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EXPERIMENTAL INVESTIGATIONS ON PERFORMANCE IMPROVEMENT OF AN I.C ENGINE USING WASTE HEAT RECOVERY TECHNIQUE

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Abstract

This experimental work focuses on the performance improvement of an I.C engine by using the waste heat, which is recovered from exhaust gases of the I.C engine. Because a lot of heat energy is dissipated to the surrounding as waste from the exhaust gas. Now a day we need to utilize a large amount of fuel and electricity to produce heat energy. In this reflection, it is plan to utilize the waste heat to heat the fuel and air mixture before entering into the engine cylinder as preheat for complete burning of fuel, this will increase the efficiency of the I.C engine. This can be achieving by using an economizer preheating technique. This method of preheating is low cost also no need to modify engine specifications. It will increase the brake power efficiency of the IC engine.

Keywords: I.C Engine, performance, improvement, waste heat recovery, economizer, air pre-heater.

1. Introduction

In recent years, the scientific and public awareness on environmental and energy issues has brought in major interests to the research of advanced technologies particularly in highly efficient internal combustion engines [1]. Commonly used fuels such as petrol and diesel have definite energy values and the extent of energy retrieval is limited due to the operating principle of the I.C engine [2]. Most of the heat energy released from the fuel of an internal combustion engine is wasted to the environment. This is a serious issue in this world of depleting fuels [3]. In internal combustion engine, Most of the energy is not converted into mechanical energy and remaining energy is released into atmosphere as a waste exhausts. Therefore, waste heat recovery helps in reducing the fuel consumption and emissions [4]. 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 [5]. Usually exhaust gases pass Internal Combustion engine an extensive heat away. To recover the waste heat, varieties of methods are being adopted [6]. Many heat recovery technologies reduce the operating costs are already well developed and technically proven; however, there are numerous applications where heat is not recovered due to market and technical constraints [7]. A number of irreversible processes in the engine limit its capability to achieve a highly balanced efficiency [8]. Waste heat recovery is one of the solutions for increasing energy demand. The growth of the country, both economical and social, depends on the amount of energy consumed and available [9]. The waste heat available from the engine exhaust has potential to recover and utilize the thermal energy available. In the era of global warming, it is mandatory to concentrate on the waste heat recovery [10]. Preheating the air to the engine causes complete combustion of the fuel and hence increases the efficiency of the engine [11]. The recovery and utilization of waste heat not only conserves fuel, usually fossil fuel but also reduces the amount of waste heat and greenhouse gases damped to environment [12]. Measuring the exhaust gas temperature from automotive exhaust system is useful to understand the engine processes. The exhaust gases coming out from engine are at very high speed and at high temperature [13]. An attempt has been made in this research work to use preheating of exhaust gas is giving to

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input of ignition in Two/Four Stroke engine to increase the efficiency [14]. Main requirements of waste heat recovery are an accessible source of waste heat, a waste heat recovery technology and use for the recovered energy [15]. In this project paper, we modified the air intake into the cylinder in single cylinder, two stroke air-cooled engine to increase the fuel Efficiency [16].

The attempt has been made in this research to use preheating of exhaust gas is given to input of ignition in Two/Four stroke engine to increase the efficiency [17]. This work deals with the experimental evaluation of a IC engine with the preheating technique. The results obtained from the experimental valuation proves that it is one of the possible methods to recover the waste heat from internal combustion engine in order to increase performance and lower the emissions of the internal combustion engine [18]. There are various losses associated with internal combustion engines that tend to reduce its efficiency and performance [19]. Many researchers recognize that Waste Heat Recovery from engine exhaust has the potential to decrease fuel consumption without increasing emissions, and recent technological advancements [20]. In this present experimental work, a two-wheeler engine was taken to improve its performance by using waste heat recovery technique.

2. Experimental plans

2.1 Details of the test engine

In this experimental work, a single cylinder, petrol engine was used to establish and compare its performance with and without preheater. The technical specification of the test engine is given in table.1.

