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# Effect of Preheating Air in Petrol Engine by Using Exhaust Gas Heat Energy

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**ABSTRACT**

**In current situation there is a rapid increase worldwide problem regarding fast economy development and subsequent short in energy, greenhouse effect has been increased recently to very high level within a short period of time thus leading to damage of ozone layer which might take several million years to recover. Out of the total heat supplied to the engine in the form of fuel, approximately, 30 to 40% is converted in to useful mechanical work; the remaining heat is expelled to the environmental pollution, so it is required to utilize waste heat in to useful work. The recovery of waste heat not only conserves fuel but also reduces greenhouse effect. The concept of increasing the fuel efficiency of petrol engine by preheating the intake air of engine with preheater. The humidity in the air affects the petrol vaporization in the carburettor. Therefore by preheating air to the carburettor to a considerable amount evaporation can be made easy and in turn complete combustion is being achieved. Thus a preheating system is being used which recover the heat from the exhaust gases through heat exchanger which recovers the heat, in order to improve the heat of the intake air an additional preheating element is being added to the setup which is being powered by the battery.**

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## I. INTRODUCTION

The concept of increasing the fuel efficiency of petrol engine in this project, is to pre-heat the intakes air which is flowing through the carburettor. The humidity in the atmospheric air affects the petrol vaporization in the carburettor. Therefore, by preheating the inlet to the carburettor for a considerable amount, the vaporization can be ease and in turn complete combustion is achieved. Moreover by reducing the water vapour to the engine, the steam formation in the engine can be reduced. This prevents the pitting of the engine, piston and exhaust pipe. The pre-heating of inlet air to the engine can be achieved by fixing a heat exchanger in the exhaust pipe. The atmospheric air is sucked through the heat exchanger to the carburettor. The air, which is flowing through the heat exchanger, gets heated by the engine exhaust gas, this reduces the water vapour in the inlet air and the temperature of the air is raised. The temperature raise cause complete combustion in the engine. The humidity in the air affects the petrol vaporization in the carburettor. Therefore by preheating air to the carburettor to a considerable amount evaporation can be made easy and in turn complete combustion is being achieved.

## II. LITERATURE REVIEW

**Chirtravelan** et al**.,** have experimentally prove that the effect of preheated air on standard diesel fuel engine indicated a good result on emission control. NOx and CO emissions at intake air temperature of 55°C were less when compared at intake air temperature of 32°C. Result are proved from this experiments like that Higher inlet air temperature will be affect some factors (a) lower ignition delay (b) lower NOx formation. (c) Uniform or better combustion (d) lower engine noise (e) Easy vaporization (f) better mixing of air and fuel occur due to warm up of inlet air (g) lower CO emission.

**A. Malaisamy** et al. have experimentally investigated that by two types of designing heat exchanger matrix using for air pre heater in two stroke single cylinder air cooled SI engine. Aluminium is selected for the research work because of highly resistant to corrosion attack, lightweight & bright appearance, cost is less compare to copper and steel. Using the matrix two is more applicable because of flow of turbulent occur when air is passed through spiral path. Matrix one is complicated and difficult to weld for the design point of view. Percentage of CO of two stroke single cylinder engine is 5.20,5.51,5.45,7.19 at different load condition(25%,50%,75%,100%).With the use of heating chamber, percentage of CO is 4.84, 5.02, 5.14, 6.80. Similar percentage of HC is reducing with the use of heating chamber. The result of the experiment is to improve the volumetric efficiency because of the reducing the %CO, HC using the air pre heater as compared to normal condition of the engine.

**J. S. Jadhao** et al. have explained the Review on Exhaust Gas Heat Recovery for I.C Engine. In this paper will be represented that the large amount of hot flue gases is generated from IC engine. If same of this waste heat could be recovered, a considerable amount of primary fuel could be saved. So heat recovery system will be beneficial to the large engines comparatively to smaller engines. The heat recovery from exhaust gas and conversion in to mechanical power is possible with the help of different cycle like that Rankine, Stirling and Brayton thermodynamic cycles, vapour absorption cycle. These cycles are proved for low temperature heat conversion in to the useful power. Waste heat can be utilized for the heating purpose like space heating, Preheating intake air and fuel, dryer etc. It is helpful for increases in thermal efficiency and reduction in emission level.

