchanging heat with the engine's exhaust gas, an air preheater warms the surrounding air. This air preheater is similar to a counter flow heat exchanger and is made out of a chamber with an input hole for outside air and an output hole for warmed air that is sent to the carburetor for combustion. This chamber is built on the engine's exhaust pipe. By raising the carburetor's inlet air temperature, the proposed model improves mileage and lowers fuel usage. When the carburator's intake air is warmed using an air preheater, exhaust emissions are reduced. In order to improve the fuel economy or mileage, we adjusted the air intake into the cylinder of a single cylinder, four stroke air cooled engine (two-wheeler Hero Splendor 97 cc bike) in this work. The bike we are using for our project typically gets 80 to 86 kilometers per liter of gasoline. The design is straightforward, affordable, and causes the engine no issues. It is especially beneficial in chilly climates. In the winter, the ambient air temperature has an impact on how gasoline vaporizes in the carburetor. Therefore, during cold weather, prepared air might make evaporation in the carburetor simple. Thus, waste heat is being recovered using a preheating device.*

***Keyword:****Air-Preheater, Carburettor, Complete Combustion, Homogeneous Mixture, Emission , Hydrocarbons, Fuel , Economy.*

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## Introduction

Ignition Methods Spark ignition (SI) or compression ignition must be used to ignite the mixture in internal combustion engines (CI). Hot tube and flame procedures were in use prior to the development of dependable electrical techniques. There have been developed experimental engines using laser ignition. The majority of the time, lead-acid batteries are used in conjunction with an alternator or generator to power gasoline engine ignition systems. The battery provides electrical power both while the engine is running and when it is not. Additionally, the battery provides electricity when the alternator can't sustain more than 13.8 volts, which happens on occasion (for a common 12V automotive electrical system). Lead-acid storage battery electrical load increases as alternator voltage drops below 13.8 volts. The alternator provides the principal electrical power under almost all running circumstances, including typical idle circumstances.

Some systems turn off the power to the alternator field (rotor) when the throttle is fully open. By turning off the field, crankshaft power is increased while the mechanical stress on the alternator pulley is almost nil. In this instance, all primary electrical power is provided by the battery.

Gasoline engines take in an air/gasoline combination and compress it to a maximum of 12.8 bar (1.28 MPa). A spark plug ignites the compressed mixture when the piston nears the cylinder head and reaches its full stroke.

An induction coil or transformer provides the required high voltage, which is normally between 10,000 and over 30,000 volts. The fly-back induction coil system interrupts the electrical primary system current using a synchronized interrupter of some sort. A power transistor or contact points might serve as the interrupter. Capacitive discharge systems are used in several ignition systems. Step-up transformers are used with CD ignitions. To produce an electric spark, the step-up transformer employs energy that is stored in a capacitor. In either arrangement, the right cylinder receives a precisely timed high-voltage via a mechanical or electrical control mechanism. This spark ignites the air-fuel combination in the engine's cylinders through the spark plug.

Even while gasoline internal combustion engines are more simpler to start in cold weather than diesel engines, they can still have issues in severe circumstances. Parking the automobile in heated spaces has been the solution for many years. In some regions of the world, the engine's oil was in fact emptied, heated overnight, and then refilled for cold starts. On cold weather starts, raw gasoline was routed to the unit's gasifier where some of the fuel was burnt, enabling the remaining portion to create a hot vapor that was then fed straight to the intake valve manifold. This technology was developed in the early 1950s. Before electric engine block warmers were a requirement for gasoline engines sold in cold locations, this item was extremely common.

## I. Combustion in Spark-Ignition Engines

When an engine is operating normally, a spark ignites a flame that spreads outward across the combustion chamber and uniformly compresses the unburned gas in its path. This so-called "end-gas" is warmed by the simultaneous action of compression by the expanding gases and radiation from the moving flame front. Under conditions when the temperature and pressure are below critical values, the flame front will travel steadily across the room to the far wall, burning the mixture as it goes [11-14]. However, if the temperature and pressure circumstances are high enough, the chemical reaction rate will surpass a critical value, and the unburned or partly burnt mixture in the "end-gas" will be consumed at a very fast rate just before the flame reaches the far edge of the combustion chamber. The rapid combustion and subsequent temporary disruption of the combustion chamber's pressure equilibrium causes extremely rapid pressure increase, setting up shock waves that impact on the cylinder walls and produce the high-pitched, distinctive "knocking" sound. Although "knock" had been known to working engineers since 1882, it wasn't until after World War I, when its prevalence significantly stifled power increases, that real efforts were made to explain it.