Table 1. Technical specifications of test engine

Engine type	Engine cooling	No. of cylinder	Bore (mm)	Stroke (mm)	Capacity (CC)	Transmission type	Gear box type	Fuel delivery system
Spark Ignition	Air cooled	One	51	48	99.70	Chain drive	Manual	Carburetor

2.2 Air preheater design

The complete three-dimensional model of the heat exchanger was created by using solid works software and the air preheater model is shown in figure.1. The steel plate has a diameter of 100x65mm and 95x95mm. The steel plate have a thickness of 5mm steel pipe have a diameter of 50mm and length 25mm the

copper tube has a diameter of 6mm respectively. A hole is provided in the heat exchanger box at its right side for incoming atmospheric air and another hole is provided at back of the heat exchanger pipe for passing to the filter.

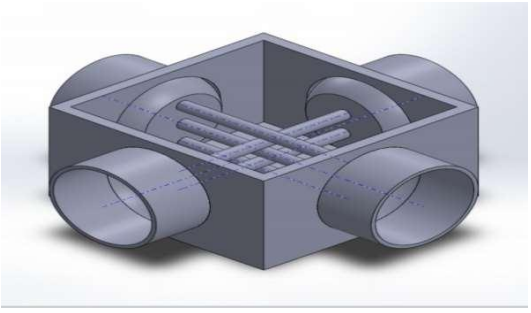

Figure 1. Three dimensional model of air preheater

2.3 Performance measures of the test engine

The main aim of preheating air in two-wheeler is to increase the efficiency of the engine. This is achieved by fixing heat exchanger setup, in which the exhaust gas is main source to heat the atmospheric air before entering into filter. Here some amount of flue gas from silencer enters to the heat exchange pipe (steel pipe) which is connected to air pre heater where the copper tube is placed. The complete experimental setup

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is shown in figure.2. The copper tube gets heated here because of flue gas, when the atmospheric air flows through this pre heater it get heated to some amount and this heated air flows through the filter. The hot air from the filter enters to the carburetor. The speed of the flame increases with an increase of intake temperature of air. Due to higher initial temperature, it gives homogenous air vapor mixture that tends to increase the flame speed. It also reduce ignition lag of combustion. Due to this, the efficiency of the engine is improved and the thermal efficiency is increased. The vehicle modified will run without any complication.

Figure 2. Experimental setup

3. Results and discussions

An experimental study has been accomplished on an unmodified two-wheeler (TVS Sport) engine to establish its performance by using the recovered waste heat from its exhaust gases. The following results were drawn from the experimental results, for comparison purpose the test engine was first run without preheater arrangement. Variation on time taken for 50 ml fuel consumption of the test engine with and without air preheater was illustrated in figure.3.