**D. Tamilvendhan**, have performed that the Performance and Emission and Combustion Investigation on Hot Air by using the pre –heater in single cylinder, air cooled, vertical and direct injection diesel engine. The inlet side of the engine consists of anti-pulsating drum, air heater and air temperature measuring device. The amount of preheat required for the intake air is depends upon the load condition of the engine. Basically the engine requires more preheat when the starting condition and the idling condition and at lower loads but it requires less preheat when higher loads and peak loads are requires. The result from this paper is below when increasing temperature. 1. The brake thermal efficiency increases with increase in intake temperature, reaches a maximum condition and thereafter decreases considerably at all loads. 2. Reduces ignition delay and advances the occurrence of peak pressure. 3. Volumetric efficiency decreasing. 4. Decreases air density.

## III. SETUP WORKING

### 3.1 Waste Heat Analysis:

The I.C engine is a device which converts the chemical energy of fuel into heat and again heat energy in to mechanical work. It is the fact that the total heat supplied to the engine in the form of fuel approximately only 30-40% get converted in to useful mechanical work and remaining almost 70% of the energy released from fuel due to combustion is lost mainly in the form of Heat. Approximately 25-30% of the total energy generated by the engine is dissipated in the form of Exhaust loss energy. If some amount of this waste heat could be recovered it possible to reduce the primary fuel required. If exhaust gases of engines are directly released into atmosphere it will not only waste heat but also causes the environmental problems, so there is requirement to utilize the waste heat for useful work to increase the efficiency of the engine.

**3.1.1 Benefits of Waste Heat Recovery from I.C Engine.**

Benefits of waste heat recovery from engines can be broadly classified in two categories:

**I) Direct Benefits:** Recovery of waste heat has a direct effect on the combustion process efficiency. This is reflected by reduction in the utility consumption and process cost.

**II) Indirect Benefits:**

a) Reduction in pollution: A number of toxic combustible wastes such as carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NOx), and particulate matter (PM) etc., releasing to atmosphere. Recovering of heat reduces the environmental pollution levels.

b) Reduction in equipment sizes: Waste heat recovery reduces the fuel consumption, which leads to reduction in the flue gas produced. This results in reduction in equipment sizes.

c) Reduction in auxiliary energy consumption: Reduction in equipment sizes gives additional benefits in the form of reduction in auxiliary energy consumption. 3.1.2 Effect of Low Temperature Intake Air

1. An inadequate final compression temperature occurs.
2. Increase in emission delay.
3. Time from the entry of the fuel into the combustion chamber until the ignition of the same becomes too long.
4. Local over-enrichment.
5. Incomplete combustion and high pressure gradients occur as a result of abrupt mixture conversion in the cylinder.

Consequences of low temperature intake air:

1. Increase in emission of hydrocarbons in the exhaust gas.
2. Severe loading of the environment.

### 3.2 Experimental Work

The engine we are going to use in this experimental work is a two stroke, Single Cylinder, air cooled Petrol Engine. We are going to install air preheater before the carburettor. The preheating of inlet air to the engine can be achieved by fixing a heat exchanger in the exhaust pipe. The atmospheric air is sucked through the heat exchanger to the carburettor. The air, which is flowing through the heat exchanger, gets heated by the engine exhaust gas, this reduces the water vapour in the inlet air and the temperature of the air is raised. A typically Air intake heater system for an engine comprises the following: 1. Air preheater is adopted to be positioned in communication with an intake and exhaust gas passage way of an engine. 2. Temperature sensor to provide a temperature at inlet and outlet streams in air preheater. The fresh intake air for combustion is taken from atmosphere through air filter and passed through an air preheater. On the other hand the hot exhaust gases from engine exhaust are passed through the air preheater in counter flow direction. Due to air preheater the heat exchange from engine exhaust to fresh air takes place and air gets heated. This hot air is supplied to the carburettor and exhaust gases are exhausted in atmosphere. The test we are going to conduct at various engine speeds and performance of engine will obtain by measuring the time required specific quantity of fuel taken in the burette. The emissions from the engine we are going to measure using Gas analyzer, like gases HC (ppm), CO (%), $CO_2$ (%) and NOx (ppm) are with this analyzer. The fuel flow rate is measured by volume basis using a burette and stop watch. The fuel from tank is supplied to the engine through a graduated burette using a two-way valve. 3.2.1 Air-Preheater (Heat Exchanger) An air-preheated is nothing but a heat exchanger in which heat is transferred from a hot fluid to air for useful Utilization of energy. Pre-heating the air, save the fuel that would otherwise require to heat the combustion air .In addition fuel is burned more completely and the combustible materials lost is less. While designing an air-preheated the laws, which govern this process, should be well understood and thus should be used in this design, construction, testing and operation of the equipment. Heat exchanger differs from mixing chambers in that they do not allow the two fluids involve mixing.

