

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.

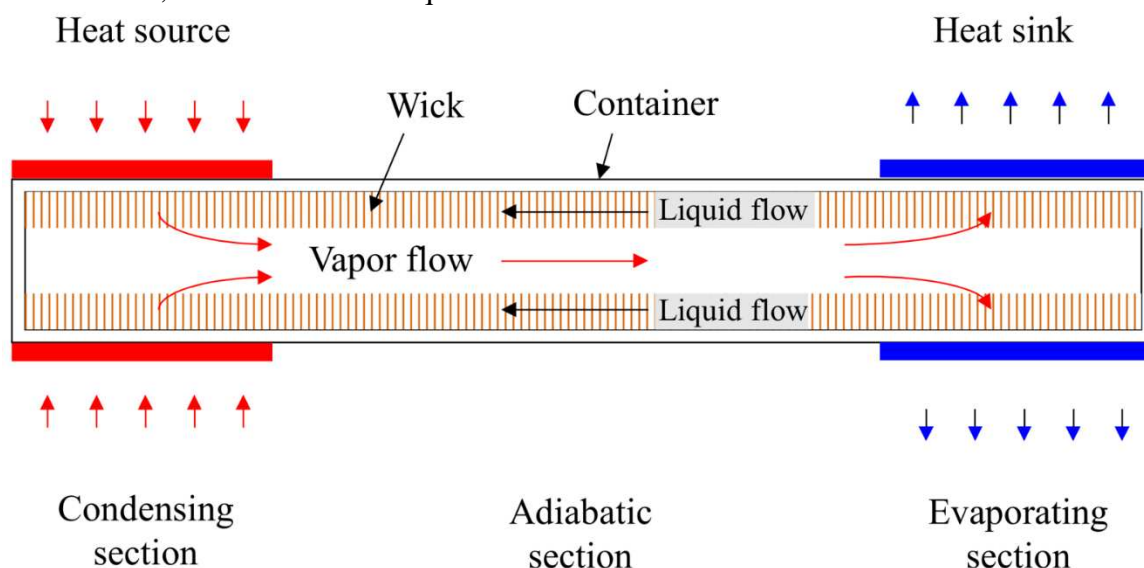


Fig. 1: Heat Pipe Basic Structure



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 ($100-200^{\circ}\text{C}$) at limited space, which is conventionally not possible.

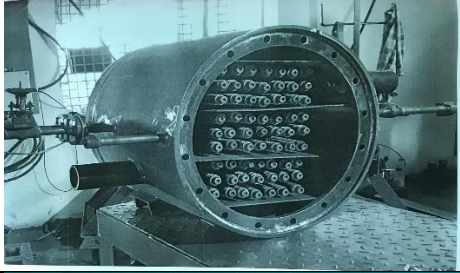



OBJECTIVES

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 ($100-200^{\circ}\text{C}$), 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 Enclosurement	
4	Outlet Circuit	
5	Super Heater	
6	Control Panel	

EXPERIMENTAL ANALYSIS

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

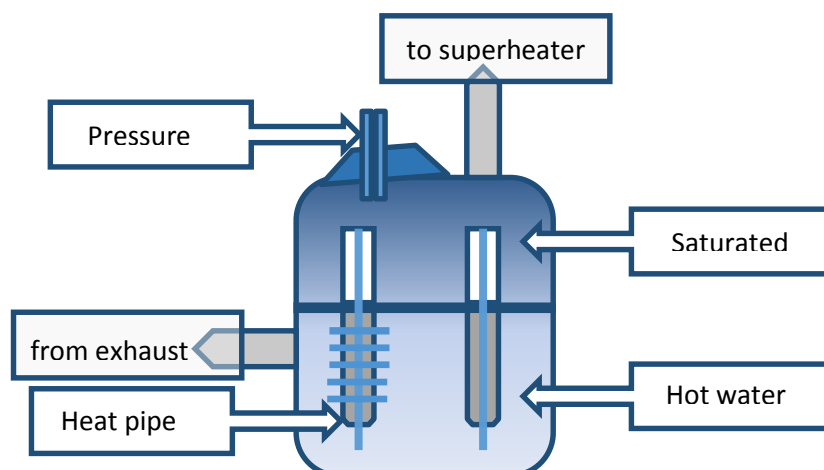


Fig.3: Basic Structure of Setup



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

$$\text{A] HEAT LOSS} = H_L = m \text{ (kg/hr)} \times C_p \text{ (kcal/kg}^\circ\text{C)} \times \Delta T \text{ (}^\circ\text{C)}$$

$$\text{Fuel Consumption} = 2 \text{ diesel / hour}$$

$$\text{At 80 \% load} = 2 \times 0.80$$

$$= 1.6 \text{ kg/hr}$$

$$\text{Flue gases generated} = 1.6 \text{ (kg)} + (1.6 \times 16) \text{ kg air}$$

$$= 27.2 \text{ kg/hr}$$

$$\text{HEAT LOSS} = H_L = 27.2 \times (250 - 120) \times$$

$$= 1697 \text{ kcal/hr} \quad \left(\frac{253}{273 + 250} \right)$$

B] HEAT GAIN

$$\text{Sensible Heat} = m \times C_p \times \Delta T$$

$$= 1 \times 1 \times (100 - 30)$$

.....(at atmosphere)

$$= 70 \text{ kcal / kg}$$

$$\text{Latent Heat} = m \times \alpha$$

.....(Dryness fraction rejected)

$$= 1 \text{ kg} \times 540$$

$$= 540 \text{ kcal/kg}$$

C] HEAT REQUIRED TO GENERATE 1 KG OF STEAM

$$= 70 + 540$$

$$= 610 \text{ kcal/kg hr}$$

$$\text{Heat available} = 1697 \times 0.80$$

$$= 1357 \text{ kW/ hr}$$

$$\text{Steam generated per hour} =$$

$$\frac{1357}{610}$$

$$= 2.22 \text{ kg/hr}$$

• Trial 1 ,

Friday, 22nd November 2019.

$$\text{Flue gas} \quad T_i = 250 \text{ }^\circ\text{C}$$

$$T_o = 120 \text{ }^\circ\text{C}$$

$$\text{Time} = 1.5 \text{ hours}$$

$$\text{Water Flow} = 2.1 \text{ Liters}$$

$$\text{DG Load} = 80\%$$

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.

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