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HEAT PIPE AN ENERGY RECOVRY SYSTEM- A REVIEW PAPER

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Abstract: Heat pipes are very flexible systems with regard to effective thermal control. They can easily be implemented as heat exchangers inside sorption and vapor-compression heat pumps, refrigerators and other types of heat transfer devices. Heat pipe air preheater is used in thermal power plants to preheat the secondary–primary air required for combustion of fuel in the boiler using the energy available. A novel type of heat pipe application for cold energy storage has been proposed and discussed in this paper. The cold storage system is aiming to save electricity for data center cooling. A typical wickless heat pipe - thermo siphon (thermal-diode heat pipe) will be employed in this application. The thermo siphon cold energy storage systems can be designed into several types that are ice storage, cold water storage and precool heat exchanger. Those systems can be used for co-operating with conventional chiller system for cooling data centers.

Keywords: Hot rolling; Gear forces; Herringbone

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INTRODUCTION

A heat pipe is a heat-transfer device that combines the principles of both conductivity and phase transition to efficiently manage the transfer of heat between two solid interfaces. At the hot interface of a heat pipe a liquid in contact with a thermally conductive solid surface turns into vapor by absorbing heat from that surface. The vapor then travels along the heat pipe to the cold interface and condenses back into a liquid - releasing the latent heat. The liquid then returns to the hot interface through either capillary action, centrifugal, gravity, and the cycle repeats. Heat pipes are thermal superconductors, due to the very high heat transfer coefficient for boiling and condensation. The effective thermal conductivity varies with heat pipe length, and can approach 100,000 W/m K for long heat pipes, in comparison with approximately 400 W/m K for copper. Heat pipes contain no mechanical moving parts and Through the pipe walls, resulting from breakdown of the working fluid or as impurities extent in the material may eventually reduce the pipe effectivenes transferring heat.

CONSTRUCTION:

Heat pipe is mainly divided into three parts as evaporator section, adiabatic (transport) section, Condenser section.

A typical heat pipe consists of a sealed pipe or tube made of a material that is compatible with the working fluid such as copper for water heat pipes, or aluminum for ammonia heat pipes. Typically, a vacuum pump is used to remove the air from the empty heat pipe. The heat pipe is partially filled with a working fluid and then sealed. The working fluid mass is chosen so that the heat pipe contains both vapor and liquid over the operating temperature range. Water heat pipes are sometime filled by partially filling with water, heating until the water boils and displaces the air, and then sealed while hot.

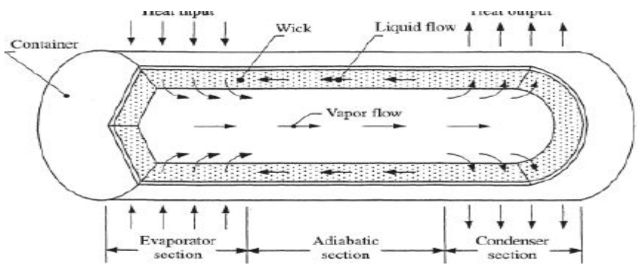


Fig : heat pipe

TYPE OF HEAT PIPES:

There are various types of heat pipes now a

days .let's have a brief introduction of these heat pipes

1. CONVENTIONAL HEAT PIPE:

A very important feature of the heat pipe is the ability to transport a large amount of energy over its length with a small temperature drop by means of liquid evaporation at the heat pipe evaporator, vapour condensation at the condenser and liquid movement in the opposite direction inside a wick by capillary force.

Essential is the possibility to change the direction of heat flow along the HP in time and to use Heat pipe for cooling and heating alternately.

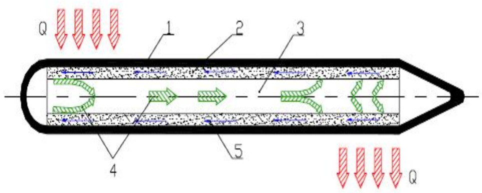


Fig: conventional heat pipe

2. LOOP HEAT PIPE:

In the LHP the capillary pumped evaporator is used instead of a boiler. Such an evaporator is more flexible from the point of view of its orientation space and is more compact. In the LHP there is a possibility to use an evaporator above the condenser. In the LHP the vapour flows through the vapour channels towards the condenser and the liquid goes back the evaporator due to the capillary pressure head of the porous wick. In the near future an LHP should be used as thermal control devices in scientific and telecommunication satellites (efficient and flexible thermal link between dissipative elements and radiators). From a

Thermal modeling point of view, on the one hand the simple spreadsheet analysis is only convenient at the LHP, or thermal subsystem level. On the other hand, a complete thermo hydraulic analysis tool could be heavy and time-consuming for system level modeling.