Knock limitations of engine design and operating factors on the one hand, and of fuel composition and additives on the other, were possible to be assessed after a great deal of practical data was acquired in the years after Ricardol's study in 1923. There are two primary schools of thought on the act of knocking itself.
Two things induce this:
(1) Following the initiation of the flame front, a part of the combination might auto-ignite because of the high temperature as well as pressure, and
(2) Similarity to the detonation phenomena seen during the propagation of flame in long closed tubes. The most recent idea, proposed by Curry, seems to have gained little traction so far; it holds that knock may be induced without auto-ignition or the production of a real detonation wave if the flame front sweeps through the gases quickly enough. After looking through the published literature, it seems that the majority of the data (particularly Downes' and Wheeler's research) supports the auto-ignition hypothesis. Both Simonson and Felt and Steele's research and observations on spark-ignition engines show that knocking in dual-fuel engines is of an auto-ignition nature.

## II. Thermodynamic Modelling: Principles and Components

In engineering undergraduate thermodynamics textbooks, spark-ignition engines are typically considered to have a high enough combustion rate for their operation to be successfully described by an idealized Otto cycle. The Otto cycle becomes more thermally efficient as compression ratios rise. In terms of thermal efficiency, the Otto cycle improves with increasing compression ratios$r_v$ is $\eta = 1 - r_v^{1-\gamma}$ (1) where the specific heat capacity ratio is denoted by the symbol = c p/cv. A modern naturally-aspirated engine may run at r v11 whereas early engines had a compression ratio of r v3, causing combustion to occur at extraordinarily high temperatures and pressures. The formula in the textbooks is very simplistic, and a real engine cycle resembles Figure 1 more. When interpreting the results of simulating the combustion event in an engine, it is also important to take into account the torque and power of the engine, which are determined by the dependence of in tension on operating point, the structure of exhaust, including pollutants, which is determined by the dependence of the mass fraction combusted upon operating point, as well as the potential for such trying to knock events [3–9]. The combustion rate and the heat losses in the cylinder walls, head, and piston crown during the closed part of the cycle influence the pressure in the cylinder.

A straight line between the pressure and the mass fraction used in an engine is nonetheless challenging due to a variety of factors:

In a piston engine, heat may be lost in two different ways: (a) through the flame form; and (b) by blow-by, or mass loss through the piston rings. The amount of the total imprisoned mass that burns relies on the rate of momentum transfer between the cylinder and non-combustible areas like the crank case, inter-ring gap, and top land crevice. This later mass exchange, also referred to as "the blow-by flow," is a popular topic of discussion among meteorologists. The issue is made more difficult by the fact that the chemical equilibrium and specific temperature of the charred gas are continually shifting, necessitating an iterative approach. The modeling of these connected processes is covered in more detail in this section.

The following might serve as a summary of the approach employed in this article. The compression process is initially modeled using the end of the intake process. The flame marks the boundary between these two regions. While the extended Zel'dovich mechanism is used to calculate the concentration of nitrogen mono-oxide, the rate of the one-step reversible reaction CO+OH CO2+H is utilized to calculate the synthesis of carbon mono-oxide [13–23].

The phrase "Fresh" gas is deceptive since it might also refer to combustion leftovers from recovered exhaust gases or restricted residuals (EGR). The speed at which the flame spreads determines how quickly mass moves from the ex post facto to the charred zone. The flame is considered to move in a circular motion in this research from the site of ignition to the point at which it reaches the chamber walls, although this assumption can be changed as necessary. The pace at which the agitated mass burns and the rate at which the flame spreads are inversely proportional [2, 6]. Finally, because the simulations end at the start of the exhaust process, the engine's breathing is not taken into consideration. To simplify modeling and properly depict combustion, all the variations in engine respiration are represented by changes in charge temperature, pressures, and content. Polynomial functions of temperature are used to compute temperature dependences of specific enthalpies hi(T) and specific entropies si(T), as well as key temperature dependences of specific molar heats cpi(T) for various species [9]. (T). They are regarded as being essential for extremely super- or rapid charging engines [23–35], however the results presented here disregard their pressure dependence on "real-gas." The molecular transport coefficients are calculated using the formulae established by the gas kinetic theory.

