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DESIGN AND DEVELOPMENT OF ECO-FRIENDLY ALCOHOL ENGINE FITTED WITH WASTE HEAT RECOVERY SYSTEM

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Abstract :- The present paper discusses the design and development of an eco-friendly alcohol engine fitted with the waste heat recovery system as a remedial alternative to the existing commonly used internal combustion engine. With the present trends in Internal combustion engines, many improvements have been made. But still, the environmental pollution aspects have not been dealt with due care. Eco-friendly alcohol engine with waste heat recovery system, which I have invented, could provide a means to put an end to environmental pollution through internal combustion engines. Besides this, it could also provide better efficiency and it could independently work on alcohol also. The present day Internal combustion engines have poor over all efficiency, mainly due to the various heat losses they encounter in the form of exhaust gases, cooling water etc. So by reducing losses the present engines significantly increase the performance as well thermal efficiency. The new project idea behind my engine is to the reuse of the heat carried by the exhaust gases to the extent of 30% and to possibly nullify the heat rejected to the cooling water losses to the extent of 30%. In order to achieve this, I have developed a new principle design and cycle of operation. The most interesting thing about this innovation is that – no exhaust gases are let out to pollute the atmosphere.

Objectives:

1. To bring about a new design principle in Internal combustion engine
2. The engine ensures the use of a renewable fuel.
3. To increase the mechanical efficiency of an internal combustion engines
4. To nullify the air pollution caused by the exhaust gases of the internal combustion engines

Heat balance sheet of the existing petrol engines , diesel engines and my proposed engines : Legend: ( ) – Actual - Theoretical

% heat energy	Diesel engine	Petrol engine	My engine (Proposed)
Chemical energy input	100%	100%	100%
Heat to power at brakes	33.33% (17%)	40% (23%)	Greater than 70%
Heat rejected to cooling water	33.33% (40%)	20%(23%)	> 10%
Heat carried by exhaust gases	33.33% (>40%)	10% (<27%)	<18%
Heat unaccounted	<1% (>5%)	1% (>5%)	1-2%

1 Introduction

With the present trends in Internal combustion engines, many improvements have been made. But still, the environmental pollution aspects have not been dealt with due care. Eco-friendly alcohol engine with waste heat recovery system, which I have invented, could provide a means to put an end to environmental pollution through internal combustion engines. Besides this, it could also provide better efficiency and it could independently work on alcohol also. The technical aspects of the newly invented engine are discussed in the following lines.

2 Problem Formulation

With the present trends in Internal combustion engines, many improvements have been made. But still, the environmental pollution aspects have not been dealt with due care. The present day Internal combustion engines have poor over all efficiency, mainly due to the various heat losses they encounter in the form of exhaust gases, cooling water etc. So by reducing losses the present engines significantly increase the performance as well thermal efficiency.

3 Problem Solution

Eco-friendly alcohol engine with waste heat recovery system, which I have invented, could provide a means to put an end to environmental pollution through internal combustion engines. Besides this, it could also provide better efficiency and it could independently work on alcohol also.

3.1 Working of eco-friendly engine on Dr.G.Vijayan Iyer's Cycle

1. During the initial engine operation, the gasoline – air mixture enters the combustion chamber as the piston head had already moved from the top dead center(T.D.C) to the bottom dead center (B.D.C).
2. The fresh mixture is later compressed by the piston movement from the B.D.C. to the T.D.C.
3. The spark plug ignites the mixture and the piston is pushed down by the burning mixture to B.D.C., now the fresh Gasoline – air mixture is allowed to enter the combustion chamber through the IV1 (inlet valve 1) . (The combustion chamber (CC) already has the exhaust in it.). After this the mixture is again compressed, alcohol is sprayed in and now the mixture is ignited as usual , but during expansion the piston would now move further down to B.D.C. due to an increase in volume of the exhaust gases.
4. When the piston moves to B.D.C. the Exhaust opening (EO) get opened , simultaneously IV1 (inlet valve 1) gets opened and the exhaust gases are forced out to the exhaust jacket through the exhaust opening (EO). (mainly due to the pressure that gets built in the combustion chamber.
5. The cycle gets repeated. (Gasoline fuel need not be used in the subsequent cycles, once the eco-friendly engine get started.