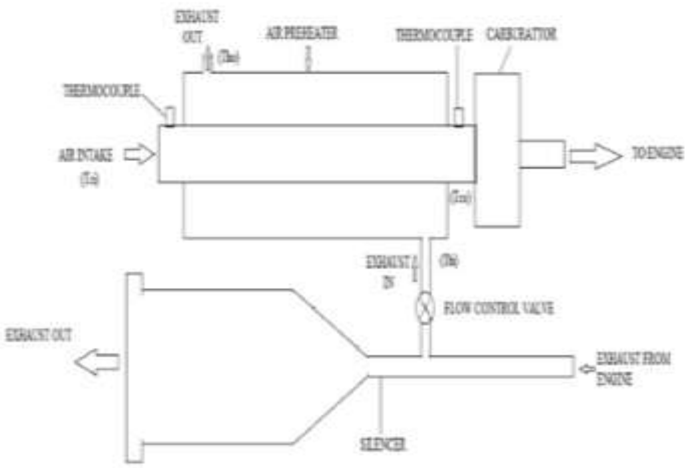
**3.3 Engine specification**

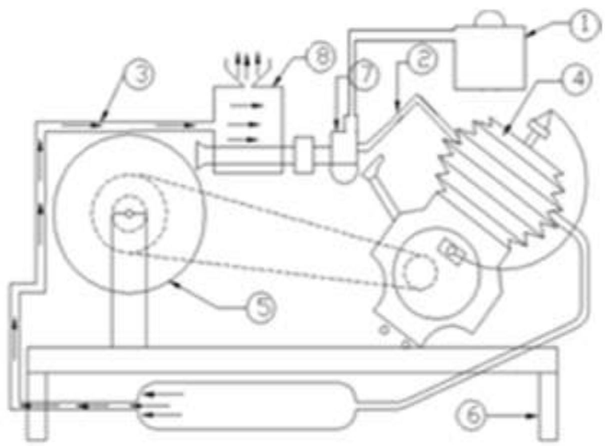
Engine : spark ignition
Type : 2-stroke air cooled engine.
Intake : Inlet port through carburettor.
Stroke : 43 mm.
Bore : 42 mm.
Displacement : 59.57 cc.
Compression ratio: 8.8:1

**Engine Performance**

Maximum power: 3.08 BHP @ 6250 rpm.
Maximum torque: 4.2 N-m @ 4000 rpm.

**3.4 Experimental Setup:**



**3.4.1 Components Used:**

1. Fuel tank
2. Ignition inlet tube
3. Exhaust gas
4. Engine
5. Wheel
6. Stand
7. Carburettor
8. Heating chamber

**3.4.1 Actual Experimental Model**

**3.5 Exhaust Gas Heat Recovery**

Exhaust gas heat recovery setup consist of heat exchanger generally of counter flow type heat exchanger, counter flow type is chosen because heat transfer is high in counter flow type When compared with the parallel flow type. By comparing the property of various metals, aluminium is being chosen for the inside part of the heat exchanger and outside part is being covered with the mild steel.

**3.6 Experimental Procedure**

To Calculate Fuel Efficiency:

1. Check the fuel level.
2. Check the lubrication of oil level.
3. Open the way cock so that fuel flows to engine tank.
4. Start the engine.
5. The first test for its actual fuel consumption (without air pre-heater connection):

Test was being conducted under two conditions one without preheater and the other with the air preheater setup, 50ml of fuel is being used here for the testing. 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.