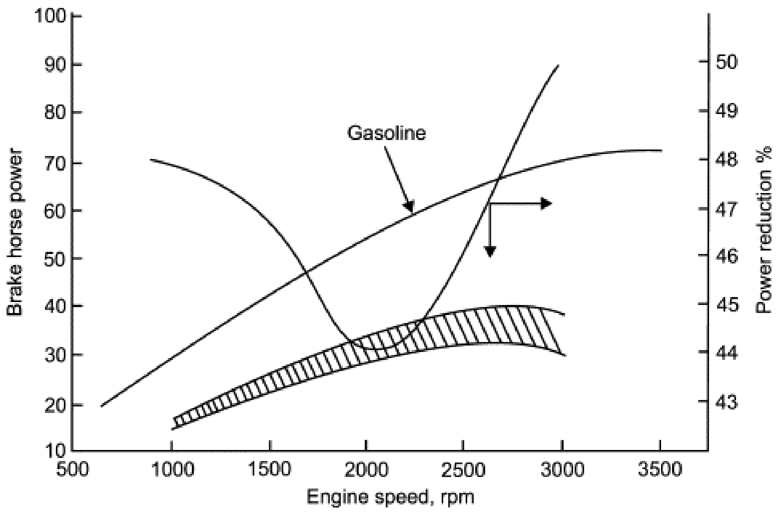


**Figure 1-Example of a thermodynamics method to ignition in a SI engine.**

The specific entropy (s) is plotted against the actual temperature (T) to depict the thermodynamic state in the thermal diagram (Ts diagram). Ts diagrams are often used and useful since they show heat transfer during the course of a single process. The quantity of heat produced or released from a system during a reversible (ideal) process is represented by the area beneath the T-s curve. We can assess the effectiveness of heat exchangers using Logarithm Mean Temperature Difference (LMTD) and then adjust their operation for optimal effectiveness. These equations apply equally to heat exchangers with counterflow, crossflow, and parallel directions of flow. The following are the exchanger performance equations:

$Q=UA\Delta TLM$

in which,

$\Delta TLM=Ln(\Delta TB\Delta TA)\Delta TA-\Delta TB$

and:

Q= heat transfer rate [BTU/hr]

U= Standardized heat transfer coefficient between two fluids [BTU/$ft^2$-hr-F]

A= Location of the heat exchanger's transfer surface [$ft^2$]

***ΔTLM = Differences in fluid temperatures are often represented by a logarithm. [F]***

It is frequently used in large canteens, hospitals, and the food industry's heat recovery systems. In contrast to spinning heat exchangers, cross-flow heat exchangers do not transport moisture.

