

# A Review Paper on Design and Fabrication of Air Preheater for SI Engine

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**Abstract:** To satisfy the increasing fuel demand is a challenge for Engineer. Enhancing the engine performance is very important regarding to satisfy fuel demand and pollution control. In existing engine at cold season and rainy season carburetion process gets affected due to low temperature of air. Many researches done to increase the evaporation rate of fuel by use of some heat exchanger chamber named as air pre heater. In our research we introduce air pre heater chamber at front side of on silencer which having fin to increase heat transfer rate from exhaust gas of silencer to fresh atmospheric air. Such an arrangement increases evaporation rate of petrol and results in proper combustion in engine which can be identified by increasing brake thermal efficiency of engine and reduction in emission content of engine.

**Keywords:** air preheating, heat exchanger, vaporization, SI engine, efficiency.

## I. INTRODUCTION

On going pattern about the most ideal methods for utilizing the deployable wellsprings of vitality in to valuable work so as to diminish the rate of utilization of petroleum product just as contamination. Out of all the accessible sources, the interior ignition motors are the significant buyer of petroleum derivative around the world. Out of the absolute warmth provided to the motor as fuel, roughly, 30 to 40% is changed over into valuable mechanical work. The rest of the warmth is removed to the earth through fumes gases and motor cooling frameworks, bringing about to entropy rise and genuine natural contamination, so it is required to use waste warmth into helpful work. The recuperation and usage of waste warmth rations fuel, typically petroleum derivative yet in addition decreases the measure of waste warmth and ozone harming substances damped to condition. It is basic that genuine and solid exertion ought to be propelled for saving this vitality through fumes heat recuperation strategies.

Such a waste warmth recuperation would at last decrease the general vitality prerequisite and furthermore the effect on an Earth-wide temperature boost. The Internal Combustion Engine has been an essential power hotspot for cars and car over the previous century. By and by, high fuel expenses and worries about outside oil reliance have brought about progressively complex motor plans to diminish fuel utilization. For instance, motor producers have executed strategies, for example, improved fuel-air blending, turbo-charging, and variable valve timing so as to build warm proficiency. Be that as it may, around 60-70% of the fuel vitality is as yet lost as waste warmth through the coolant or the fumes. In addition, progressively stringent emanations guidelines are making motor producers limit burning temperatures and weights bringing down potential effectiveness gains. Given the significance of expanding vitality transformation proficiency for diminishing both the fuel utilization and discharges of motor, researchers and specialists have done heaps of fruitful research meant to improve motor warm productivity, including supercharge, lean blend ignition, and so on. Be that as it may, in all the vitality sparing advances examined. Motor fumes heat recuperation is viewed as a standout amongst the best.

Numerous specialists perceive that Waste Heat Recovery from motor fumes can possibly diminish fuel utilization without expanding discharges, and later mechanical progressions have made these frameworks practical and financially savvy. The improvement in effectiveness of the motors of today might just be one of the initial moves towards further advancements and unrests in the field of vitality the board which may go from viable administration of non-renewable energy sources to the full-time utilization of inexhaustible assets driving us to a cleaner and greener future.

## II. SURVEY

Krishna Perumal et al. [1] consistent with them, primary pollution contributed by using S.I. Engines are CO, NOX and unburned hydrocarbons. Dangerous hydrocarbon smokes from inner combustion(IC) Petrol engine is due to incomplete combustion of gas. For maximum combustion of fuel in engine and to avoid dangerous dangerous gases from exhaust, they recommend a new concept of pre heating a gasoline-oxygen aggregate, before fed into the S.I. Engine. That preheating of gas makes the enlargement in gasoline. This preheating and expansion of gasoline is accomplished in separate expansion chamber by way of exhaust gas from engine. Preheating of fuel is completed at constant pressure which expands the gasoline volume as the ratio of growing in temperature. Hence that makes

