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WASTE HEAT RECOVERY TECHNIQUE TO INCREASE EFFICIENCY AND TO DECREASE HAZARDOUS EMISSIONS IN C.I ENGINE

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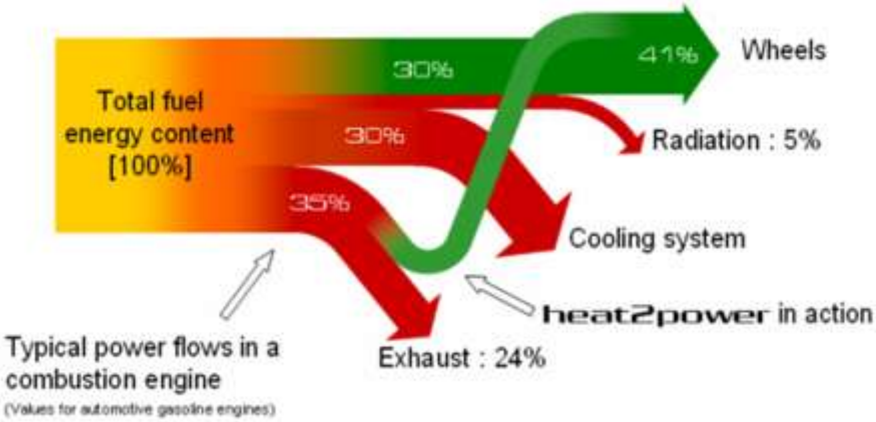
ABSTRACT
Waste heat is heat, which is generated in a process by way of fuel combustion or chemical reaction, and then "dumped" into the environment even though it could still be reused for some useful and economic purpose. The essential quality of heat is not the amount but rather its "value". The strategy of how to recover this heat depends in part on the temperature of the waste heat gases and the economics involved.
Large quantity of hot flue gases is generated from C.I. If some of this waste heat could be recovered, a considerable amount of primary fuel could be saved. The energy lost in waste gases cannot be fully recovered. However, much of the heat could be recovered and loss minimized by adopting following measures as outlined in this project

Keywords: Internal Combustion Engine, Heat Exchanger, Flue Gases, Waste Heat.

I. INTRODUCTION

Energy is an underlying driver of economic growth and social development. Human consumption of energy in the form of fossil fuels, primarily in developed countries, is altering the Earth's climate and has been a matter of great concern. While evidence suggests a need for both demand reduction through energy efficient engine and less harmful emissions. Internal combustion engine convert about 25% to 35% of the chemical energy contained in the fuel into the mechanical energy. About 35% of the heat generated is lost to the cooling medium and the remaining heat is dissipated through the exhaust gases and other radiation losses. During the process of combustion the cylinder gas temperature reaches quite a higher value.



II. LITERATURE REVIEW

Mr. JanakRathavi et.al [1] -

This technical paper shows the experimental results for significant reduction of engine fuel consumption and hazardous emissions could be attained by recovering of exhaust heat by using self made heat exchanger. One of the most important issues is to develop an efficient heat exchanger which provides optimal recovery of heat from exhaust gases.

Akira Numata et.al [2]

With a view to reduction in NOx emission and increase of the thermal efficiency of DI diesel engines, this study was started with research on a combustion system with high compression ratio and high fuel-injection pressure in order to determine the basic characteristics

J. S. Jadhao et.al [3]

Author investigated effect of preheating intake air on Nox emission on diesel engine. They have design waste heat recovery for preheating intake air, and fabricated and its effect has been tested on diesel combustion and exhaust emissions. Result shows that NOx emission is reduced with the new air preheating waste heat recovery setup.

M. Dubey, A. Arora, H. Chandra et.al et.al [4]

The researcher concluded that the overall efficiency of an engine can be improved when waste heat energy is tapped and converted into usable energy. The study shows the loss of exhaust gas energy and also describes the availability and possibility of waste heat from internal combustion engine. The best way to recover the waste heat and saving the fuel is waste heat recovery system.

D. G. Thombare et.al [5]

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.

III. LITERATURE GAP

From the previous research works (1-5) it is noticed that early injection, late injection and port fuel injection systems like Air assisted port injection with DI system (PCCI-DI) were used. It is well known that EGR is a useful way to vary the cylinder gas temperature and the ignition timing could be delayed. In addition to that high levels of EGR and reduced compression ratio were demonstrated for simultaneous and substantial reduction of NOx and smoke emissions. In the above detailed methods the mixture was partially homogeneous. Hence the present system was developed to prepare a homogeneous mixture.