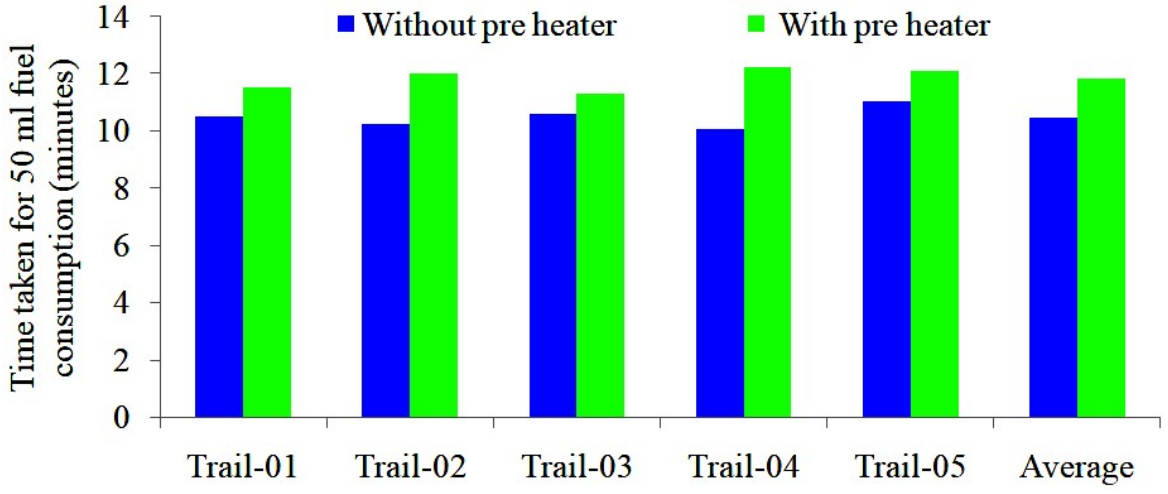

Figure 3. Variation on time taken for 50 ml fuel consumption of the test engine with and without air preheater

The test engine was initially run without the preheater arrangement and the fuel consumption time for 0.050 liter Petrol was noted down under the complete running condition of the engine. In order to enhance the output results of the experimental studies, the test engine was allowed to run with and without preheater arrangement multiple times.

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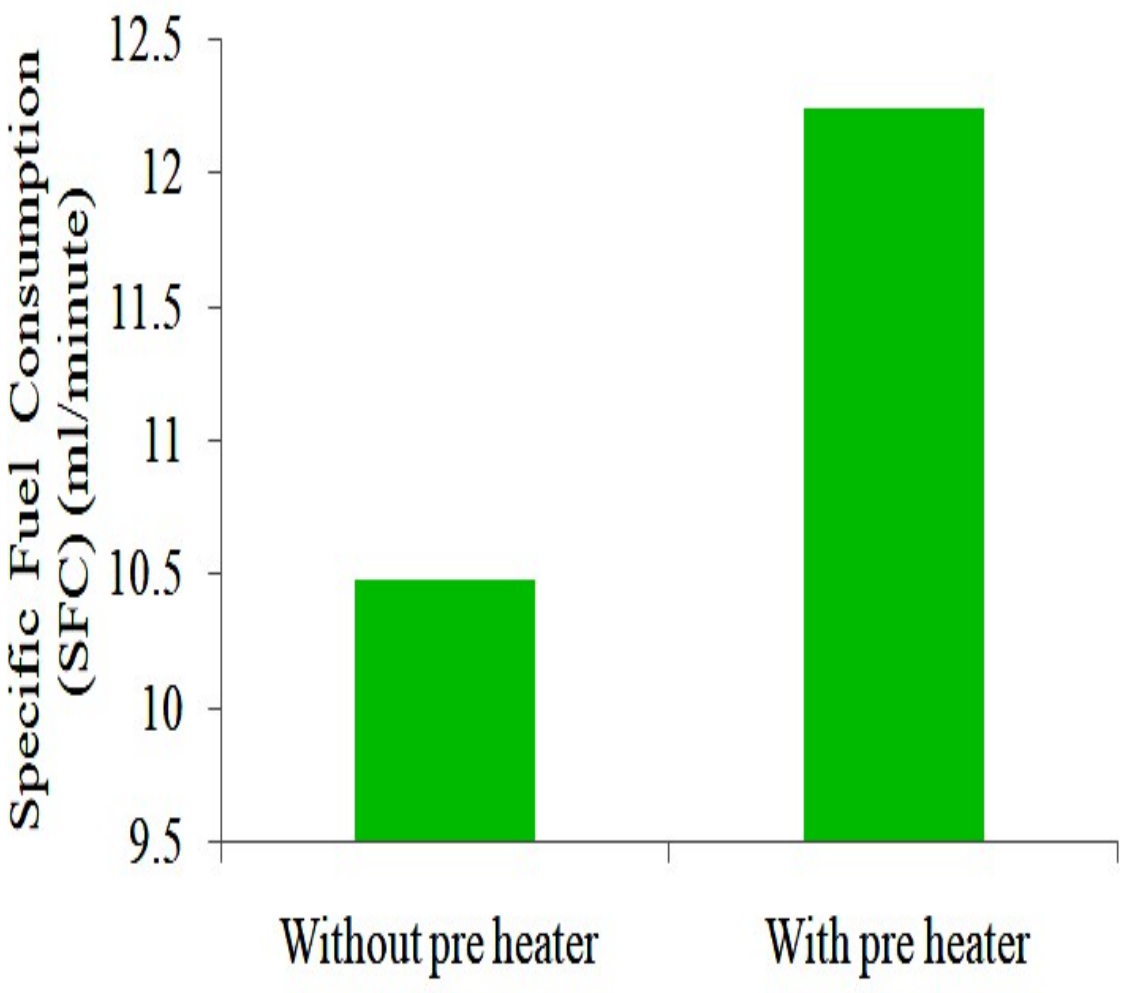