the reduction of hydrocarbon and increase the thermal performance of the engine. Fuel preheater is a well-known term which describes any tool designed to warmness the fuel aggregate before every other method with some resources, in this experimental setup hot flue gas from engine is used as source of preheating the gasoline. While enlargement chamber is the chamber wherein the expansion of fuel takes place with the assist of preheater. The preheating of inlet air to the engine can be performed by solving a warmth exchanger within the exhaust pipe. Fuel is sucked through the warmth exchanger to carburetor. The gasoline mixture from air injector is flowing through warmth exchanger receives heated by using engine exhaust gas. This reduces the water vapour inside the inlet air and the temperature of the gasoline combination is raised. The temperature boost reasons most combustion inside the engine and it's also greater appropriate for warming up the engine in bloodless condition and additionally will increase the thermal efficiency of the engine. Since the temperature of the combination is doubled by preheater, extent of the mixture is also doubled because of regular stress process. As the mixture is extended, entire combustion takes region within the engine at some stage in energystroke. Because of complete combustion there may be no unburned hydrocarbon at the same time as exhaust stroke, subsequently the hydrocarbon is completely burned this reduces the presence of hydrocarbon in flue gas.

Rameshbabul et al. [2] tells that, Waste heat is heat, that is generated during a method by means of fuel combustion or chemical change, then "dumped" into the setting albeit it may still be reused for a few helpful and economic purpose. That heat depends in part on the temperature of the waste heat gases and mass flow rate of exhaust gas. Waste heat losses arise each from instrumentation inefficiencies and from thermodynamical limitations on instrumentation and processes. For example, consider internal combustion engine approximately 30 to 40% is converted into useful mechanical work. The remaining heat is expelled to the atmosphere through exhaust gases and engine cooling systems. This exhaust gases are used to heat fresh air in the heating chamber where heat exchanger is used.

Pram Kumar et al. [3] they modified the air intake into the cylinder in a single cylinder, two stroke air cooled engine (two-wheeler TVS-50XL 50 cc bike) to increase the fuel efficiency. At traditional condition, the vehicle which is taken for our project, gives 45 to 50 Km, per liter of petrol. The fuel economy are often achieved up to fifty to sixty five kilometer per cubic decimetre by pre-heating of air to a selected temperature causes a rise of ten kilometer per liter of petrol. The preheating of intake air is achieved by introducing an air pre-heater in the exhaust pipe of the vehicle. The air inlet to the engine is fed through the air pre-heater in counter action for effective heat transfer. So for this kind of system has not been introduced in 2 wheelers, this may be very useful to two wheelers without any complication and maintenance. But the pre-heater style depends on the pipe fitted to the actual two-wheeler. The design is straightforward, cheap and does not give any trouble to the engine.

#### 1) Without Attachment

Distance travel/day = 22 KMS

Distance traveled /month = twenty two X thirty = 660 metric linear unit

Consumption/ liter = 46 km (average)

No. of liters /month =  $660/46 = 14.3$  liters

Cost of 1 liter of petrol = Rs.65

Cost of 15.7 liters of petrol =  $65 \times 14.3 = \text{Rs.}930$

#### 2) With Attachment

Distance travel/day = 22 KMS

Distance traveled /month = twenty two X thirty = 660 metric linear unit

Consumption/ liter = 56 km (approximately...)

No. of liters /month =  $660/56 = 11.7$  liters

Cost of 1 liter of petrol = Rs.65

Cost of 15.7 liters of petrol =  $65 \times 11.7 = \text{Rs.}761$

Saving / month =  $\text{Rs.}930 - 761 = \text{Rs.}169$

From the above calculation it is clear that, by investing an amount of Rs.1500/- for fabricating this system saves Rs.169/- per month for a minimum distance of 22 Km/day. So this technique could also be much helpful and appropriate for 2 wheelers. In addition to that, it needs nil maintenance and will not give any complications; so far, the test vehicle has covered a distance of more than 500 Km with this attachment.

Bhagwan Singh et al. [4] exhaust gas is used to pre-heat the air and charge leading to increased combustion efficiency of the engine. That results in the increase in the mileage by 25 to 30 per cent. The exhaust gas enters the heat exchanger through the nozzle attached to the main exhaust line and supplies the exhaust gases from the same pipe to the heat exchanging chamber. One end of the



modified intake airline is kept between the engine fins so that it gets fresh air easily and the other end of the pipes is connected with the filter. This line is made of copper. The additional chamber is located behind the most chamber is connected with smoke outlet nozzle on the opposite facet. Its purpose is to reduce the noise level. The aluminum covers are provided at both the sides of main chamber and make the device cool from the outside.

