WASTE HEAT RECOVERY BY HEAT PIPE HEAT EXCHANGER

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ABSTRACT

The objective of this paper is to focus on the recovery of waste heat by using heat pipe heat exchanger in various applications like in air conditioner, hospitals, from urban waste waters etc. As the natural source of energy is continuously diminishing on the earth, in this scenario reduction in consumption or saving of energy is vital necessity. This would reduce dependencies on natural fossil fuels, global warming by reducing greenhouse gas emissions and would increase the energy independence. Heat pipe heat exchanger has been designed to recover heat in various applications such as in the field of engineering.

Keyword: - *Heat pipe, Heat pipe heat exchanger.*

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1. INTRODUCTION

Heat pipes with heat exchanger is one of the most useful devices for the recovery of waste heat. The importance of applying a heat pipe is that large quantities of heat can be conveyed through a small cross-sectional area over a long distance with no extra power input to the system. Also, simple design and manufacturing, less end-to-end temperature drops, wide temperature application range and the capacity to control and transfer high heat rates at various temperature levels are unique features of heat pipes. Some of the important applications of heat pipes are in the area of heat exchangers for heat recovery, human body temperature control and medicine, electrical and electronic equipment cooling and as spacecraft cooling.

The application of the heat pipe heat exchanger would reduce primary energy consumption and reducing carbon dioxide production. Commercial production of heat pipe heat exchangers began in the mid-1970s. Since that time, it is found number of applications in many industries. Heat pipe heat exchanger has many applications which can be divided into three main categories:

1. Heat recovery in air conditioning devices like air conditioner, air heater, humidifier and dehumidifier.
2. Heat recovery from the exhaust stream of heat to preheat air for space heating, process heating in industries as well as in any organization.
3. Heat recovery from the process exhaust stream to re-use in the process.

Heat pipe appropriate design and construction is very complicated but the operating condition of a heat pipe is simple. Number of parameters like effect of fluid charge, effect of wick structure, effect of working fluid, effect of tilt angle should be controlled. In this way we can say that experimental investigations are very important.
In this research, at the beginning material and dimensions of a heat pipe. Heat pipe designed on the base of past literatures. The types of wick and working fluids compatible with the pipe material and wick structure were selected. The characteristic design and heat transport limitations of heat pipes for three types of wick made of 50 mesh nickel, 250 mesh nickel and 100 mesh stainless steel tested. Also working fluids like acetone, methanol and water through a computer simulation of a single heat pipe were examined. The rate of heat input to the evaporator section was maintained within 20±400 W.

1. LITERATURE REVIEW

Research has been already carried out on the theory, design and construction of heat pipes and their applications as heat pipe heat exchangers for reduction of air pollution, energy recovery and environmental conservation. A heat pipe heat exchanger has been designed and constructed for heat recovery in most hygienic places like hospital and laboratories, where the air must be fresh and to be replaced up to 40 times per hour. In this research, the characteristic design and limitations of heat transfer of single heat pipes for mentioned types of wick and working fluids have been investigated.

Construction of heat pipes as well as washing, wick insertion, vacuum creation, fluid injection in heat pipe and installation have also been carried out. Once appropriate heat flux is obtained, the air-to-air heat pipe heat exchanger was designed, manufactured and examined under low temperature operating conditions, using all three fluid mentioned in the literature as the working fluid. Experimental results for heat absorbed by the evaporator section are very much similar to the rate of heat transfer obtained from computer simulation.

In air conditioning facilities with high outside air requirements such as clean room air conditioning systems, good amount of energy savings is obtained by heat recovery using heat pipe heat exchanger. The literature review indicated that the annual energy saving analysis of air conditioning system with heat pipe heat exchanger for Indian climatic conditions has not been performed. The investigation carried for the possible energy savings using heat pipe heat exchanger for heat recovery in air conditioning system for an air conditioning facility. The impact of number of rows of heat pipe heat exchanger and variations in the operating air conditions on the savings in cooling coil capacity.

The use of energy consumption control has become a priority for all countries in the world. This fact is due to the limitation of Earth's natural resources, the increasingly high costs of energy consumption as well as global warming. Heat recovery from wastewater from drains, represents a waste heat source which is untapped so far. The recovery of heat from wastewaters would increase the energy independence by reducing the dependencies on fossil fuels, the greenhouse gas emissions. This paper presents a research on the use of heat pipe heat exchangers in the recovery of waste heat from urban wastewaters.