Figure 4. Variation on specific fuel consumption of the test engine with and without air preheater for 50ml petrol

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The time taken by the test engine to consume the 0.050 liter Petrol without preheater arrangement under the constant speed and load for trail-01, trail-02, trail-03, trail-04, trail-05 and average of all trails were observed in the range of 10.52, 10.23, 10.59, 10.08, 11.02 and
10.48 minutes respectively. Similarly, the consumption of the 0.050 liter Petrol by the test engine with preheater arrangement under the constant speed and load for trail-01, trail-02, trail-03, trail-04, trail-05 and average of all trails were noticed in the range of 11.54, 12.03,
11.31, 12.23, 12.12 and 12.24 minutes correspondingly.

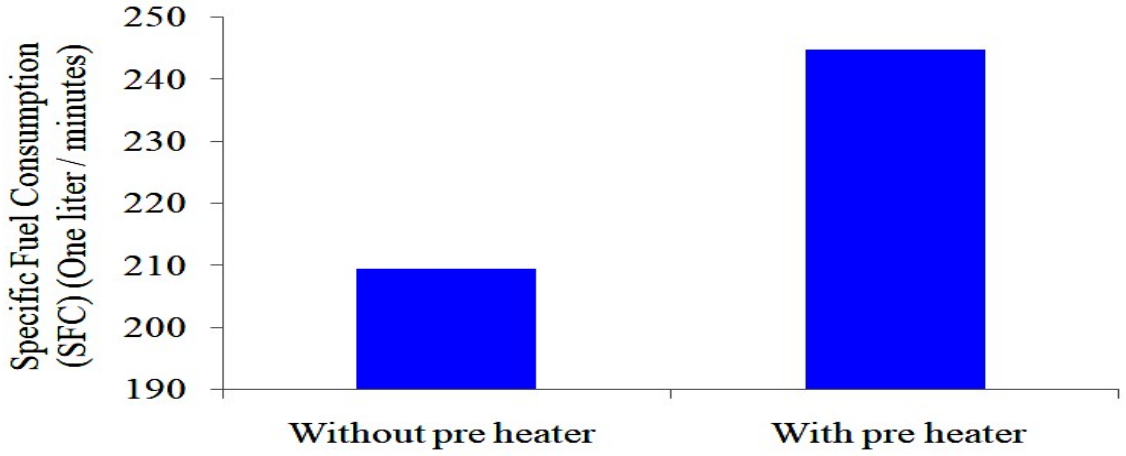

Figure 5. Variation on specific fuel consumption of the test engine with and without air preheater for One-liter petrol

From the figure.3, it was found that the time taken to consume the 0.050-liter Petrol by the test engine is significantly increased when the test engine was operated with preheater arrangement. The variation on specific fuel consumption of the test engine that is operated with and without preheater arrangement for 0.050 liter Petrol is shown in figure.4.

