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DESIGN OF ADVANCED AIR PRE-HEATING IN TWO WHEELERS

Avinash Jare[1]; Manoj Shete; Gaurav Madake; Walunj Pramod
Dept. Of Mechanical Engg.;
S.C.S.M.C.O.E., Ahmednagar.
avinashjarepatil@gmail.com

Prof. Aditya B. Kale
Dept. Of Mechanical Engg.;
S.C.S.M.C.O.E., Ahmednagar.
Adityakale26@Gmail.Com

Abstract—The increasingly worldwide problem regarding rapid economy development and a relative shortage of energy, the internal combustion engine exhaust waste heat and environmental pollution has been more emphasized heavily recently. Out of the total heat supplied to the engine in the form of fuel, approximately, 30 to 40% is converted into useful mechanical work; the remaining heat is expelled to the environment through exhaust gases and engine cooling systems, resulting in to entropy rise and serious environmental pollution, so it is required to utilized waste heat into useful work. The recovery and utilization of waste heat not only conserves fuel (fossil fuel) but also reduces the amount of waste heat and greenhouse gases damped to environment. The study shows the availability and possibility of waste heat from internal combustion engine, also describe loss of exhaust gas energy of an internal combustion engine. Possible methods to recover the waste heat from internal combustion engine and performance and emissions of the internal combustion engine. Waste heat recovery system is the best way to recover waste heat and saving the fuel.

Keywords - Efficiency, Emission, Waste heat from I. C. Engine, Waste heat recovery system for I. C. Engine

[1]. INTRODUCTION

Recent trend about the best ways of using the deployable sources of energy in to useful work in order to reduce the rate of consumption of fossil fuel as well as pollution. Out of all the available sources, the internal combustion engines are the major consumer of fossil fuel around the globe. Out of the total heat supplied to the engine in the form of fuel, approximately, 30 to 40% is converted into useful mechanical work. The remaining heat is expelled to the environment through exhaust gases and engine cooling systems, resulting in to entropy rise and serious environmental pollution, so it is required to utilized waste heat into useful work. 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. It is imperative that serious and concrete effort should be launched for conserving this energy through exhaust heat recovery techniques. Such a waste heat recovery would ultimately reduce the overall energy requirement and also the impact on global warming. The Internal Combustion Engine has been a primary power source for automobiles and automotives over the past century. Presently, high fuel costs and concerns about foreign oil dependence have resulted in increasingly complex engine designs to decrease fuel consumption. For example, engine manufacturers have implemented techniques such as enhanced fuel-air mixing, turbo-charging, and variable valve timing in order to increase thermal efficiency. However, around 60-70% of the fuel energy is still lost as waste heat through the coolant or the exhaust. Moreover, increasingly stringent emissions regulations are causing engine manufacturers to limit combustion temperatures and pressures lowering potential efficiency gains [1]. As the most widely used source of primary power for machinery critical to the transportation, construction and agricultural sectors, engine has consumed more than 60% of fossil oil. On the other hand, legislation of exhaust emission levels has focused on carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NOx), and particulate matter (PM). Energy conservation on engine is one of best ways to deal with these problems since it can improve the energy utilization efficiency of engine and reduces emissions [2]. 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]. This paper gives a comprehensive review of the waste heat from internal combustion engine, waste heat recovery system and methods of waste heat recovery system.

PERFECT COMBUSTION:

FUEL (hydrocarbons) and AIR (oxygen and nitrogen) which gives CARBON DIOXIDE, water and unaffected nitrogen.

$C_3H_8 + 5O_2 + 3CO_2 + 4H_2O$.

TYPICAL ENGINE COMBUSTION:

FUEL (hydrocarbons) and AIR(oxygen and nitrogen) which gives UNBURNED HYDROCARBONS, NITROGEN OXIDES, CARBON MONOXIDE, CARBON DIOXIDE and H_2O.

$C_3H_8 + 2O_2 + 3C + 4H_2O + C + H_2O$

FUEL PREHEATER —- EXPANSION CHAMBER:

Fuel preheater is a general term which describe any device designed to heat the fuel mixture before another process with some sources, in this experimental setup hot flue gas from engine is used as source of preheating the fuel. While expansion chamber is the chamber where the expansion of fuel takes place with the help of pre-heater.

The pre-heating of inlet ait to the engine can be achieved by fixing a heat exchanger inside the exhaust pipe. Fuel is sucked through the heat exchanger to carburetor. The fuel mixture from air injector is flowing through heat exchanger gets heated by engine exhaust gas. This reduces the water vapour in the inlet air and the temperature of the fuel mixture is raised. The temperature raise causes maximum combustion in the engine and it is also more suitable for warming up the engine in cold condition and also increase the thermal efficiency of the engine.

[2]. AIR-PREHEATER

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 required 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.

TYPES OF AIR PRE-HEATER (HEAT EXCHANGER)

The Air pre-heater are mainly divided in to two groups according to their working features a) Recuperative pre-heaters b) Regenerative pre-heaters. It is proposed to apply the items "Recuperative "to the heat transferring method (continuous flow) and Regenerative to the heat charging and discharging (periodic flow) method.