## IV. Literature Review

For spark-ignition engines, the combined state and parameter estimation problem has not been well studied. The intake manifold's transient temperature behavior is modeled in [3]. The parameter estimate approach is Extended Kalman filter-based. The literature primarily uses linear models when reporting generalized combination estimating strategies. The combined estimating approach for linear state-space systems with a certain structure of the state dynamics and the output being one of the states was established by the authors in [4]. Models with nonlinear system dynamics and states as outputs can use coupled estimating techniques based on Kalman filters; for more information, see [5–9]. There are typically two forms of Kalman filter-based combined estimation. The first is a dual estimation, which involves stacking the original state vector and parameter vector to produce an augmented state vector, then estimating the enhanced state. Another method is to successively apply two Kalman filters, one of which is used to estimate the states and the other to estimate the parameters [5]. The spark advance concept has been used to gasoline engine combustion phase control in [21]. Control adaptation is used in [19] to maintain a meaningful torque response, a degree of combustion that is optimized, and engine knock prevention. Controlling the air-fuel ratio at a stoichiometric value [20], necessary for the ideal combustion, is a standard technique to maintain the best balance between engine efficiency and emissions. The control mechanism to inject fuel into the intake manifold for the air-fuel mixture is built using first-principles models in the majority of port fuel injection systems. For observer design and defect detection, physics-based models have also been used [4,3]. For the purpose of estimating the nonlinear parameters defining the dynamics of the fuel film, feedforward neural networks are modelled in [12]. The air-fuel ratio control is then performed using these parameters. There are several publications in the literature that concentrate on estimating one or more engine variables. The volumetric efficiency of an internal combustion (IC) engine is evaluated in [13] using a variety of models based on parametric, non-parametric, and neural approaches, as well as its dependency on engine speed, throttle angle, and intake manifold temperature. Numerous strategies for enhancing ICE's fuel economy are outlined in [14]. In [15], it is calculated that the air charge and residual gas percentage will produce the necessary torque for control. A sliding mode observer is used in [16] to calculate the discharge coefficient for internal combustion engines. [17] explored strategies for estimating the throttle discharge coefficient based on empirical techniques such as linear, polynomial functions, and neural networks.Using a multilayer perceptron neural network, [18] models the relationship between the crankshaft speed and a few parameters taken from the incylinder pressure cycle. Additionally, it is utilized to estimate the combustion parameters by providing a non-intuitive estimate of in-cylinder pressure and combustion quality. In [19], the authors build a sliding mode observer to estimate intake manifold pressure and simulate the uncertainty that results from a change in the coefficient of discharge is mitigated by the observer's switching signal. The coefficient of discharge, a time-varying quantity, is computed using the switching signal.

This study by Yamin, J. A., Gupta, H. N., & Bansal, B. B. (2003).'The effect of combustion duration on the performance and emission characteristics of propane-fueled 4-stroke SI engines'.By increasing the intake air temperature with a Thermo-Electric Generator (TEG), which enables more complete fuel vaporization and therefore more complete combustion, the experiment aims to minimize emissions and enhance engine performance. In trials, it has been demonstrated that preheating the air reduces CO2 and HC emissions. Author is aware that levels of carbon monoxide and hydrocarbons have drastically decreased based on the data. In this paper author worked on a project titled 'Simulation of the combustion of alternative fuels in spark ignition engines' by Verhelst, S. (2000). This project includes a turbocharger, a thermoelectric generator, and I.C. engine exhaust gas. The engine uses around 30–40% of the energy in the fuel to do mechanical work, whereas 60–70% is lost as heat through friction, exhaust gas, and cooling systems. I.C. engines release waste heat into the environment along with exhaust gases. The thermoelectric generator's efficiency has suffered significantly. But using waste heat boosts thermal effectiveness and cuts emissions. A significant advantage is a quicker rate of cabin warming.Sanjay Kumar.D and Srihari's (2018) study focused on the impact of intake air temperature on a SI engine using diethyl ether-gasoline combinations. The impact of diethyl ether (DEE) on the effectiveness and emissions of a spark ignition gen-set engine was examined in this study. Three different DEE/gasoline volume mixtures are possible: 3%, 6%, and 9%. In this experiment, a SI four-stroke engine was used. The effects of intake air temperatures of 32 and 22.1 degrees Celsius on fuel use and emissions were investigated. For the test, the engine is running at 3000 RPM. The CO level increased by 20% with the load, reaching 14 ppm at 22°C and 11 ppm at 32°C. The HC level increased by 20%, reaching 260 ppm at 22°C and 140 ppm at 32°C. The BSFC level increased by 20%, reaching 1.10 kg/kWh at 22°C and 1.0 kg/kWh at 32°C. The concentrations of CO, HC, and BSFC all increased by 1 ppm (0.010 ppm at 22°C and 0.08 ppm at 32°C, respectively) with a 100% increase in load. Nandakumar, S., &Mohanan, P. (2017) conducted an experimental investigation on how to increase engine performance in a SI engine by preheating the air.An air preheater was installed to the top of the silencer and the warmed air was sent into the carburetor to hasten the rate of fuel evaporation. By fastening a dynamometer to the engine shaft and measuring the power at the shaft, it is possible to calculate an engine's braking power. Observing the exhaust gas measurements An exhaust gas analyzer is used to measure the concentration of the various exhaust gases. In a 2017 study co-authored by N. P. and P. R. Jagtap, the impact of intake air temperature on a spark-ignition engine's ability to burn hydrogen peroxide was examined.The impact of intake air temperature on a gasoline engine running on a non-conventional fuel is being researched. As an alternative fuel source, a mixture of hydrogen peroxide and regular gasoline will be employed. While hydrogen peroxide may appear to be a potent oxidant, when combined with water, it really transforms into a weak acid. To combine everything, a magnetic stirrer will be used. In the experiment, mixtures of 5% hydrogen peroxide by volume and 95% gasoline and 10% hydrogen peroxide by volume and 90% gasoline will be employed (vol). In the investigation, a single-cylinder, four-stroke generator engine made by Precision GX420 was used. By connecting the hot air gun to the engine inlet, the air temperature may be changed. The chilly air had a negative effect on the engine's performance. The experiment demonstrated that maintaining engine operation at 60 degrees Celsius was more difficult than maintaining engine operation at 40 degrees Celsius due to greater hydrogen peroxide evaporation at higher temperatures. The experiment, named "Increasing the Efficiency of IC Engine by Using Air Pre Heater," was carried out by Anil, D. (2017).A 100cc gasoline engine that takes outside air into the carburetor through a heat exchanger powers the prototype cars. A heat exchanger heats the air that is going through it by using the exhaust gas from the engine that is bled from the exhaust pipe. Changes in intake surface temperature have a relatively little impact on the carbon monoxide content in exhaust gases.

