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# Design and Development of Shell and Tube HE to Improve Thermal Efficiency of VARS using Heat Recovery from C. I Engine

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## Abstract:

The increasingly worldwide problem regarding rapid economy development and a relative shortage of energy. Out of the total heat supplied to the engine in the form of fuel, approximately, 30 to 40% is converted into useful mechanical work. With the rapid changing environment and atmospheric effect, the air conditioning of the moving vehicle has become a necessity. In the same time consumers are incapable to bear the increasing operating cost of the vehicles due to continuous raise in fuel prices, component costs and maintenance costs associated with vehicles. Keep in mind in this paper, an exploration has been done to research the possibility of waste heat recovery and its subsequent utilization in air conditioning system of a vehicle without increasing the component cost, weight, number of component and bring improvement in vehicle by making luxurious. In this system the Shell and Tube HE type will be used, designed and developed along with vapour absorption refrigeration system and is tested for performance.

*Keywords* — **Eefficiency, Exhaust Gas, Waste Heat & Shell Tube HE**

## I. INTRODUCTION

Energy efficiency has been a major topic of discussions on natural resources preservation estimates of energy resources reduction at medium and long terms, Air conditioning of a vehicle can be done by Vapour Compression Refrigeration System (hereinafter VCRS) and Vapour Absorption Refrigeration System (hereinafter VARS .Presently, in the vehicles VCRS is in use in most of the cases. Additional of conventional air conditioner in car also decreases the life of engine and increases the fuel consumption. For very small cars compressor needs 3 to 4 bhp, a significant ratio of the power output. Keeping these problems in mind, a car air conditioning system is proposed from recovery of engine waste heat using radiator water as source / generator for VARS.

- Only 1/3rd of the energy used.
- Rest of the energy is wasted.
- We can recover that waste heat from the exhaust gas.
- That recovered heat we can used in the refrigeration system.
- For that we used vapour absorption system for the refrigeration system.

In the vapour absorption system less amount of energy are required to run the RAC system instead of VCRS.The 3-type of HE will be tested by FEA/CFD for heat enhancement along with VARS for automotive air conditioning system.

In the C.I engine device which converts chemical energy of fuel into the heat and the again heat is converted into the mechanical energy. In the main fact the fuel approximately only 30-40% heat supplied for the engine converted into the mechanical work and remaining will be the released from fuel due to the combustion.

## II. WASTE HEAT RECOVERY FROM C.I.ENGINE

Waste heat energy recovery methods in conventional commercial two wheeler and four wheelers. In this topic the heat energy contained in the exhaust gases are recovered in three different methodologies.

- Firstly Waste heat energy is utilized to burn few amount of fuel.
- Second Electric generator producing electrical energy form exhaust gases.
- Third stage waste heat energy recovery by alternator and compressor.

I will experimentally measure the exhaust waste heat from C.I engine and improve the design of the heat exchanger. There are main HE are used one to generate saturated and other superheated vapour. Experimental study of waste heat recovery from C.I engine technique and observed that such systems increases efficiency and reduces the emission. They are widely used for thermodynamic properties and also widely use for heavy vehicles , four wheelers buses etc. To increase their high thermal efficiency. And generated output power for waste heat energy from C.I engine.

| Engine Type | Power output | Waste heat energy |
|---|---|---|
| Small air cooled engine | 40 | 40-50 of waste energy losses from C.I engine |
| AC water cooled engine | 35-180 | |
| Bulldozer machineries | 500-800 | |

**Table 1 . Engine type and power output**

### III. OBJECTIVES OF THE STUDY

The objectives of the study on the subject " Design and Development Shell and Tube HE for waste heat recovery from VARS using C.I engine. They can follow as..

1. Design the 4 stroke engine parameter for the heat exchanger.
2. Differentiate between the Vapour compression and vapour Absorption system of heat engine.
3. Structural FEA analysis to use to calculate the heat exchanger types.
4. The continuous optimization of the performance of internal combustion engines and the increasing utilization of air conditioning in vehicles, as it reaches the status of essential need for modern life.

### IV. METHODOLOGY

The methodology is based on the vapour absorption system for waste heat energy form heat exchanger of C.I engine. There are two categories of heat exchanger follows as..

#### *A. Experimental Set-up and Procedure*

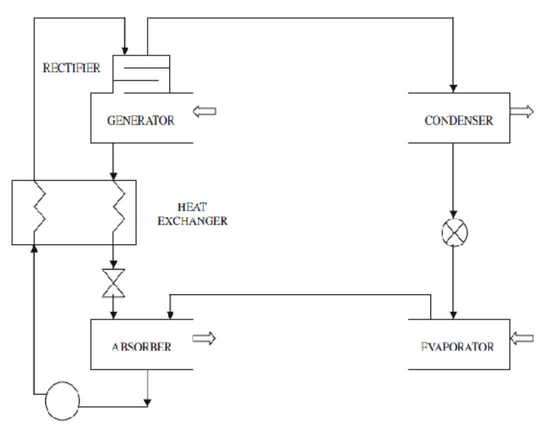



**Fig.1. Vapour Absorption system**

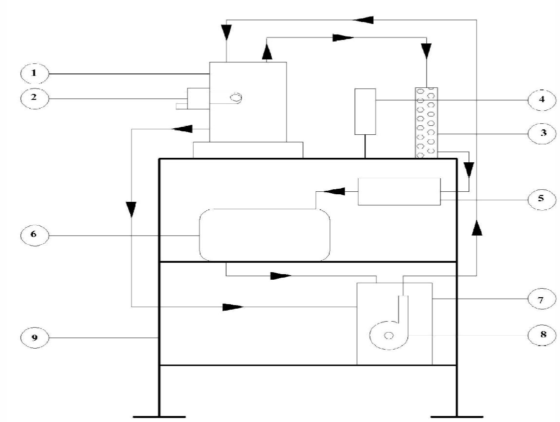



**Fig.2.Actual VARS Experiment set up**

| Sr No. | Part Name | Sr No. | Part Name |
|---|---|---|---|
| 1 | Genrator | 2 | Heator |
| 3 | Condenser | 4 | Cooling fan |
| 5 | Receiver | 6 | Evaporator |
| 7 | Absorber | 8 | Pump |
| 9 | Frame | | |

The various components are used for VARS system they are follows as. Condensers are typically heat exchangers which have various designs and come in many sizes ranging from rather small (hand-held) to very large industrial-scale units used in plant processes.

