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Experimental Investigation on Heat Recovery from Diesel Engine Exhaust Using Shell and Horizontal tube Heat Exchanger

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ABSTRACT: The aim of this work is to utilize the heat energy wasted in exhaust gas of an internal combustion engine of low capacity for desalination using a submerged horizontal tube heat exchanger, without the aid of any external energy used for pumping system. In this work a horizontal tube heat exchanger and fabricated. Experimental were conducted in 5hp Diesel engine to analyse the performance submerged horizontal tube heat exchanger under various load condition. A shell and tube heat exchanger is used to extract heat from exhaust gas using oil as a working fluid.

I. INTRODUCTION

The modern world relies very much on Diesel Engines in so many ways like power generation, transportation, water pumping etc. Especially for transportation and power generation it plays a vital role. In the developing countries the main source of power generation based on Diesel Engines and Coal based power plants. Even though the cost of producing electricity using Diesel engine is higher than any other source, for hospitals, hotels it is used as an emergency source of power.

II. EXPERIMENTAL

The thermal energy of the exhaust flue gas is utilized directly for desalination by using a Submerged Horizontal tube straight pass heat exchanger in the exhaust line, to avoid the energy loss by using two or three heat exchangers.

III. RESULT

The aim of this work is to utilize the heat energy wasted in the exhausted gas of IC engine for desalination. A horizontal tube straight pass heat exchanger is used to absorb the heat energy from IC engine.

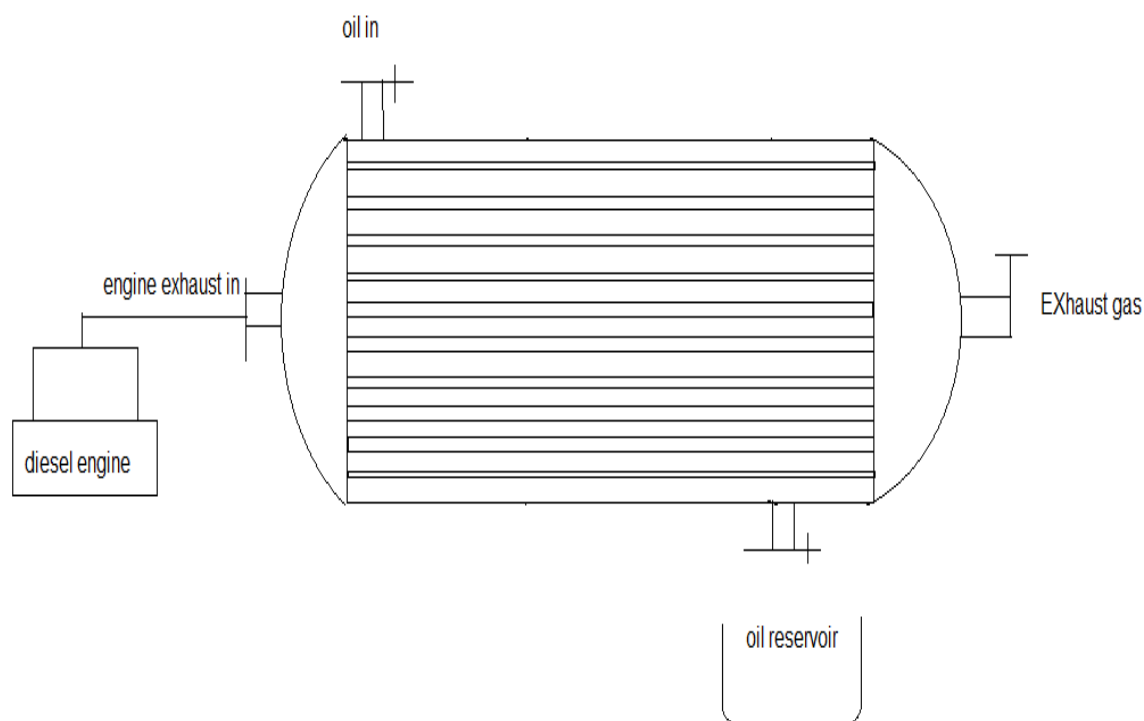
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IV. PROJECT LAYOUT



V. CLASSIFICATION

Heat exchanger are typically classified according to **FLOW ARRANGEMENT**,

- ❖ Parallel flow arrangement
- ❖ Counter flow arrangement

Classified according to **Type of construction**,

- ❖ Double pipe heat exchanger
- ❖ Shell and tube heat exchanger
- ❖ Plate heat exchanger

Heat exchanger specification.