In an experiment by Madhu L. Kasturi and Amol S. Patil titled "Effect of Inlet Air Preheating on Exhaust Gases in Single Cylinder I.C Engine," they examined this issue (2017). The research involved testing four-stroke motorbike engines. They used an air preheater to warm the intake air through heat exchange with exhaust gas. The project is put to the test using a 2 kilogram weight. They list a number of results, including a rise in fuel consumption from 550 ml/hr to 560 ml/hr but falls in CO and HC levels from 0.11%vol to 0.09%vol and 24%vol to 21%vol, respectively. Recent design improvements, according to Jianqin Fu et al. (2013), have made it possible for regenerator systems that use ceramic honeycombs to hold heat to effectively pre-heat air to 1600 K before burning it. Burning fuel with warm air enhances the flue gas's capacity for heating while lowering running costs. However, the likelihood of NOx generation increases when highly hot air is burned. A coffee NOx burner that can be used in production environments is required.In this study, a newly constructed regenerative burner that was supposed to reduce NOx emissions fails to do so. Additionally offered are theoretical and analytical assessments of fuel efficiency in combustion with highly warmer air. Steam power-assisted turbo charging is a technique created by Jianqin Fu et al. (2014) to help the exhaust turbo charger recover exhaust energy and show that intake gas pressure reached their desired value and torque would increase by 25th. Pumps' mean effective pressure and thermal efficiency have both marginally increased.

## V. Proposed Methodology

The first difficulty is deciding on the material that would best achieve the objectives of the design. There should be plenty of materials available. The cost of studying and supplies shouldn't be prohibitive. An exhaust pipe is brazed with copper fins, and the whole assembly is then covered with stainless steel tubing to form a heat exchanger. The heat exchanger is made out of stainless steel pipe, copper sheet and pipe, and a hose pipe.

Chamber made of stainless steel covering brazed fins For entering ambient air and intake air to the filter by hose-pipe, two holes are supplied in the chamber's top. Figure 2 displays copper pipes with exhaust pipes and brazed copper fins. This system is attached to the engine silencer by welding and is made of MS pipe measuring 50mm in diameter by 300mm in length.

**Figure 2: Copper fins placed on copper pipe and attached with exhaust pipe.**

**Figure 3: System covered by MS pipe and weld with silencer.**

***5.1 Methodology***

When the operation begins, exhaust gases leak out the tailpipe. The design of an intake air preheating heat recovery system allows air to be warmed by the temperature of the exhaust gases. The air entering a tubes heat exchanger enters the outer pipe while the exhaust gases exit the inner pipe. During this period, heat from the exhaust gases will be absorbed and heated to warm the entering air. Instead of the customary frigid air, the carburetor is now supplied with this warm air.

***5.2 Material Required***

To prepare an air-preheating system requires certain materials such as mild steel, copper, and rubber hose pipe.