Secondly, Evaporator cabinet is mounted on middle storey of the frame. It is made of thin metal sheet having internal tubes for circulating the refrigerant..Third, Absorption refrigerator is a refrigerator that uses a heat source (e.g., solar, kerosene-fuelled flame, waste heat from factories or district heating systems) to provide the energy needed to drive the cooling system. It has two holes created on its top portion. The vapour coming from evaporator cabinet is mixed with weak solution in absorber. Actual vapour absorption system part list explain above their HE. There are also include Frame , Tube, Pump , Receiver etc. Are experimental setup arranged in VARS system. The mathematical model develops thermodynamic properties , absorption equations and processes , refrigerating of coefficient of performance and also increasing their efficiency.

The mathematical relation will be develop through the mathematical model and the extent heat generated in the engine and utilising the amount of heat energy recovery for the C.I. engine.

**V. SHELL AND TUBE HE.**

It is a common type heat exchangers. These are easily design method and facility is available for successful construction methods and reliable mathematical calculation. There are various types of heat exchangers but this type is most important for the heat energy from C.I. engine. These heat exchanger are used for the experimental part pump , generator , condenser , water heater and also refrigeration an air conditioning system. There are various important factors are available for C.I engine they are thermal stresses , mechanical stress , chemical properties and vibration problems are main parameters when designing the shell and tube heat exchanger. Dimensions of shell and tube heat exchangers are given in the tabulated form.

If the reverse is attempted, the condensation of vapours within small diameter parallel tubes causes flow instabilities. Tube and shell heat exchangers are available in a wide range of standard sizes with many combinations of materials for the tubes and shells.

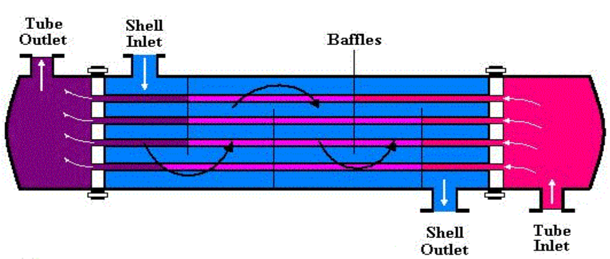
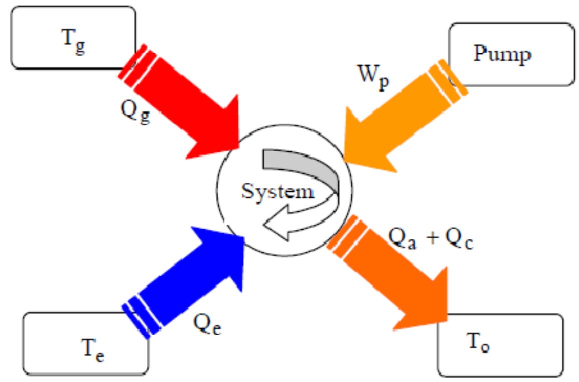



Figure-3: Shell & Tube Heat Exchanger

**VI. CALCULATIONS**




To find the Coefficient of performance of the system, we have following formula.

COP = [Te / Tg] [(Tg – TO)/ΔT]

Where,

Te = Temperature of Evaporator

Tg = Temperature of Generator

To = Temperature of surrounding

ΔT = Difference between outside & evaporator temperature.

1.From first observation

Water = 90% and Ammonia = 10%

Te = 260 C

COP = [26/80] [(80-34)/8]

COP = 0.6

2. From second observation

Water = 80% and Ammonia = 20%

Te = 240 C

COP = [24/80] [(80-34)/10]

COP = 0.76

3. From third observation

Water = 70% and Ammonia = 30%

Te = 220 C

COP = [22/80] [(80-34)/12]

COP = 0.82

### *A. RESULT*

From the above calculations we tabulated the result as follows

| Sr. No | Concentrations | | Evaporator Temperature $T_e$ ($^0C$) | COP |
|---|---|---|---|---|
| | $H_2O$ | $NH_3$ | | |
| 1 | 90% | 10% | 26 | 0.6 |
| 2 | 80% | 20% | 24 | 0.76 |
| 3 | 70% | 30% | 22 | 0.82 |

Table no.1

## VII. CONCLUSIONS

The study of waste heat cooling system analyzed in this article will be experimentally investigated and the data will be captured for further analysis. This will be supported by a suitable mathematical model and a simulation tool. The study reveals that it comprises four heat exchanges, namely, an air finned forced convection condenser, an air finned forced convection evaporator, and a pair of shell and tube type absorbers, plus four one-way refrigerant valves, an expansion valve, and an exchange valve. For a refrigerant system the following things are needed.

At present, for an automobile waste heat absorption cooling system, the demand for CWHC can be easily met, but for SCP, further research is needed, which will be studied in part II of this project The optimum HE design will be made by FEA/CFD to use with the system.

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