6. 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 carburettor the hot air from the air preheating setup is being transferred with the help of a plastic pipe in which one end is being attached to the air preheating setup and the other end is being attached to the carburettor thus when the air enters in the carburettor is preheated by exhaust gas heat recovery setup, thus hot air enters into the carburettor 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.

7. Operate the throttle valve so that engine pick up speed to required level say 300rpm.

8. Repeat step 6 for different speeds.

9. Repeat step 1-6 for condition- without exchanger and with exchanger.

10. Emissions from the engine were measured using exhaust gas analyzer at different speeds.

## IV. RESULTS DISCUSSION

### 4.1 Without Air-preheater Setup:

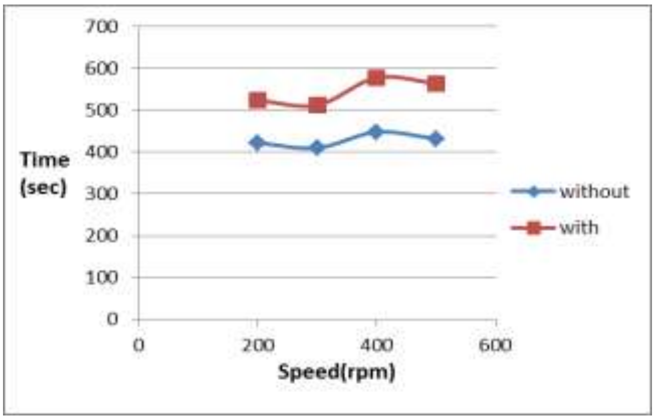
TABLE 1: fuel consumption test (without setup)

| Sr No. | Speed (rpm) | Fuel (ml) | Time (Sec) |
|---|---|---|---|
| 1 | 200 | 50 | 422 |
| 2 | 300 | 50 | 410 |
| 3 | 400 | 50 | 448 |
| 4 | 500 | 50 | 432 |

### 4.2 With Air-preheater Setup:

TABLE 2: fuel consumption test (with setup)

| Sr No. | Speed (rpm) | Fuel (ml) | Time (Sec) |
|---|---|---|---|
| 1 | 200 | 50 | 524 |
| 2 | 300 | 50 | 512 |
| 3 | 400 | 50 | 578 |
| 4 | 500 | 50 | 564 |




Graph : Speed Vs time

### 4.3 To Calculate % Of Emission Gases From Exhaust:

1. Start the engine.

2. Start the exhaust gas analyser unit

3. Note down the % of exhaust gases says CO2, HC, and CO. 4. Repeat step 1-3 for condition- without exchanger and with exchanger.

### 4.3.1 Result and Observation of Emission test:

**Observation of Emission test without Air preheating:**

Table 3: Emission test without Air preheating

| Sr.No. | Speed (RPM) | CO (%) | HC (ppm) | $CO_2$ (%) | AFR (air-fuel ratio) |
|---|---|---|---|---|---|
| 1 | 200 | 4.3 | 3100 | 9.8 | 13.378 |
| 2 | 300 | 4.12 | 3083 | 9.37 | 13.234 |
| 3 | 400 | 4.056 | 3048 | 9.12 | 14.678 |
| 4 | 500 | 4.43 | 3072 | 9.26 | 14.864 |

**Observation of Emission test with Air preheating:**

Table 4: Emission test with Air preheating

| Sr.No. | Speed (RPM) | CO (%) | HC (ppm) | $CO_2$ (%) | AFR (air-fuel ratio) |
|---|---|---|---|---|---|
| 1 | 200 | 3.2 | 3080 | 9.6 | 13.732 |
| 2 | 300 | 3.11 | 3050 | 9.28 | 13.986 |
| 3 | 400 | 2.832 | 2910 | 8.23 | 14.43 |
| 4 | 500 | 3.029 | 2960 | 8.87 | 14.62 |

## V. CONCLUSION

We have done this project with great effort with 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. This setup is made by considering various aspect mainly cost thus it becomes cost effective. Future work can be done the heat exchanger by making it more compact by reducing its size same efficiency can be obtained by increasing the fins inside the air preheater setup improving the heat transfer.

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