1. Mild steel – In this project mild steel is used to cover the inner copper tubes and fins. Mild steel is durable and it can resist more load, it can weld easily by Gas welding.It has less Thermal Conductivty then copper and alluminium.
2. Copper – To prepare inner tube and baffle fins we choose copper. It is highly thermal conductive and light in weight.
3. Rubber Hose Pipe – It transfer preheated ambient air to the carburetor. It is a poor conductor of heat so very less heat loss in this process.

Table 4.1: Material Required.

| Sl No. | Material | Description of Material | Dimensions (units) |
|---|---|---|---|
| 1 | Mil Steel (Pipe) | To cover inner copper tubes and thermal conductivity is 50W /mK. | OD-Ø50mm ID-47mm Length 300mm |
| 2 | Copper Pipe | Attach with exhaust pipe of the engine. It have high thermal conductivity 400W/mK. | OD-Ø20mm ID-17.5mm Length 200mm |
| 3 | Copper Sheet | To prepare Buffle plates which placed onto copper pipe. | OD-Ø45mm ID-20.2mm Thichness-1.25mm |
| 4 | Rubber Hose Pipe | To transfer Preheated Air to the Carburettor.It is poor conductor of heat. | L- type with lenth – 300mm (2nos) |

## VI. Experimental Setup

Experimental setup for determining the engine performance in terms of following parameter.

Parameter

1. Fuel Consumption- The amount of fuel consumed by a vehicle for a unit time.
2. Mileage- Mileage is the distance traveled in kilometers divided by the amount of fuel consumed in liters.

Mileage – KMPL

3. Emission testing- It is calculated by using Automotive Emission Analyzer.

Components Used

1. Fuel tank
2. Spark Plug
3. Silencer
4. Engine
5. Carburetor
6. Air-Preheater

Engine Specification

1. Engine : spark ignition

2. Type : 4-stroke air cooled engine.
3. Stroke : 49.5 mm.
4. Bore : 50 mm.
5. Displacement : 97.20 cc.

The proposed work reveals the necessity of how much of a difference preheating the air makes to the performance of a SI engine, will be obtainedafter constructing an air preheater, which is connected to the silencer in the diagram shown in Figure 3, to heat the ambient air by exchanging its temperature with the echaust hydrocarbons and then channel it into the carburetor.

**Figure4.Air Preheater Attached with Engine Silencer**

***6.1 Calculate Fuel Consumption***

1. Check the fuel level.
2. Fuel level should be 50ml.
3. Open the way cock so that fuel flows to engine tank.
4. Start the engine.
5. Mentain RPM at constant speed by using speedometer and note it.
6. Note the temperature of air at inlet of caburettor in ºC at varios speed of engine.
7. Initially the test is made without the preheater setup then the engine is made to run at various rpm for the fuel of 50ml then timing is noted, the rpm noted here is crank shaft rpm and the results are being noted.
8. The second test for its actual fuel consumption (with air pre-heater connection): Then the test is being conducted with the preheating setup being attached along with the carburetor the hot air from the air preheating setup is being transferred with the help of a hose pipe in which one end is being attached to the air preheating setup and the other end is being attached to the carburetor thus when the air enters in the carburetor is preheated by exhaust gas heat recovery setup, thus hot air enters into the carburetor and the engine is made to run at different rpm for the same amount of fuel 50ml and the time for which the engine is running is noted.
9. Operate the throttle valve so that engine pickup speed to required level 300rpm.
10. Repeat step 4 for different speeds.
11. Repeat step 1-4 for condition- without air-preheater and with air-preheater.

***6.2 Calculate Mileage of Motorcycle***

1. Check the fuel level.
2. Fuel level should be 100ml.
3. Open the way cock so that fuel flows to engine tank.
4. Start the engine.
5. Ride smoothly and note the travelled distance
6. Mentainspeed as given ranges 0-40 km/hr, 40-50 km/hr and 50-60 km/hr.
7. Note the temperature of air at inlet of caburettor in ºC at varios speed of engine.
8. Initially the test is made without the preheater setup then the engine is made to run at various speed for the fuel of 100ml then distance is noted.
9. The second test for its actual fuel consumption (with air pre-heater connection): Then the test is being conducted with the preheating setup being attached along with the carburetor the hot air from the air preheating setup is being transferred with the help of a hose pipe in which one end is being attached to the air preheating

setup and the other end is being attached to the carburetor thus when the air enters in the carburetor is preheated by exhaust gas heat recovery setup, thus hot air enters into the carburetor and the engine is made to run at different rpm for the same amount of fuel 100ml and the distance for which the engine is running is noted.