RECUPERATIVE

The two fluids performing the exchangers of heat in exchanger can flow (a) with each order in the same direction (parallel flow) or in opposite directions (counter flow) or (b) at right angles to one another (cross flow) with both types of flow, a single or a multi-pass arrangement is possible.

REGENERATIVE

The regeneration type H.E consists of heat conducting member, which is exposed alternatively to the hot exhaust gases and the cooler air or any other fluids. The heat capacity member is made of a metallic mesh or matrix, which is rotated slowly and continuously exposed to hot and cold medium. Some of the commonly employed heat exchanger types are discussed below:

> Double pipe heat exchanger
> Double pipe extended surface exchangers
> Shell and tube heat exchangers
> Counter flows exchanger

[3]. METHODOLOGY

(A). DESIGN

1. MATERIAL SELECTION

To prepare any machine part, the type of material should be properly selected, considering design, safety .The selection of material for engineering application is given by the following factors:-
1) Availability of materials
2) Suitability of the material for the required components.
3) Cost of the materials.

The machine is basically made up of mild steel. The reasons for the selection are Mild steel is readily available in market .It is economical to use and is available in standard sizes. It has good mechanical properties i.e. it is easily machinable. It has moderate factor of safety, because factor of safety results in unnecessary wastage of material and heavy selection. Low factor of safety results in unnecessary risk of failure. It has high tensile strength. Low coefficient of thermal expansion. The materials of the sheets to be cut are taken as aluminium and plastic as they are replacing many metals in the present scenario because of their distinguished properties and features.

2. SILENCER

The exhaust manifold mounted on the cylinder head of an engine collects a gas exhausted from an engine, and sends it to a silencer which consists of catalyst converter. The exhaust manifold plays an important role in the performance of an engine system. Particularly, the efficiencies of emission and fuel consumption are closely related to the exhaust manifold. The exhaust manifold is under a thermal fatigue produced by increasing and decreasing temperature, which leads to a crack of the exhaust manifold.

Fig.1 Silencer (TVS CT100)

3. FINS

The cooling mechanism of the air cooled engine is mostly dependent on the fin design of the cylinder head and block. Cooling fins are used to increase the heat transfer rate of specified surface. Engine life and effectiveness can be improved with effective cooling Most internal combustion engines are fluid cooled using either air (a gaseous fluid) or a liquid coolant run through a heat exchanger (radiator) cooled by air. In air cooling system, heat is carried away by the air flowing over and around the cylinder. Here fins are cast on the cylinder head and cylinder barrel which provide additional conductive and radiating surface. Air cooled system is generally used in small engines say up to 15-20 kW and in aero plane engines. In this system fins or extended surfaces are provided on the cylinder walls, cylinder head, etc. The amount of heat dissipated to air depends upon
1. Amount of air flowing through the fins.
2. Fin surface area.
3. Thermal conductivity of metal used for fins.

Similarly as engine fin we now introducing the fin on silencer to achieve same effect as that of air cooled engine. By providing the fin on silencer we increases the area of silencer. Hence we get maximum rate of heat transfer from this fin surface hence fresh air heat more due to increased

area of fin. Copper galvanized plates are used to increase thermal conductivity of fin material.

Fig.2 Fins on silencer

4. HEAT EXCHANGER

Heat exchangers are devices used to transfer heat energy from one fluid to another. Typical heat exchangers experienced by us in our daily lives include condensers and evaporators used in air conditioning units and refrigerators. Boilers and condensers in thermal power plants are examples of large industrial heat exchangers. There are heat exchangers in our automobiles in the form of radiators and oil coolers. Heat exchangers are also abundant in chemical and process industries. Heat exchangers are devices used to transfer heat energy from one fluid to another. Typical heat exchangers experienced by us in our daily lives include condensers and evaporators used in air conditioning units and refrigerators. Boilers and condensers in thermal power plants are examples of large industrial heat exchangers. There are heat exchangers in our automobiles in the form of radiators and oil coolers. Heat exchangers are also abundant in chemical and process industries. There is a wide variety of heat exchangers for diverse kinds of uses, hence the construction also would differ widely. However, in spite of the variety, most heat exchangers can be classified into some common types based on some fundamental design concepts. We will consider only the more common types here for discussing some analysis and design methodologies.

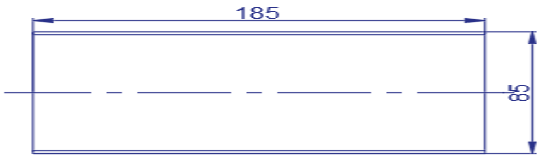

Fig.4 Heat Exchanger Pipe

5. TEMPERATURE INDICATOR (SENSORS)

This is temperature sensing device séances the temperature of air pre-heater at 4 position. This sensor gives idea about decrease in temperature of silencer at pre-heater position and change in temperature of fresh air.