In this system<sup>1</sup>, the intake air is passed over the exhaust manifold (silencer), which results pre-heating of the intake air. NIF facilitated its testing at BIT Mesra, Ranchi. The check report mentions that the utilization of the changed silencer and also the system for preheating of intake air will increase the mileage by twenty five to thirty per cent. This technology is still in the process of being refined so that it can be used at a wide scale and needs some adjustments in filter, intake manifold and the timing of fuel supply. NIF also filed a patent (1460/MUM/2009) in his name for the technology.

Pradip G. Karale et al. [5] tells the performance of Diesel engine is depends upon various parameters. Intake air temperature is one of them which play an important role in achieving better efficiency. This paper work is focused of investigation of effect of increasing intake air temperature on performance and emission characteristics of diesel engine. This paper highlights the availability of warmth wheel for preheating intake air by mistreatment waste heat from the engine exhaust gases. The check is administrated on four stroke, single cylinder, water cooled, and diesel engine at various loads. The test results show that the increasing inlet air temperature the fuel consumption decreases. Initially with increase in inlet air temperature emission of CO, HC reduces but NOx formation increases with increase in temperature.

IC Engine set up under test is Kirloskar TV1 having power 5.20 kW @ 1500 rpm which is 1 Cylinder, Four stroke, Constant Speed, Water Cooled, Diesel Engine, with Cylinder Bore 87.50(mm), Stroke Length one hundred ten.00(mm), Connecting Rod length 234.00(mm), Compression Ratio 16.00, Swept volume 661.45 (cc).

Air is drawn from the upstream aspect of associate degree manifold mistreatment associate degree air offer unit. The air and exhaust gases of engine flows in opposite direction. The required piping for inlet and outlet of exhaust gases and fresh air to the heat wheel are made, also thermocouples are connected to pipe for recording required temperature. The air is heated employing a waste heat from exhaust gas by mistreatment heat wheel. In this manner, vaporization of the fuel is enhanced. One feature of this revelation provides associate degree intake air heating equipment having capability of waste heat recovery.

The recovery and utilization of waste heat not only conserves fuel but also reduces waste heat by increasing the efficiency of engine and the greenhouse gases. This study shows the advantages of waste heat recovery, Heat carried away by the exhaust gas, to pre heat the intake air. The results of this experiment shows that the effectiveness of warmth wheel will increase with increase in wheel rate. The outlet temperature of warmth wheel will increase with increase in wheel rate and with increase in engine load. Specific fuel consumption decreases with increase in air temperature. CO at various Engine Load and Heat Wheel RPM shows that CO is decreases as heat wheel RPM increases. CO is increases as load on engine increases.

Dr. R. Sudhakaran et al. [6] they present fuel resources are not going to be around forever and with the ever increasing consumption their extinction is nearly unavoidable. Also, their fuel resources which are mostly made up of fossil fuels are not renewable in nature. Currently round the world the consumption of fossil fuels is a hundred,000 times faster than their natural production. According to an estimate the demand for these fuels will suddenly outstrip their availability in a matter of centuries-or less. Also, the combustion of fossil fuels emits carbon dioxide. This harmful gas once discharged into the atmosphere makes an enormous contribution to the atmospheric phenomenon. This effect prompts the atmosphere to capture and reflect back the energy that radiate from the surface of the earth, instead of letting them to escape back into space. This causes global warming that melts the polar ice caps and affects weather all around the world. This project is discussing about the variability of using H<sub>2</sub> as a fuel along with petroleum. There are many reasons to choose H<sub>2</sub> as a motive power. H<sub>2</sub> has one of the highest gravimetric energy densities of all available fuels, which means it has very high energy content per unit mass (143MJ/kg) four-hundredth quite alternative. Also, we have to preheat the inlet air to get the more efficient for the performance of engine. The preheating of recess air to the engine is achieved by fixing a device within the pipe.

