Analysis of Energy Storage from Exhaust of an Internal Combustion Engine

Rinku Jangra[1]
[1]Department of Mechanical Engineering,
Ganga Institute of Technology Management,
Kablana

The increasingly worldwide problem relative to 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, Exhaust gas occurs as a result of the combustion of fuels such as natural gas, gasoline/petrol, diesel, fuel oil or coal. It is discharged into the atmosphere through an exhaust pipe or flue gas stack. The exhaust gas from an internal combustion engine carries away much of the heat of combustion. The energy available in the exit stream of many energy conversion devices goes as waste, if not utilized properly. The main objective of the proposed project is to utilize heat from the exhaust gases of a diesel engine and convert heat to useful work. In the present work, a shell and finned tube heat exchanger integrated with an Internal Combustion engine setup to extract heat from the exhaust gas and a thermal energy storage tank used to store the excess energy available is investigated in detail. Energy supplied to an engine is the heat value of the fuel consumed. But only a part of this energy is transferred into useful work. From heat balance sheet of a typical IC engine. I find out that the total heat loss is around 35-45%, of which 33% is due to exhaust gases and the rest is lost to the surroundings

Keywords: Waste Heat Recovery, Comet Diesel Engine.

I. 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. 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 carbonmonoxide (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,]

II. AVAILABILITY OF HEAT FROM I.C.ENGINE

Waste heat is heat, which is generated in a process by way of fuel combustion or chemical reaction. consider internal combustion engine 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 [1]. It means approximately 60 to 70% energy losses as a waste heat through exhaust (30% as engine cooling system and 30 to 40% as environment through exhaust gas). Exhaust gases immediately leaving the engine can have temperatures as high as 450-600°C

Benefits of 'waste heat recovery'

- Recovery of waste heat has a direct effect on the combustion process efficiency. This is reflected by reduction in the utility consumption and process cost.
- Reduction in pollution: A number of toxic combustible wastes such as carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NOx), and particulate matter (PM) etc, releasing to atmosphere. Recovering of heat reduces the environmental pollution levels.
- Reduction in equipment sizes: Waste heat recovery reduces the fuel consumption, which leads to reduction in the flue gas produced. This results in reduction in equipment sizes.

III . EXPERIMENT ON TWIN CYLINDER DIESEL ENGINE

Twin cylinder diesel engine specifications

- Vertical, double cylinder, water cooled, compression ignition, 4 stroke.
- Power output 10 h.p. running at 1500 rpm.
- Engine's moving parts are lubricated by force feed and partly by splash lubrication.
- Water cooled engine is cooled by air flow generated with the help of a fan mounted on the flywheel called conventional cooling.
- Test rig coupled with eddy current dynamometer loading.

To estimate the exhaust gas temperature, we conducted an experiment on the twin cylinder COMET Diesel engine available so that the exhaust gas temperature could be estimated.

The engine was tested at different loads starting from 10 kg to 35 kg at different time intervals, by connecting a thermocouple at the engine's exhaust.The engine was running at a constant rpm of 1500 rpm.

The twin cylinder diesel engine was water cooled and a dynamometer was attached at the output.

IV. EXPERIMENTAL REQUIREMENTS

I used the heat exchanger at the exhaust of twin cylinder diesel engine and a low boiling fluid ie. Diethyl ether which used the heat from the exhaust pipe of the engine and vaporize the low boiling fluid which is further used to rotate the turbine which is basically other working unit attached to the engine. The heat used by the heat exchanger is used to vaporize the working fluid and there is reduction in the loss of exhaust heat as some heat is utilize by the external unit which is attached to the exhaust of the engine . The performance parameters pertaining to the heat exchanger and the storage tank such as amount of heat recovered, heat lost, and increased efficiency is evaluated.

Selection of low boiling point fluid

For the purpose of experiment a low boiling point fluid was selected from the list of low boiling point fluids. Taking into consideration all the aspects the most appropriate fluid was Diethyl Ether.

Properties	
Molecular formula	$C_4H_{10}O$ $C_2H_5OC_2H_5$
Molar mass	74.12 g/mol
Appearance	clear, colorless liquid
Density	0.7134 g/cm³, liquid
Melting point	−116.3 °C (156.85 K)
Boiling point	34.6 °C (307.75 K)

Properties of Diethyl ether

Diethyl ether, also known as ether and ethoxy ethane, is a clear, colorless, and highly flammable liquid with a low boiling point and a characteristic odor.

After conducting the experiment we find that the exhaust gas temperature increases with increasing load and reaches a maximum of 450^{0}C for full load condition. The experiment was carried out at different loads starting from 10 kg to 35 kg. The readings were also noted down for zero load case. When we used diethyl ether as the working fluid to extract heat we find that the exhaust gas temperature drops which may due to the heat extracted by the exhaust gas inside the heat exchanger. The table shows the results from the experiment

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Sl. No.	Load (kg)	Temperature (Celsius)
1.	0	285
2.	10	313
3.	15	345
4.	20	375
5.	25	410
6.	30	440
7.	35	450

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s	Load (kg)	V (Volts)	I (A)	Time for 20 c.c. of fuel	Air inlet temp. (°C)	Exhaust gas temp. (°C)	Water inlet temp. (°C)	Water outlet temp (°C)	Vapor inlet pressure (bar)	Vapor outlet pressure (bar)	TFC (g/s)	Heat lost exhaust gas (kJ/hr)	Heat lost cooling water (kJ/hr)
1.	0	240	-	84	26	44	28	44	0.35	0.60	-	12912.6	19223.3
2.	10	240	5	76	26	44	28	44	0.45	0.65	0.13	16435.5	19223.3
3.	15	240	8	62	26	44	28	44	0.50	0.70	0.17	17910.4	19223.3
4.	20	240	12.5	53	26	44	28	44	0.65	0.75	0.19	19607.4	19223.3
5.	25	240	17.5	47	26	44	28	44	0.75	0.90	0.26	20905.3	19223.3
6.	30	240	22	34	26	44	28	44	0.95	1.00	0.34	20981.5	19223.3
7.	35	240	26	26	26	44	28	44	1.00	1.15	0.39	21853.4	19223.3

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