Shell type
Shell material

E type
Mild steel

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Shell outer diameter	323 mm
Shell thickness	6mm
Tube type	Finned tube
Tube material	Copper
Fin material	Copper
Type of fin	longitudinal fin
Fin thickness	2 mm
Fin height	6 mm
Tube outer diameter	12.5 mm
Tube thickness	1.65 mm
Length of shell	500 mm
No of tubes inside the shell	36
Type of tube layout	Round layout
Type of tube arrangement	In line arrangement
Transverse pitch	37.5 mm
Longitudinal pitch	37.5 mm
Thermal conductivity of copper	388 W/m K

Parts of the heat exchanger is designed and made using CATIA. The major parts of heat exchanger are:

1. Tube
2. Shell
3. Front endhead
4. Rear end head
5. TubePlate

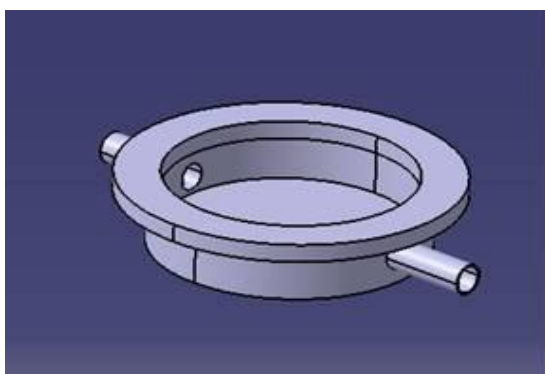


Fig. 2: Front End Head

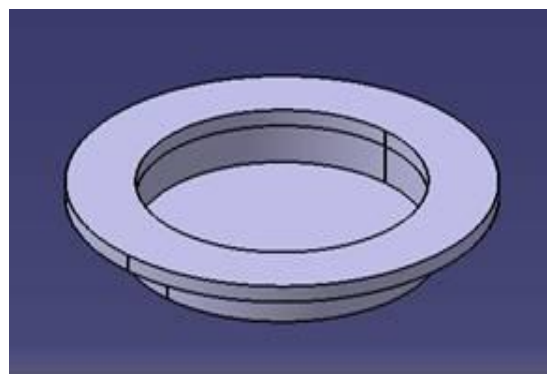


Fig. 3: Rear End Head

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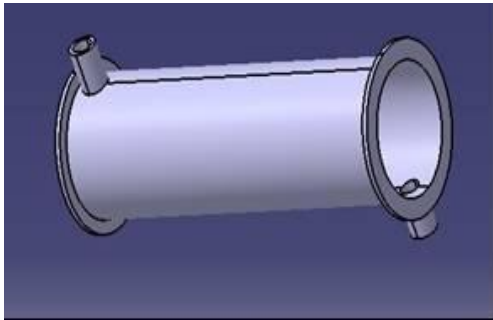


