DESIGN AND DEVELOPMENT OF WASTE HEAT RECOVERY SYSTEM USING HEAT PIPE

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ABSTRACT
Heat produced by the engines is mostly wasted in absence of any system to recover it. This heat can be utilised for few applications with the system to effectively recover it. Heat pipes are useful to carry out the heat produced by the engines and machines. Heat absorption capacity of heat pipes makes them effective for designing the applications for heat recovery. Better control is provided by the heat pipes by controlling the temperature. The heat generated in most of the machines is not utilised anywhere and it is wasted in absence of a system to utilise it. Heat pipes are capable of heat transfer which can be useful to design the effective thermal based systems. The pipe based solar collectors are proven effective in heat exchange and transfer process. Authors have presented the recovery system for heat in order to utilise the waste heat.

KEYWORDS: Heat recovery, waste heat, heat pipes, heat recovery system, etc.

INTRODUCTION
The heat pipes are found suitable for the heat transfer applications now days. The heat pipes are available in different materials such as copper, aluminium, fluid filled and vapour filled. The working principle of heat pipe is to vaporise the liquid by absorbing the heat, and transferring the heat to the area where it can be utilised for some application. The vaporized liquid when heated starts travelling from one place to other with pressure. When it is condensed, it returns back to liquid form.

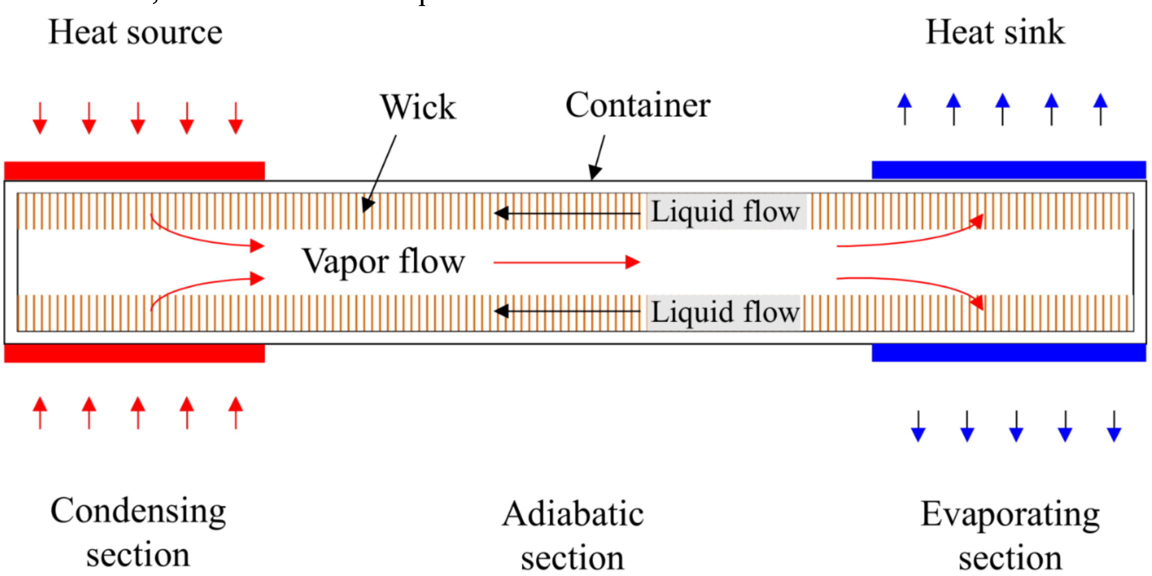


Fig. 1: Heat Pipe Basic Structure

Fig. 2: Heat Pipe

The heat pipe is shown in the figure above, which is useful to carry the heat produced in the machines. Generally the rotating machines produces more heat due to the friction of mechanics parts. The engines working to convert the energy from one form to other are also producing the heat as a waste in energy during the conversion process.

PROBLEM STATEMENT

To design a waste heat recovery systems (WHRS) for lower temperatures (100-200° C) at limited space, which is conventionally not possible.

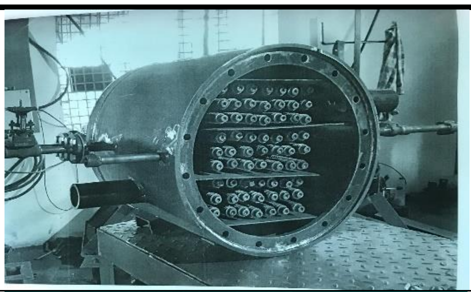
OBJECTIVES

Conventionally waste heat recovery systems (WHRS) require temperature above 500°C to operate. In this system we challenge the conventional way and design a waste heat recovery systems (WHRS) to operate at lower temperatures (100-200° C), by using the new concept of Heat Pipe.