10. Repeat step 3 for different speeds.
11. Repeat step 1-3 for condition- without air-preheater and with air-preheater.

### *6.3 Check volume of pollutants in engine's exhaust*

1. Emissions from the engine were measured using Automotive Emission Analyzer at different speeds.
2. Note Carbon-monoxides in percentage which shows the ratio of volume of CO and total exhaust gas volume.
3. Note Carbon-dixides in percentage which shows the ratio of volume of CO and total exhaust gas volume.
4. NoteHydrocarbons parts in ppm which shows how much parts of HC present in million parts of gas.

### *6.4 Observation table for fuel consumption test*

The test carried on experimental setup for 50ml fuel. Following are the observation for 4 different rpm.
1. Without Air-Preheater Setup

**Table2: Fuel consumption test (without air preheater)**

| Sr. no | Speed(rpm) | Fuel(ml) | Carburetor inlet Temprature ºC | Consumption Time(sec) |
|---|---|---|---|---|
| 1 | 200 | 50 | Ambient | 420 |
| 2 | 300 | 50 | Ambient | 400 |
| 3 | 400 | 50 | Ambient | 455 |
| 4 | 500 | 50 | Ambient | 435 |

2. With Air-Preheater Setup

**Table 3: Fuel consumption test (with air preheater)**

| Sr. no | Speed(rpm) | Fuel(ml) | Carburetor inlet Temprature ºC | Time(sec) |
|---|---|---|---|---|
| 1 | 200 | 50 | 55 | 536 |
| 2 | 300 | 50 | 55 | 530 |
| 3 | 400 | 50 | 60 | 590 |
| 4 | 500 | 50 | 65 | 560 |

The results of test are shown in graph for experimental

### *6.5 Results for practical observation*

This graph shows the time taken by engine to consume 50ml of fuel at different shaft rpm.

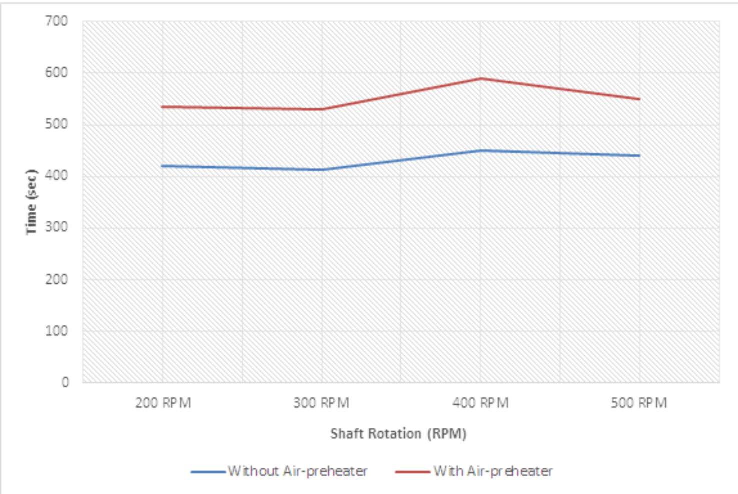


Figure 5:Shaft Rotations Vs Time.

***6.6 Observation table for mileage test***

The test carried on experimental setup for 100ml fuel. Following are the observation for 4 different speeds.

1. Without Air-Preheater Setup

**Table 4: Fuel consumption test (without air preheater)**

| Sr. no | Speed(Km/hr) | Fuel(ml) | Carburetor inlet Temprature ºC | Distance Travelled (km) |
|---|---|---|---|---|
| 1 | 0-30 | 100 | Ambient | 8.6 |
| 2 | 30-40 | 100 | Ambient | 8.2 |
| 3 | 40-50 | 100 | Ambient | 8.8 |
| 4 | 50-60 | 100 | Ambient | 7.1 |

2. With Air-Preheater Setup

**Table 5: Fuel consumption test (with air preheater)**

| Sr. no | Speed(Km/hr) | Fuel(ml) | Carburetor inlet Temprature ºC | Distance Travelled (km) |
|---|---|---|---|---|
| 1 | 0-30 | 100 | 40 | 9.1 |
| 2 | 30-40 | 100 | 52 | 9.3 |
| 3 | 40-50 | 100 | 58 | 9.6 |
| 4 | 50-60 | 100 | 65 | 7.5 |

The results of test are shown in graph for experimental

***6.7 Results for practical observation***

This graph shows the distance travelled by motorcycle to consume 100ml of fuel at different speed.