Fig 4: shell

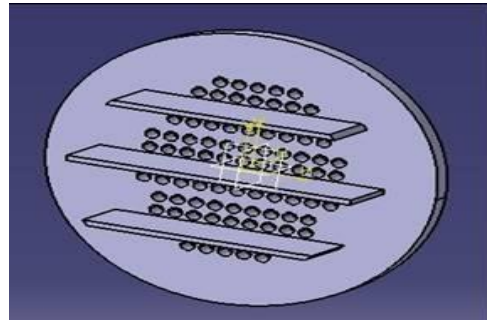


Fig 5:Tube plate

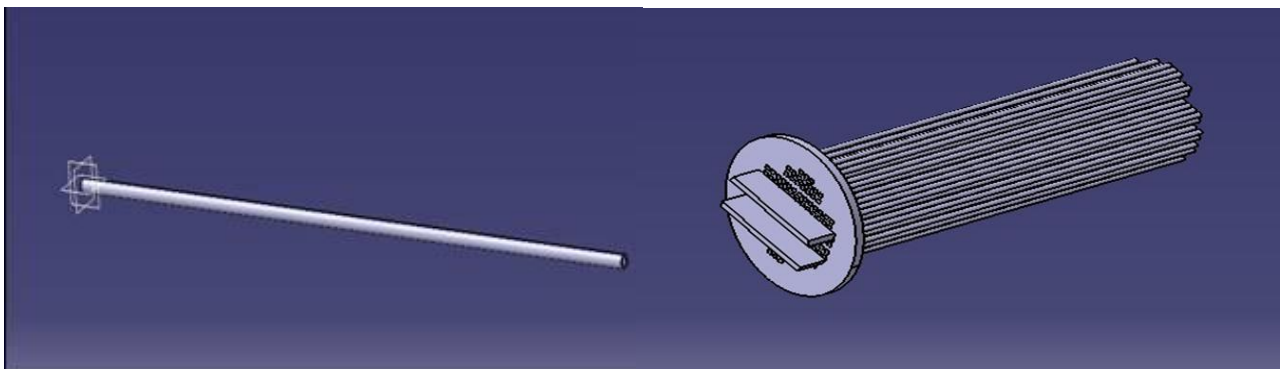


Fig6:Tube

Fig7: Tubes Assembled in TubePlate



Fig8: Fully Assembled Heat Exchanger

VI. METHODOLOGY

- The heat energy released to the exhaust gas in engines of various cubic capacities is analyzed.
- Engine suitable for this system is selected.
- The amount of heat in exhaust gas is calculated.
- Suitable heat exchanger type is selected.

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- Numerical designing of heat exchanger is done.
- The different parts of the heat exchanger are modeled using CATIA.

ENGINE SELECTION

Field analysis and literature study on different engines of various cubic capacity from 150cc to 1500cc were conducted. We studied the temperature of exhaust gas from these engines and found that the temperature is too low for low capacity engines.

IC in engines of higher capacities. Also, the mass flow rate of the exhaust is higher in large engines. Finally we selected 1573cc diesel engine.

Engine specification:

- Enginetype : inline 4cylinder
- Bore : 75mm
- Stroke : 89mm
- Displacement : 1573cc
- Compression ratio : 18
- Ratedpower : 80bhp@4000rpm

We also checked the exhaust gas temperature from the engine when it is working under various rpm, i.e. from 1000rpm to 4000 rpm. Here we also found that the temperature is high when the engine speed is 4000 rpm.

<i>ITEM</i>	<i>CONTENT</i>			
<i>Engine Speed(rpm)</i>	<i>1000</i>	<i>2000</i>	<i>3000</i>	<i>4000</i>
<i>Engine Power (kW)</i>	<i>14.9</i>	<i>50.2</i>	<i>70.8</i>	<i>84.8</i>
<i>Exhaust temperature(K)</i>	<i>801.5</i>	<i>862.4</i>	<i>890.8</i>	<i>900.5</i>
<i>Exhaust mass flow rate(g/s)</i>	<i>18.7</i>	<i>59.6</i>	<i>83.3</i>	<i>108</i>