The atmospherical air is sucked through the warmth money dealer to the carburettor. The air which is flowing though the heat exchanger gets heated by the engine exhaust gas. This reduces the vapor within the recess air and therefore the temperature of the air is raised. The temperature raise causes complete combustion in the engine and it is also more suitable for warming up the engine in cold conditions.

R. Vishal et al. [7] tells that, today's IC engines have a maximum efficiency of only around 40%. This is because of a range of losses that occur within the engine within the style of losses through exhaust, incomplete combustion, frictional losses inside the combustion cylinder, poor mixture of air and fuel within the cylinder etc. Out of those factors, incomplete combustion contributes to majority of the warmth loss. Incomplete combustion might occur principally because of production of steam within the engine and

humidness within the atmosphere attributable to that the fuel might not burn utterly. Incomplete combustion not solely reduces engine potency, however conjointly releases harmful gases like CO, CO<sub>2</sub>, NO<sub>2</sub> and SO<sub>2</sub> into the atmosphere that cause devastating environmental development like green-house effect and global warming. This paper suggests a attainable thanks to cut back exhaust losses through the method of preheating that as a result will increase the potency of the IC engine a bit additional.

The atmosphere contains around 4.24% of water vapour. Water vapor not only is the Principle reason for incomplete combustion but also causes the generation of steam inside the combustion cylinder which reduces the overall thermal efficiency of the engine. Steam generation conjointly causes the corrosion of walls of the cylinder that ultimately reduces the sturdiness of the engine. The concept of preheating is the same for both two wheelers and four wheelers although the setup might change slightly.

A device is hooked up at the recess pipe of the IC engine. The heat from the exhaust gases are absorbed and sent back to the inlet by the heat exchanger. As a result, the air getting into the engine is heated and an excellent deal of vapour is far from it that permits the fuel to bear about to complete combustion which further decreases the emission of harmful effluents. Steam formation throughout combustion may be stopped by the removal of vapour.

The experimental results obtained show that there's a rise in mileage and so, the thermal efficiency of the IC engine. Although this increase solely corresponds to around 2-3 nada, it can be increased a little further by using other techniques like variable valve timing, charge exchange work etc. The improvement in potency of the engines of these days might o.k. be one among the primary steps towards additional developments and revolutions within the field of energy management which may go from effective management of fossil fuels to the regular North American countryrage of renewable resources leading us to a cleaner and greener future.

#### A. Research Gap

Here are complicated techniques are performed for increasing the effect of air preheating by using complicated heat exchanger. But no research had done for analyzing the parameter by adding fins in heat exchanger.

### III. WORKING PRINCIPLE

#### A. Construction

Following figure 3.1 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 that silencer fins of galvanized copper are 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 comprises parallel flow form of device created of pipe that|during which|within which} Silencer of hot flue gases is encircled by contemporary atmospherical air which is enclosed in a pipe having no. of air gap at front facet for the entry of contemporary air. Drain screw is provided to remove any debris, dust or impurity collected in air preheater. Air preheater conjointly having mammilla that is followed by hoses that provide heated air to the air intake chamber.



Fig. 3.1 Air Preheater installation on vehicle

#### B. Working of Air Preheater

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.

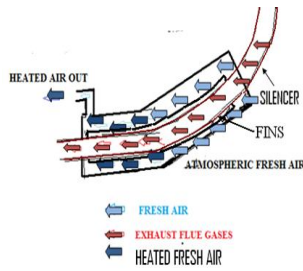


Fig. 3.2 Schematic diagram of air preheater

#### IV. DESIGN CONSIDERATION

##### A. Material Selection

To prepare any machine half, the type of material should be properly selected, considering design, safety. The selection of fabric for engineering application is given by the subsequent factors:-

- 1) Availability of materials
- 2) Suitability of the material for the required components.
- 3) Suitability of the material for the required components.
- 4) Cost of the materials.