3.2 Exhaust gases

1. The exhaust gases reach the exhaust jackets that surround the main cylinder.
2. The exhaust jacket maintains the exhaust gases inside it till a sufficient pressure is reached by the exhaust gases to lift the exhaust valve which leads to the exhaust circuit.

3.3 Alcohol Chamber

1. The alcohol chamber surrounds the exhaust jacket. This is of special interest because it acts both as a coolant to the cylinder and as an auxiliary fuel tank.
2. The alcohol gets heated by the heat in the exhaust jacket and once its temperature and pressure raises it lifts the alcohol valve, which leads the hot, high pressure alcohol vapors to the alcohol fuel feeding system.
3. The alcohol level is maintained inside the alcohol chamber, by supplying alcohol to the chamber periodically from the main storage tank.

3.4 Exhaust Circuit

The exhaust gases enter a tank filled with $Ca(OH)_2$ solution. The tank also has an inbuilt alcohol chamber. The carbon dioxide in the exhaust gas reacts with $Ca(OH)_2$ and form calcium carbonate. Calcium carbonate is insoluble in water and hence it gets precipitated . The particulate impurities in the exhaust also settle down in water.

The precipitate impurities in the exhaust also settle down in water. The precipitates are collected and stored. Periodically the CaO salt is added in the $Ca(OH)_2$ solution to maintain its strength.

The chemical equations notes:

1. $CaO + H_2O \longrightarrow Ca(OH)_2 + \text{Heat (exothermic reactions)}$
   Reaction 1 along with the heat left in the exhaust gases, helps to heat the alcohol in the in-built alcohol chamber
2. $Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O$

Some of the sulphate salts are also formed. They remain in the solution in the tank. The water used for the solution in the tank needs periodically replaced, say during servicing.

3.5 Cooling Water

The cooling water surrounding the alcohol chamber is very important because it prevents the alcohol from becoming fumingly hot and it also prevents the occurrence of turbulence in the alcohol chamber.

The cooling water regulates the temperature in the alcohol chamber and it is connected to a thermostat. The thermostat may be bellow or aneroid type thermostat. The thermostat regulates the cooling water flow into the cooling water chamber.

3.6 Thermostat

The thermostat is placed between the engine cylinder and the radiator. It consists of a hollow bellow, which will have a volatile fluid like benzene. Initially during the start up of the engine the cooling water from the chamber is not allowed to circulate through the thermostat, this is because the water will not be sufficiently hot to make the volatile liquid inside the bellows to expand. Only if the bellow expands, a valve connected to it will open and lead the cooling water to the radiator, which will cool the hot cooling water by forced convention and again circulate it to the cooling water chamber. When the engine starts up and gets warmed up, the cooling water gets heated up, from the heat of the alcohol chamber, and this causes the bellows to expands, and the normal process get started.

4 Conclusion

1. Eco-friendly Engine works on Dr.Vijayan Iyer's cycle. As against the present diesel and otto cycles of internal com bustion engines.
2. It has been found that no exhaust gases are let out to the atmosphere and also the engine heat losses in the form of exhaust gases and coolants are greatly reduced. Hence the engine has got the potential of highest thermal efficiency to the extent of 62 % as against 30% in the case of conventional internal combustion engines.
3. Highest mechanical efficiency of 71% as against the 40% form convention internal combustion engines.
4. There are no air pollution problems from the eco-friendly engines.
5. Heat Losses to the cooling water are nullified.
6. Heat Losses to the exhaust gases are nullified.
7. Low knocking and detonation problems.
8. Better power output that is up to the extent of 70%
9. Better combustion efficiently of 97% , since no incomplete combustion products as against very low combustion efficiency of 49% in convention internal combustion engines.
10. Brake thermal efficiency is 70%
11. Fuel efficiency is 98%
12. Degree of success of the engine is Very good.
13. Performance characters of the eco-friendly engine at full load power and partload efficiency is very good.
14. Minimal Brake specific fuel consumption to the extent of 10% as against the 40% bsfc for convention internal combustion engines.
15. There is zero maintenance required as the eco-friendly engine is smoother in operation.
16. There is less than 3% frictional power dissipated from the engine.

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References:

[1] Mathur and Sharma *Internal combustion engineering*, pp 23-54

[2] Heywood, *Internal combustion engineering*, pp . 2-390
[3] Kirpal Singh , *Automobile engineering* , pp 50-78