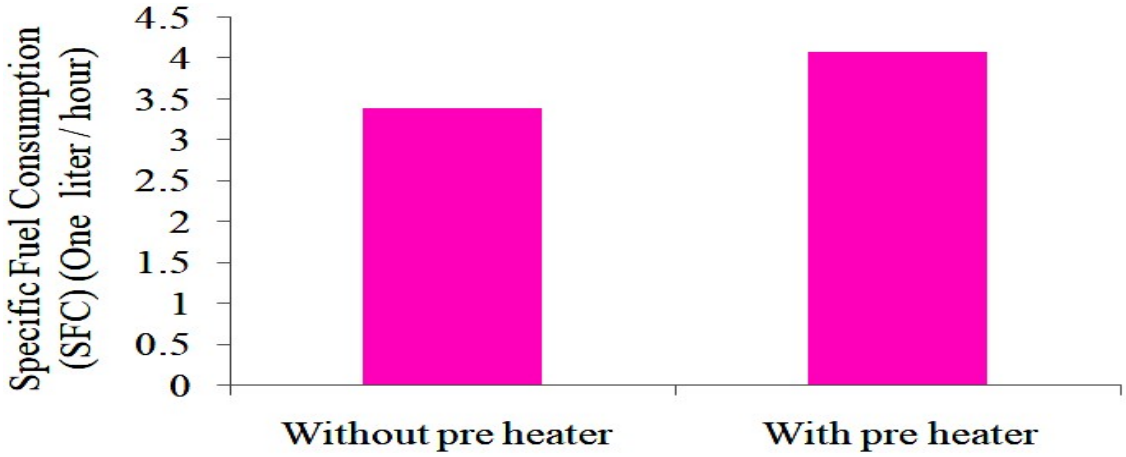

Figure 6. Variation on specific fuel consumption of the test engine with and without air preheater for One-liter petrol/hour

The average specific fuel consumption of 10.48 and 12.24 were obtained from the test engine, which is operated with and without preheater arrangement respectively. The variation on specific fuel consumption of the test engine that is operated with and without preheater arrangement for 1.0 liter Petrol per minute is shown in figure.5. The average specific fuel consumption of 209.6 and 244.8 were obtained from the test engine, which is operated with and without preheater arrangement respectively. The average specific fuel consumption of 10.48 and 12.24 were obtained from the test engine, which is operated with and without preheater arrangement respectively. The variation on specific fuel consumption of the test engine that is operated with and without preheater arrangement for 1.0 liter Petrol per hour is shown in figure.6. The average specific fuel consumption of 3.40 and 4.08 were obtained from the test engine, which is operated with and without preheater arrangement respectively.

Table 2. Economical based comparison of the test engine with and without preheater

Description	Unit	Without preheater	With preheater
Distance travel / day	km	20	20
Distance travel / month	km	600	600
Distance travel / liter	kmpl	60	66
No. of liters / month	Liters	10	9.23
Cost of 1 liter Petrol	Rs	70	70
Cost of 10 liter Petrol	Rs	700	646
Savings per month = 700 - 646 = Rs.54/-			

From the figure.3 to figure.6, it was found that the enhanced specific fuel consumption was achieved when the test engine is operated with preheater arrangement. An economical based comparison also made by using the theoretical calculations of the test engine that is operated with and without preheat assembly was given in table.2 respectively. In this comparison, it was observed that the test vehicle would save the fuel cost of Rs.54/- per month.

4. Conclusions

In this study, we consider the efficiency drop as vital problem in the IC engine and make some investigation, finally we focusing on the waste heat from exhaust gas to increase efficiency. By adopting the waste heat recovery system technique, we intended to heat the atmospheric air by using the waste heat from exhaust gas (known as Pre-heat) before entering into the carburetor. Therefore, the air fuel mixture's temperature also increased before entering into the engine. For this purpose, we introduce the economizer for pre-heating purpose. Due to pre-heat, the delay period may decrease and we may acquire the complete combustion. An experimental result shows that, the Specific Fuel Consumption (SFC) is decrease by preheating the air. In the consideration waste heat recovery system. This experiment is the simple example. There is lot of heat energies are wasted from manufacturing, production n, processing, heat treatment, textile industry etc. we need to try to utilize the heat energies for the variable purpose and make the environment green and pollution less.

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