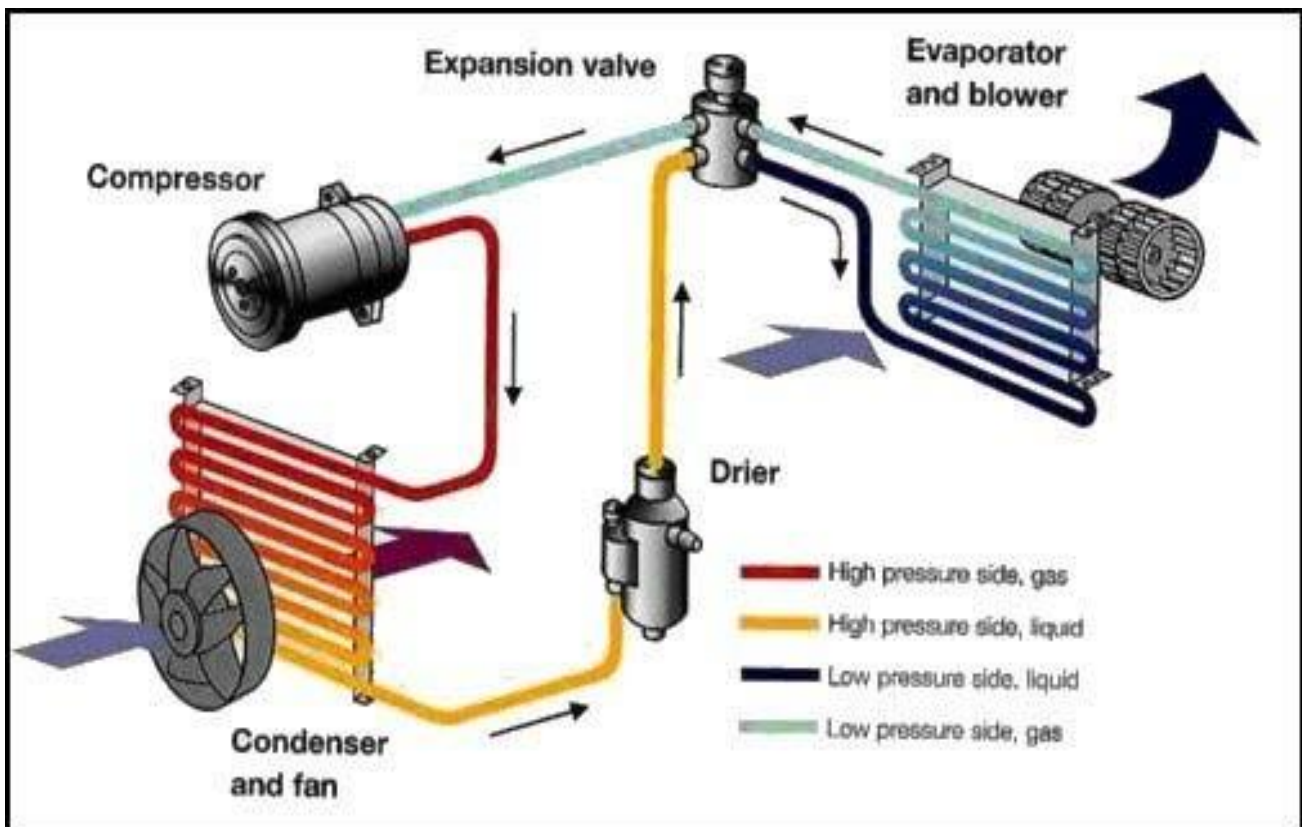
Table-1: Exhaust Gas Properties at Various Engine Speeds

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The proposed model is based on three fluid vapour absorption systems. It will contain basic components needed for vapour absorption system as shown in Fig. 3.