Fig. 5 Temperature Indicator

6. ASSEMBLY OF PROJECT

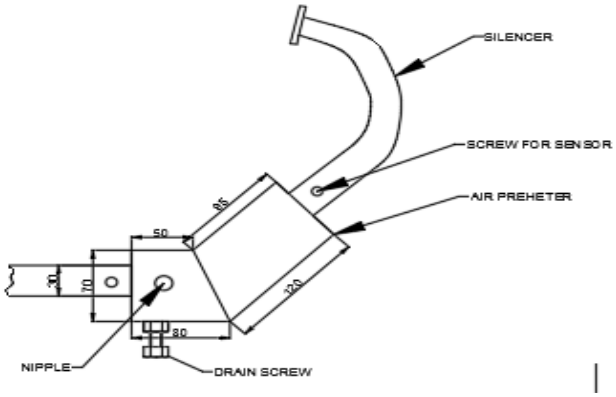

Fig.6 Assembly

Sr. No.	DISCRIPTION	MATERIAL	QUANTITY
1	SILENCER	STD (STEEL)	01
2	HEAT EXCHANGER PIPE.	M.S.	01
3	NIPPLE	BRASS	01
4	DRAIN SCREW	M.S.	01
5	FINS	GALVONISED COPPER	13

(B). CONSTRUCTION

Following figure shows the actual construction of air preheater. The exhaust manifold mounted on the cylinder head of an engine collects a gas exhausted from an engine, and sends it to a silencer which consists of catalyst converter. This exhaust gases heats the silencer. On those silencer fins of galvanized copper is provided. These fins having mounted in such a way that its axis is parallel to axis of silencer. These fins are surrounded by air preheater. Air preheater consist of parallel flow type of heat exchanger made up of pipe in which Silencer of hot flue gases is surrounded by fresh atmospheric air which is enclosed in a pipe having no. of air opening at front side for the entry of fresh air . Drain screw is provided to remove any derbis, dust or impurity collected in air preheater. Air preheater also having nipple which is followed by hoses which supply heated air to the air intake chamber.

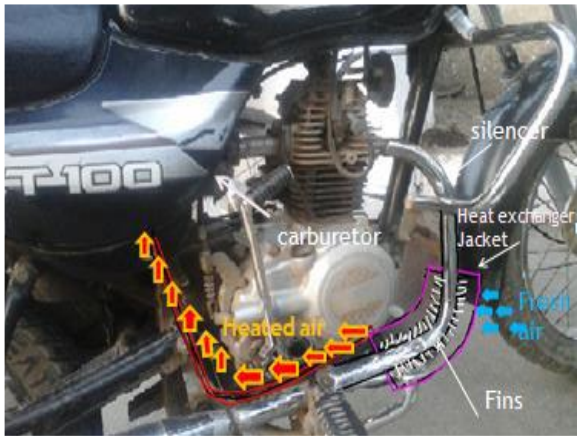

Fig.6 Air Preheater installation on vehicle

(C). WORKING OF AIR PRE-HEATER

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 carburettor. In carburettor 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.

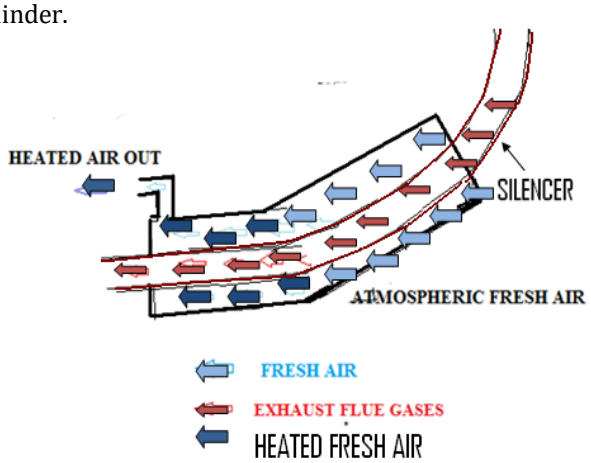

Fig.7 Schematic diagram of air preheater

[4]. ADVANTAGES

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 Temperature Of Exhaust Pipe.
5. Reduction in Hydrocarbon from the engine exhaust.

[5]. LIMITATIONS

1. Air temp should not very large because it lowers the volumetric efficiency or may be chances of problem related to detonation in SI Engine.

[6]. APPLICATIONS

1. Air preheater is used in 2 wheelers for increasing power output.
2. Air preheater is used in 2 wheelers for increasing Efficiency by proper combustion.
3. Air preheater is used in 2 wheelers for decreasing emissions of hydrocarbons from the engine exhaust.

[7]. CONCLUSION

It has been identified that there are large potentials of energy savings through the use of waste heat recovery technologies. Waste heat recovery defines capturing and reusing the waste heat from internal combustion engine for heating, generating mechanical or electrical work and refrigeration system. It would also help to recognize the improvement in performance and emissions of the engine. If these technologies were adopted by the automotive manufacturers then it will be result in efficient engine performance and Low emission. The waste heat recovery from exhaust gas and conversion in to mechanical power is possible with the help of pre-heating the inlet air. For waste heat recovery thermoelectric generator is use low heat, which has low efficiency. It is helpful for the same amount of increases in thermal efficiency and reduction in emission.

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