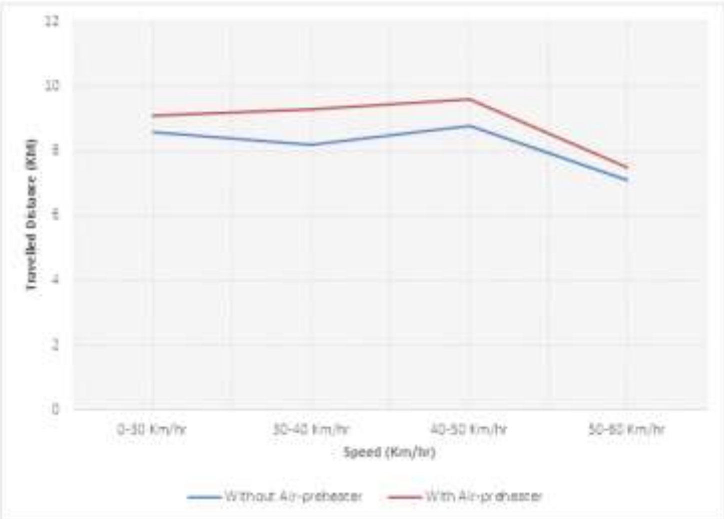


Figure 6: Speed Vs Distance

This graph show if engine run in between 40-50 km/hr speed. It will give better mileage and save cost.

***6.8 Calculation to save fuel cost***

As we can identify with the help of graphical reprentation of Speed and Travelled distance,Maximum distance covered by motorcycle is 8.8km without air preheater at speed of 40-50km/hr with the consumption of 100ml of fuel.We also obeserve in graphical reprentation of Speed and Travelled distance,Maximum distance covered by motorcycle is 9.6km with air preheater at speed of 40-50km/hr with the consumption of 100ml of fuel.

***6.9Result and Observation of Emission test***

**Table 6: Emission test Results**

| Condition | CO (%) | HC (ppm) | CO2 (%) |
|---|---|---|---|
| Without Air Preheater | 2.3 | 464 | 3.2 |
| With Air Preheater | 1.8 | 470 | 2.8 |

As observation table the CO2 and CO volume percentage in exhaust gas reduced as increase in temperature of inlet air of carburetor. HC matters in exhaust gas slightly increases when temperature carburattor inlet air temperature increases.

## VII. Conclusion

We've spent a lot of time and attention into this project and taken advantage of all the resources and possibilities available to us to see it through to the end. The utilization of waste heat renewal techniques has been found to have a significant potential for energy savings. Reusing the exhaust heat from an internal combustion engine for heating is referred to as waste heat renewable. Recognizing the performance enhancement and lowering the engine's emissions would also be beneficial. The car industry would benefit from efficient engine performance and low emissions if these technologies were adopted. With the use of an air preheating system, waste heat from exhaust gas may be recovered and converted into mechanical power. It is beneficial for similar gains in mileage, pollution reductions, and fuel consumption. With a rise in intake air temperature, the engine's need for heat decreases. With a rise in intake air temperature, the CO and $CO_2$ concentration in the exhaust gas is only marginally reduced. When intake air temperature rises, the HC content in the exhaust gases also slightly rises. Due to the emphasis on minimal costs throughout design, this configuration is cost-effective.

### Future Scope

By positioning a propeller fan in front of the heat exchanger chamber in the future, we want to include turbo charging into this air preheating system, pulling air at high pressure and resulting in even more power gain. Second, the air-pre-heater needs to be reduced in size. Third, the higher volumetric efficiency of the preheating arrangement translates into an increase in air temperature, which is quantified by this study. Installing an aqua silencer will result in a four-degree reduction in exhaust temperature.

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