The present work deals with the study of performance, combustion and emission characteristics of diesel vapours combustion process in a DI diesel engine with mixture formation in heat exchanger- accumulator mechanism. In this investigation a stationary four stroke, single cylinder, direct injection diesel engine was modified to operate in dual mode- without diesel vapour mixture and with diesel vapour mixture formation of fuel. A heat exchanger-accumulator mechanism was used to vaporize the diesel fuel and catalytic cracking. It was mounted in the intake system to prepare the homogenous diesel vapour-air mixture. The experiments were conducted with diesel vapours induction with different injection timings. Experimental results obtained are compared with the base line readings. The results show that through this approach simultaneous and substantial reduction of NOx, fuel consumption and smoke emission can be achieved. Also it increases the efficiency of the engine.

IV. PROBLEM DEFINITION

While recent improvements in diesel engine design and calibration have greatly reduced both NOx and smoke emissions, there are still many alternatives being researched to improve the engine-out emission further. In recent years, a lot of attention has been focused on air pollution caused by automotive engines. Diesel engines have been particularly targeted for their production of oxides of nitrogen (NOx) and smoke emissions. NOx is formed at high rates when temperatures are high, whereas smoke is formed in fuel rich regions within the combustion chamber . Hence, it is essential to keep the peak cylinder temperature low in order to minimize NOx emission and also to allow for better fuel–air mixing thereby, reducing the smoke emission. Homogeneous charge compression ignition (HCCI) is a combustion concept that constitutes a valid approach to achieve high efficiencies and low nitrogen oxides and particulate emissions in comparison with traditional

V. OBJECTIVE

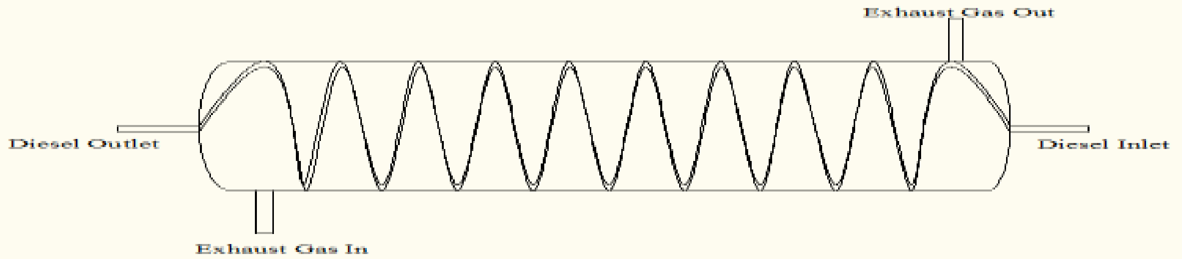
- To study the working principle of the Heat Exchanger and different affecting parameters associated with it through different literature study.
- To study the effective and condition for the use of shell and tube heat exchanger.
- To design the Heat Exchanger as working medium.
- Obtained performance results with used of different conditions and compare it.

VI. PRESENT WORK

6.1 Fundamental Working Principles:

Experiments were conducted on a modified single-cylinder, water-cooled, direct injection diesel engine developing 5.2 kW at 1500 rpm. Test rig is provided with necessary equipment and instruments for combustion pressure and crank angle measurements with accuracy. The schematic diagram of the experimental set-up is shown in Figure 1 and Table 1 shows the test rig specifications.

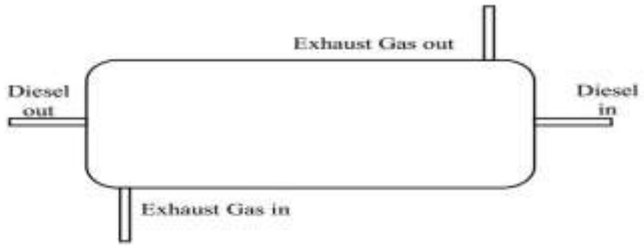
Exhaust emission from the engine was measured with the help of gas analyzer, was used to measure the NOx (ppm), CO2 (%) and UBHC (ppm) emissions in the exhaust. Smoke intensity was measured with the help of a Smoke meter. Fig. 2 shows the schematic of diesel fuel vaporizing heat exchanger.