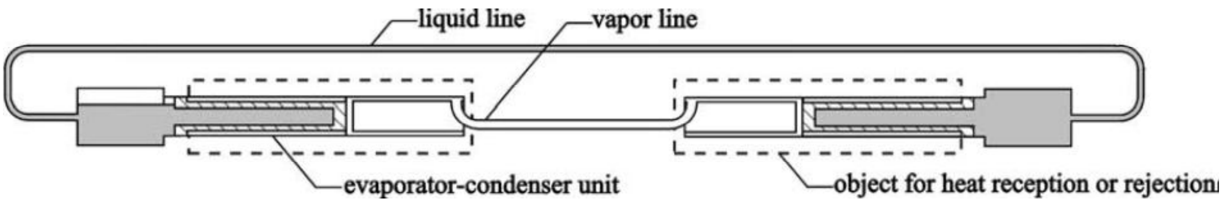


Fig: oop heat pipe

3. PULSATING HEAT PIPE:

Pulsating heat pipes have also emerged as interesting alternatives to conventional heat pipes. PHP have complicated thermo hydrodynamic operational characteristics. In fact, it is rare to find a combination of such events and mechanisms like bubble nucleation and collapse, bubble agglomeration and pumping action, flow regime changes, pressure/temperature perturbations, dynamic instabilities, metastable non-equilibrium conditions, flooding or bridging etc., all together contributing towards the thermal performance of a device.

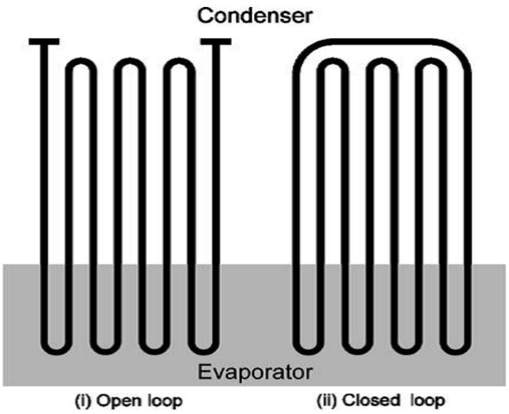


FIG. Pulsating Heat Pipe

4. SORPTION HEAT PIPES:

The sorption heat pipe (SHP) is a novelty and combines the enhanced heat and mass transfer in conventional heat pipes with sorption phenomena of a sorbent bed. Sorption heat pipe could be used as a sorption heat transfer element and be cooled and heated as a heat pipe . The sorption heat pipe has a sorbent bed (adsorber/desorber and evaporator) at one end and a condenser and evaporator at the other end.

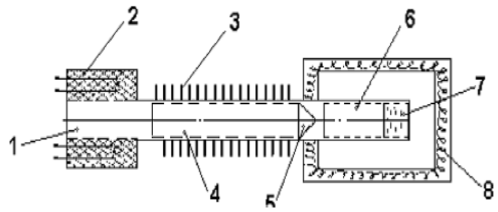
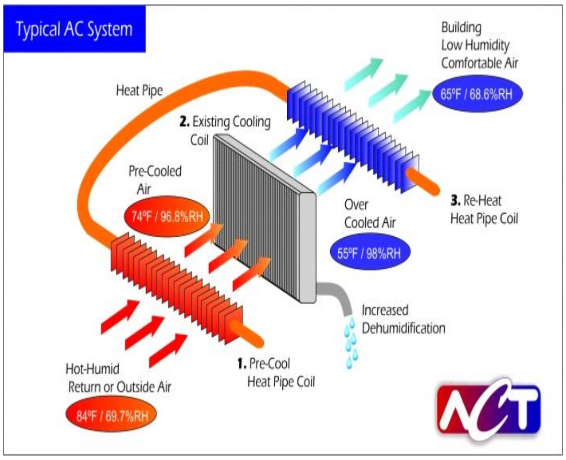


Fig. Sorption heat pipe. Longitudinal cross section, [3]. (1) Vapour channel;(2) porous sorption structure(3),finned surface of heat pipe evaporator/condenser;(4) porous wick inside heat pipe; (5) porous valve;(6) heat pipe low temperature evaporator with porous wick;(7) working fluid accumulated inside the evaporator; and (8) cold box with thermal insulation.