The machine is essentially created of low-carbon 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 issue of safety, because factor of safety results in unnecessary wastage of material and heavy selection. Low issue of safety leads to gratuitous risk of failure. It has high tensile strength. Low coefficient of thermal expansion. The materials of the sheets to be cut ar taken as aluminium and plastic as they're commutation several metals within the gift situation owing to their distinguished properties and features.

From the study of various heat exchangers, we come to know that some heat exchanger having complicated shapes. Also there is some complicated techniques are performed for increasing the effect of air preheating by using complicated heat exchanger. But no heat exchanger is available which having fin in heat exchanger. So for get maximum effect from exhaust gas we can use fin on that silencer. Also no heat exchanger is at front of vehicle to take effect of front air.

Space between silencer and engine body is=25mm

Radius of silencer+ Spacing=15+25=40mm

Our Air preheater pipe radius must be less than above value for proper installation shell of heat exchanger.

So available standard size of pipe is of radius=35 mm

Hence our air preheater shell diameter=70mm

Total length of air preheater is 180 mm for getting maximum area of heat exchanger.

If this length is greater than 180mm then again there is space limitation of due to restriction offered by engine body.

By increasing length on upper side of silencer then there is no use of increasing such a length of air preheater.

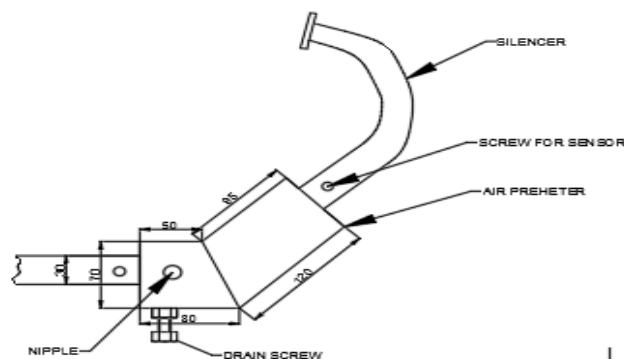


Fig. 4.1 Assembly of project



## V. ADVANTEGES AND APPLICATIONS

### A. Advantages

- 1) Maximum combustion
- 2) Increase in thermal efficiency
- 3) Reduce of hydrocarbons
- 4) Elimination of moisture
- 5) Maximum utilization of fuel.
- 6) Exhaust gas heat from the engine that was normally wasted was successfully utilized by using an air preheater.
- 7) CO emission was found to increase with increase in vapour fraction but it was successfully reduced by preheating of air.

### B. Disadvantages

- 1) Air temp should not very large because there may be chances of problem related to detonation in SI Engine.

### C. Applications

- 1) They are used in SI Engine.
- 2) They are used in heavy vehicle such as coaches, trucks, buses.
- 3) It is widely used in automotive industry.

## VI. CONCLUSION

In this way we have seen the work related to enhancing engine efficiency by method of preheating the air by various research papers. We come to know that there is some research gap related to this study. So we are now taken 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.

## VII. FUTURE SCOPE

Our project Air Preheater Technology in SI Engine has lot of scope in future some are as follows:-

- 1) In future we add turbo charging to this air preheating system in which we introduce propeller fan in front of heat exchanger chamber which draws air at high pressure and cause more increase in power
- 2) In this research we can also measure the effect of volumetric efficiency in the temperature of air by preheating arrangement.

### A. Abbreviations

- 1) CO - Carbon Monoxide
- 2) NO<sub>x</sub> -Nitrogen Oxides
- 3) H<sub>2</sub> - Hydrogen Dioxide
- 4) SO<sub>2</sub> - Sulphur Dioxide
- 5) HC - Hydrocarbon
- 6) PM - Particulate Matter
- 7) TES - Thermal Energy Storage
- 8) BSFC- Brake Specific Fuel Consumption
- 9) HCCI- Homogeneous Charge Compression Ignition
- 10) BP- Brake Power
- 11) APH- Air Preheater
- 12) UBHC- Unburned Hydrocarbons
- 13) Ts- Hot Surface Temperature
- 14) Tf- Fluid Temperature
- 15) IC - Internal Combustion
- 16) WOT - Wide-Open Throttle



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