6.2Specification of shell

Sr. No.	Particular	Dimension in mm
1	Diameter of M/S Shell	215.9
2	Length of M/S Shell	420
`3	Thickness of M/S Shell	2
4	Diameter of the copper pipe used	8

liquid-gas accumulator is totally covered by the exhaust gases flow and inside the accumulator using catalysts. This is low temperature activating and material of the accumulator is copper which also acting as a catalysts. Both the end of accumulator have one way flapper check valve. One end is connected to the pre-chamber and another end is connected to the heat exchanger. The accumulator has 20mm inner shell diameter and 50mm of outer shell diameter. The accumulator was mounted in the intake manifold system to supply the diesel fuel in vapor form in the intake manifold and it was mixed with the air.



6.3 Experimental Setup

The compact and simple engine test rig consisting of a four stroke Single cylinder, Air cooled, constant speed diesel engine coupled to an alternator by flexible coupling. The engine is started by hand cranking using the handle by employing the decompression lever. The engine is loaded using electrical load. The loading arrangement consists of a set of switches on the panel board. A voltmeter and an ammeter are used to record the load on the alternator.

STOPPING THE ENGINE:

1. Cut off the fuel supply by keeping the fuel governor lever in the other extreme position. (For Diesel Engine)

1. I = Brake power× Alternator Efficiency / (3Vcosφ) ½

$$I = \frac{0.451798*0.8}{0.3614386} = 0.99 \textbf{ Kw}$$

SPECIMEN CALCULATIONS:

1. Total fuel consumption = X/ (Time × specific gravity of fuel) ×3600/1000

Where,

X – Quantity of fuel consumed in cc

Specific gravity of fuel = 0.85 gm/cc

$$= \frac{50 * 3600}{194.4 * 0.85 * 1000} = \mathbf{1.089\ kg/hr}$$

2. Brake power= (3Vcosφ)½ / Alternator Efficiency (Where Cosφ =Power Factor)

$$= \frac{0.3614386}{0.8}$$

Brake power= 0.45179823Kw

3. Specific fuel consumption =TFC/BP

$$= \frac{65.45}{0.4517} = \mathbf{144.89\ kg/kW\text{-}hr}$$

From the graph between brake power and total fuel consumption, the frictional power is found by extrapolation method.

4. Frictional Power = 0.1773 kW

5. Indicated Power = Brake Power + Frictional Power

= 0.45179 +0.1773

Indicated Power = 0.62909 kW

6. Mechanical Efficiency = Brake Power/Indicated Power×100%

$$= \frac{0.4579}{0.62909} * 100\%$$

Mechanical Efficiency = 72.78 %

6.2 Observations

Specific gravity of Diesel = 0.83 g/cc

Calorific value = 42,000 kJ/kg

Alternator Efficiency – 0.80 % (Assumed)

Temperatures:-

Thermocouple No	Positions
T1	Diesel Inlet
T2	Diesel Outlet/Diesel inlet to Engine
T3	Exhaust Gas Inlet to Air Tank
T4	Exhaust gas out from Air tank
T5	Air inlet to Air Tank
T6	Air Outlet from Air tank/ Inlet to Engine

Thermocouple no.	^{0}C
T1	44
T2	46
T3	131
T4	60
T5	37
T6	39

Generator Load (Kw)	Voltmeter reading (V)	Ammeter reading (amp)	Engine speed in (Rpm)	Time in min. to Fuel Consumption in CC 50ml
80	240	0.3	1500	3.24
200	240	0.4	1500	3
500	240	1.7	1500	2.75
700	240	2.7	1500	2.38
880	240	3.0	1500	2

VII. CONCLUSION

The large amount waste heat is through exhaust which has high temperature is utilized to vaporizing the diesel fuel and mixed with intake air thus mixture getting homogeneity. This homogenous charge in compression ignition engine increases the combustion response and reducing the physical delay period so getting increment in combustion pressure develops more power.

The heat which is considered as waste heat come from the exhaust gases can be utilized by vaporization of diesel. This evaporated fuel mix with the intake air and burns completely. It reduces the delay period which causes increase in combustion pressure and develops more power. Due to the proper mixing, the charge burns completely and there is no un-burnt hydro carbon present in exhaust thereby reducing the emissions. Specific heat of fuel increases due to vaporizing and b.s.f.c is decreases significantly.

exhaust gases that can be used to obtain less fuel consumption and increasing thermal efficiency at decrease load condition

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