APPLICATION OF HEAT PIPE:

It is used in various fields now a days. let's we discuss one of the major application of heat pipe in dehumidification process

(i) Wrap-around enhanced dehumidification heat pipe heat exchanger :



Step 1. Incoming return or outside 84°F air is pre-cooled to 74°F DB/ 96.8%RH by the pre-cool heat pipe coil.

Step 2. The pre-cooled air flows through the existing AC evaporator cooling coil at 55°FDB / 98%RH. By adding a pre-cool heat pipe coil, the system now functions more efficiently and can perform higher levels of latent cooling and increased dehumidification. Often times a smaller capacity AC system can be chosen due to the increased cooling performance from the pre-cool coil.

Step 3. The air leaving the existing AC evaporator coil is in an over cooled state and requires re-heat. The re-heat heat pipe coil is sized to bring the entering building air to a more comfortable range of 65°FDB / 68.6% RH. ASHRAE standards describe m any instances for the requirement of humidity control. Since the building air now has low levels of humidity and more comfort, thermostat temperatures can be set higher, saving even more energy.

The addition of the ACT-HP-WA Wrap-Around System can effectively increase the dehumidification performance of any HVAC system.

FEATURES:

- Enhanced dehumidification by pre-cooling incoming airstreams
- Totally passive, no moving parts or system maintenance
- Installing an ACT-HP-WAHX may result in the choice of a smaller AHU
- Eliminates typical overcooling to dehumidify, plus free passive reheating of the buildings entering airstream

Areas of application:

- Hospitals
- Theaters
- Fitness Centers
- Government Facilities
- Universities
- Condos/hotels
- Food & Restaurant Facilities

(b) Cold storage :

The proposed system utilizes a special type of heat pipe – wickless heat pipe or named thermosiphon as shown in following fig.

A thermosiphon is made from a sealed metal pipe as its container. Unlike conventional heat pipes in which wick structure is built on the internal wall of the pipe, the thermosiphon internal wall has none wick to be built. As well known, the function of the wick is for capillary of liquid from condenser section to evaporator section in the heat pipe and vaporizing the liquid when heat is applied at the heating area, Without wick structure, the thermosiphon will not work when the heat is applied at the condenser section when this section is positioned on top of the thermosiphon, specially, when the thermosiphon is vertically located. Thus, alternatively, thermosiphon has an another name that is thermal-diode heat pipe. A certain amount working fluid which can vaporize and condense in a proper temperature range will be charged into the pipe. All no condensed gases inside of the pipe will be fully evacuated. An evaporator section of the thermosiphon is locating at the bottom area of the pipe which is dipped into the media (water) of the storage and a condenser section with fins equipped is locating at the top area of the thermosiphon which will be exposed to the ambient air, as shown in Fig. When the media (water) temperature in the storage is higher than ambient temperature or the ambient temperature is lower than water temperature, for example, during a winter season in a cold territory, working fluid in the evaporator will be vaporized and extracting the heat from the high temperature media resulting in media temperature decreasing. The vapor will carry the heat moving up into the condenser section and transfer the heat into fins. The fins will dissipate the heat into the low temperature ambient air. Simultaneously, the vapor in the condenser section will be cooled down and condensed back to liquid phase then returning to the evaporator section by gravity. This thermal cycle will be continuously carried on by means of the evaporation condensation process when the temperature of the storage media (water) is higher than the ambient temperature. However, when ambient temperature is equal to the storage media's temperature or higher than it, the heat transfer will be automatically stopped since thermal cycle has been broken due to none wick structure being built inside of the pipe. This is the unique characteristics of the thermosiphon. With this one way heat transfer characteristics it can be ensured that the heat will not be transferred in opposite way from ambient to the media during hot weather. ambient to the media (water) during hot weather as shown in right hand side picture in the given fig.

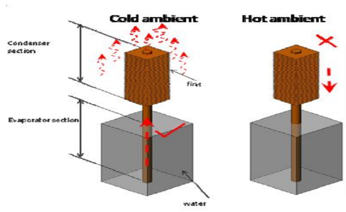


Fig: thermosiphon

CONCLUSION:

A short review of heat pipe R&D contains mainly data from FSU which testifies, that heat pipes are very efficient heat transfer devices, which can be easily implemented as thermal links and heat exchangers in different systems to ensure the energy saving and environmental protection.

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