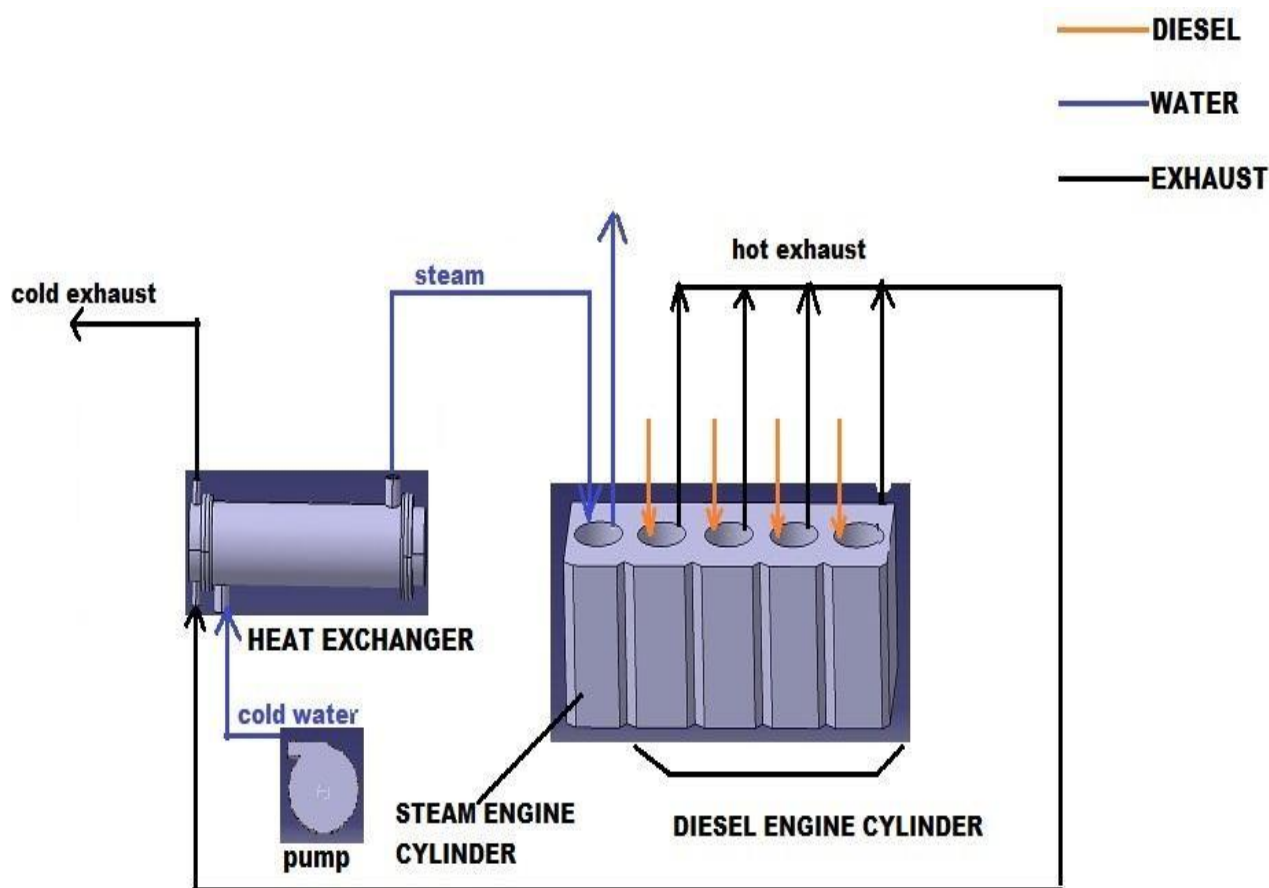
- The three fluid used in this system will be ammonia, water and hydrogen.—
 - The use of water is to absorb ammonia readily.
 - The use of hydrogen gas is to increase the rate of evaporation of the liquid ammonia • passing through the system.
- Even though ammonia is toxic, but due to absence of moving part, there will be little chance— for the leakage.
- ITEM CONTENT Engine Speed(rpm) 1000 2000 3000 4000 Engine Power (kW) 14.9 50.2 70.8 84.8 Exhaust temperature(K) 801.5 862.4 890.8 900.5 Exhaust mass flow rate(g/s) 18.7 59.6 83.3 108 The hot radiator water will be used to heat the ammonia solution in the generator. To remove water— from ammonia vapor, a rectifier will be used before condenser. The ammonia vapor is condensed and flows under gravity to the evaporator, where, it meets the hydrogen gas. The hydrogen of gas, which is being feed to the evaporator, permits the liquid ammonia to evaporate at low pressure and temperature.
- During the process of evaporation, the ammonia will absorb the latent heat from refrigerated— space and produces cooling effect. The mixture of ammonia vapor and hydrogen will be passed to the absorber where ammonia will be absorbed while hydrogen raises the top and flows back to the evaporator.

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VII. HEAT EXCHANGER SELECTION

Since we have to run a steam engine which works with the pressure of the steam, it should be critically noted that the heat exchanger selected should be on with minimum pressure drop. Also, the function of our heat exchanger is to transfer the heat from the exhaust gas to the working fluid, and the working fluid has to be vaporized and superheated when coming out from the heat exchanger.

Based on the requirements, we studied the characteristics of the available types of heat exchangers and found out that horizontal shell and tube heat exchanger with counter flow arrangement is the best suited one for our application.

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