Research has been carried out also on the theory, design and construction of waste heat recovery using heat pipes heat exchanger in waste heat recovery for energy recovery in automobile exist, reduction of air pollution and environmental conservation by using a nano fluid. A heat pipe heat exchanger has been designed and manufactured for heat recovery in exhaust gas heat recovery from IC Engine, where the air must be replaced up to 40 times per hour to have a fresh charge. In this research, the characteristic design and heat transfer limitations of heat pipes without wick and working with Hybrid Nano fluids have been examined. There has been increasing interest in nano fluid and its use in heat transfer enhancement. Nano fluids are suspensions of nano particles in fluids that show significant enhancement of their properties at modest nano particle concentrations.

In applications of heat pipes in energy conservation and renewable energy based systems, design and characteristics of different energy conservation and renewable energy based system using heat pipes as thermal control element have been described. Heat pipes give two-phase reliable heat transfer system with passive operation and high effectiveness for these kinds of applications. Electricity generation system based on renewable energy developed in this study utilizes thermo syphons to bring out stored heat as solar pond, geothermal, to expel waste heat to ambient and to accumulate waste heat into phase change materials. Heat pipe used for economical and zero greenhouse gas emission solution for these applications. Generally, the heat pipe and vapor chamber are two-phase heat transfer devices. They involve an evacuated and sealed container with a small quantity of working fluid. One end of the container is provided with waste heat from the source, causing the tapped liquid to evaporate. The vapor flows to the cold end of the container where it condenses. Since the latent heat of evaporation is much larger than the sensible heat capacity of a fluid, so considerable quantities of heat can be transferred using these equipment's with a very less end to end temperature difference. For the condenser above evaporator configuration where bottom heat mode is the return of the condensate which be aided by gravity. So it is also called as gravity assisted heat pipes or thermosyphons. While for the evaporator above condenser configuration where top heat mode or horizontal which evaporator and condenser at same level configuration, porous structure is lined on the inner circumference of the heat pipe to promote capillary pumping of the working fluid.

In this paper, research and development in the field of energy conservation and renewable energy using heat pipes has been discussed. Waste heat recovery is very important in reducing primary energy consumption and CO_2 production. This paper explains and describes the performance and applications of Thermo syphon Heat Exchangers

for heat recovery from exhaust gases in industrial plants. Heat exchangers constructed of two phase closed thermosyphons are one of the most useful equipment for waste heat recovery. The merits of this system are compactness, flexibility of size of system, ease of operation, and less maintenance requirement. Thermo syphon Heat Exchanger can act as pre-heater of air in boilers and furnaces using the heat recovered from the exhaust satisfactorily. In this research one successful industrial practice is explained using Thermo syphon Heat Exchanger.

3. SELECTION OF WORKING FLUID

Water is not applicable as fluid in the heat pipe as water has a high degree of superheat temperature especially at the low pressure. Methanol is the widely used fluid in the heat pipe as it has low degree of superheat temperature compared to water. It is also advantageous to use methanol instead of acetone as it has good capillary limit.

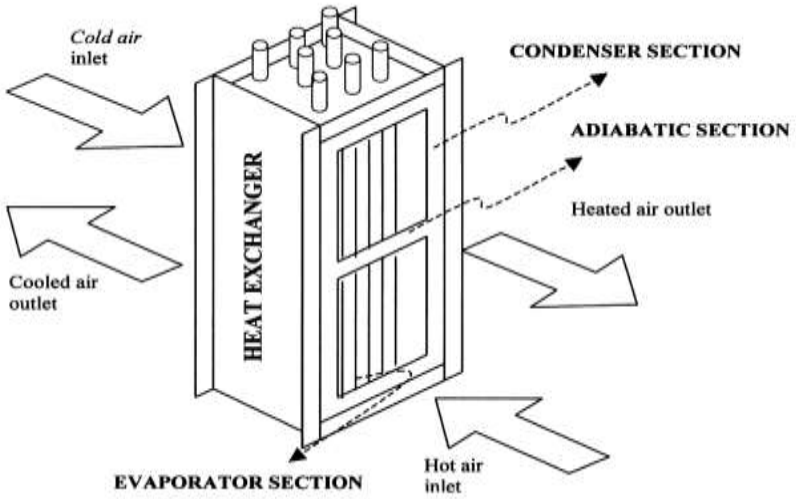

Fig -1: Schematic of heat pipe heat exchange

4. CONCLUSIONS

The use heat pipe heat exchanger provides wide range of applications for the saving of the energy which is a foremost requirement of the growing world. There is also a scope of improvement in the design and construction of heat pipe heat exchanger to recover maximum amount of heat from the urban waste water, surgery rooms in hospital, in air conditioners, cooling equipment's as well as in many applications in the field of thermodynamics.
The waste heat recovery system is mostly used to reduce cost of the system. It is very much practical to use heat pipe heat exchanger to protect environment compared to other heating systems based on oil, electricity or coal like fossil fuels.

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