CONSTRUCTIONAL DETAILS

Table 1: Construction details of the system

Sr. No.	Details	Picture
1	DG Set	
2	Inlet Circuit	

3	Heat Transfer Enclosement	
4	Outlet Circuit	
5	Super Heater	 
6	Control Panel	

EXPERIMENTAL ANALYSIS

The experimental setup shown below demonstrates the waste heat recovery system.

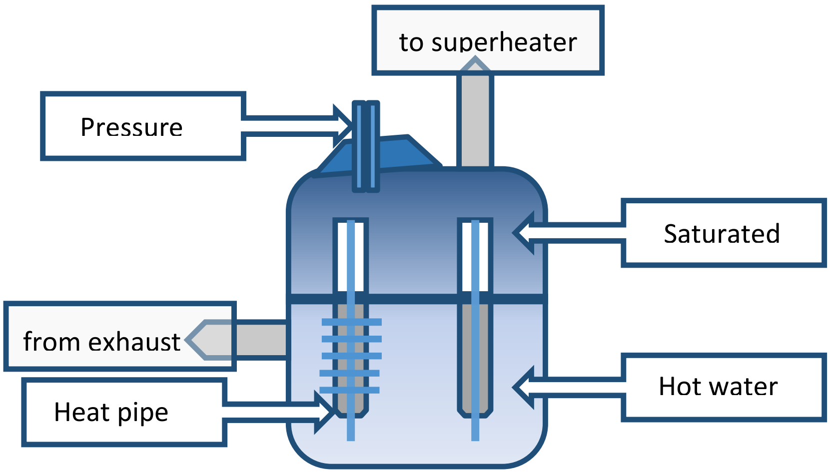


Fig.3: Basic Structure of Setup

Fig. 4: Experimental Setup

The experimental setup shows that the, how the heat pipes are utilised to develop the heat recovery system.

DG SET WHRS BOILER

A] HEAT LOSS = H_L = m (kg/hr) x Cp (kcal/kg°C) x ΔT (°C)

Fuel Consumption = 2 diesel / hour

At 80 % load = 2 x 0.80

= 1.6 kg/hr

Flue gases generated = 1.6 (kg) + (1.6 x 16) kg air

= 27.2 kg/hr

HEAT LOSS = H_L = 27.2 x (250 - 120) x $\left(\frac{253}{273 + 250}\right)$

= 1697 kcal/hr

B] HEAT GAIN

Sensible Heat = m x Cp x ΔT

= 1 x 1 x (100 - 30) ……(at atmosphere)

= 70 kcal / kg

Latent Heat = m x α …..(Dryness fraction rejected)

= 1 kg x 540

= 540 kcal/kg

C] HEAT REQUIRED TO GENERATE 1 KG OF STEAM

= 70 + 540

= 610 kcal/kg hr

Heat available =1697 x 0.80

= 1357 kW/ hr

Steam generated per hour = $\frac{1357}{610}$

=2.22 kg/hr

- **Trial 1 ,**

Friday, 22nd November 2019.

Flue gas Ti= 250 °C

To= 120 °C

Time = 1.5 hours

Water Flow = 2.1 Liters

DG Load = 80%

CONCLUSION

Heat pipes are very useful for the applications in solar, air conditioning and heat recovery system. Authors have developed the waste heat recovery system using heat pipes. This system is designed and the calculations are presented in this paper. Heat recovery system will open the doors of opportunity to save the energy. The waste energy saving is equivalent to the energy generation. Heat calculations presented in the paper shows the amount of heat which is wasted and which can be utilised for the further applications.

REFERENCES

1) Noie-Baghban, Seyed Hossein, and G. R. Majideian. "Waste heat recovery using heat pipe heat exchanger (HPHE) for surgery rooms in hospitals." Applied thermal engineering 20.14 (2000): 1271-1282.
2) Abd El-Baky, Mostafa A., and Mousa M. Mohamed. "Heat pipe heat exchanger for heat recovery in air conditioning." Applied thermal engineering 27.4 (2007): 795-801.
3) Srimuang, Wasan, and Pipatana Amatachaya. "A review of the applications of heat pipe heat exchangers for heat recovery." Renewable and Sustainable Energy Reviews 16.6 (2012): 4303-4315.
4) Chaudhry, Hassam Nasarullah, Ben Richard Hughes, and Saud Abdul Ghani. "A review of heat pipe systems for heat recovery and renewable energy applications." Renewable and Sustainable Energy Reviews 16.4 (2012): 2249-2259.
5) Lin, Song, John Broadbent, and Ryan McGlen. "Numerical study of heat pipe application in heat recovery systems." Applied Thermal Engineering 25.1 (2005): 127-133.
6) Remeli, Muhammad Fairuz, et al. "Simultaneous power generation and heat recovery using a heat pipe assisted thermoelectric generator system." Energy Conversion and management 91 (2015): 110-119.