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Recent trends in Heat pipe applications: A review

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***Abstract*— Heat pipe is the apparatus which is very much in talk as a heat transfer device in the recent scenario of heat transmission efficiently. Heat pipe applies the principle of evaporation and condensation of fluid to transfer heat. Heat pipe has a wide range of applications in aerospace, electronics packaging, building thermal management, material processing, nuclear, thermo-electro-mechanical device, heat pipe, heat exchanger and thermo siphon designers and manufacturers; mechanical, electrical and civil engineering students. This review highlights the importance of heat pipes in the current market.**

***Keywords*— Evaporation and condensation, electronics packaging, building thermal management**

I. INTRODUCTION

The heat pipe was originated by Grover in Los Alamos for use in thermionic direct conversion devices. Isothermalization is its main feature as it is possible to control the temperature of operation of the pipe by introducing a controlled pressure of inert gas, such as helium or argon.

A heat pipe is a two phase device with very high conductivity contains a hollow tube with the wick at inside walls. Heat pipe is a closed evaporator-condenser system which is a vacuum tight device. In the heat pipe, components are like working fluid and the wick are there which is covered by an envelope.

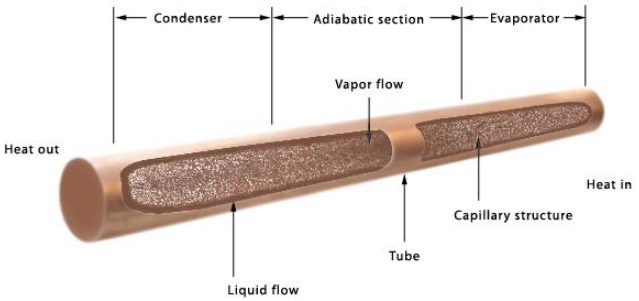

Fig. 1 Heat pipe structure

The most efficient cooling is obtained by heat pipe in which evaporation and condensation of working fluid take place simultaneously in the wick structure. The working fluid evaporates by absorbing heat from the heat source and gets vaporized. The vapour of fluid passes to condenser through the wick structure where it losses latent heat and gets cooled. Condensate means working fluid in liquid form returns to evaporator by capillary action. This process continues until the temperature of both evaporator and condenser get maintained.

Heat pipes are a low cost solution to the cooling problem. They are most effective and have great potential as power levels and volume requirements increase. For these reasons heat pipes have been applied up to now mainly in applications with special working conditions and requirements, such as in space thermal control, in aircraft devices, in traction drives, in audio amplifiers, in cooling of closed cabinets in harsh environmental conditions.

II. LITERATURE SURVEY

The heat pipe is a highly conductive device to transfer heat over a long distance with a less temperature difference between the heat source and heat sink. Very narrow research has been done with the applications of heat pipes in automobile design or manufacturing.

A number of areas for the use of heat pipes include using the heat pipe as a device for controlling the catalytic converter temperature, early warm up of the catalyst bed, heating of the rear defogger and passenger compartment, engine cooling, and oil cooling. Some of the developed applications include the use of heat pipes to intend and organize of the die casting cooling system. Similar applications of heat pipes include the use of heat pipe for the control of the solidification process and material flow during injection molding. Other manufacturing applications may contain the use of heat pipes for the cooling of machining tools during metal cutting and grinding.

Theoretical examination and outcome for one of the projected designs for the control of catalytic converter temperature are obtainable. The analysis results for the anticipated design show that heat pipes can be used for proficient control of the catalyst bed temperature and will lead to a decrease in the early exhaust emissions by allowing the catalyst to reach the light off temperature in a shorter time.

Thermal performance of heat pipe becomes poorer rapidly when heat pipe is compacted in order to be mounted on electronic equipments. This is because the highest heat transfer rate and thermal resistance of heat pipe are powerfully related to inner vapor and liquid flow space, so

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heat pipe does not work well when these spaces are lessened. In order to conquer this issue, we have obtained ultra-thin heat pipe which has both high maximum heat transfer rate and thin thickness by optimizing the inner structure.

Heat pipes are very stretchy systems with regard to the effective thermal control. They can be implemented as heat exchangers inside sorption and vapour-compression heat pumps, refrigerators and other types of heat transfer devices. Miniature and micro heat pipes are good for the electronic components, cooling and space two-phase thermal control systems. Loop heat pipes, pulsating heat pipes and sorption heal pipes are the innovation for the modern heat exchangers. Heat pipe air pre-heaters are used in thermal power plants to preheat the secondary/primary air mandatory for combustion of fuel in the boiler using the energy existing in exhaust Hue gases. Heal pipe solar collector's arc hopeful for the domestic use.

Heat pipes are broadly used as a cooling system in diverse equipment such as air conditioning systems, electronic boards, etc. To improve the heat transfer, these pipes can be finned, or enlarged the air velocity by using a fan. This study intended at exploratory the cooling effect of a finned Capillary-Driven heat pipe with forced convective heat transfer on an electronic board with known heat flux. Also, the effects of size and number of fins on the heat transferred from the electronic board were deliberated for different power inputs. The values of transferring heat were compared to and validated by the various heat transfer empirical equations existing in the literature. To gain the correct arrangement of the fins and to learn the heat transfer, the motion of air through the fins was simulated in 2-D, and the segment of the fins effective in the heat transfer process was determined. The results gained from changing the fin dimensions showed that the fin width (W) is the critical dimension so that when air velocity and other dimensions are kept constant. The rate of heat transfer also increases with increasing fin length (L), but the effect of increase is less than that of the fin width (W).

Perhaps the best way to exhibit the heat pipes application to electronics cooling is to present a few of the more common examples. Presently, one of the highest volume applications for heat pipes is cooling the Pentium processors in notebook computers. Due to the some degree of space and power available in notebook computers, heat pipes are preferably suited for cooling the high power chips.

Fan assisted heat sinks require electrical power and diminish battery life. Standard metallic heat sinks able of dissipating the heat load are too large to be integrated into the notebook package. Heat pipes, on the other hand, offer a high efficiency, passive, compact heat transfer solution. Three or four millimeter diameter heat pipes can successfully eliminate the high flux heat from the processor. The heat pipe spreads the heat load over a comparatively large area heat sink, where the heat flux is so low that it can be successfully degenerated through the notebook case to ambient air. The heat sink can be the obtainable components of the notebook, from Electro-Magnetic Interference (EMI) shielding under the key pad to metal structural components. Various configurations of notebook heat pipe heat sinks.

Heat pipe are admired in applications such as air conditioning, space technology, electronics, cooking etc. A literature review on heat pipe for air conditioning applications is conducted. The focus on the dehumidification enhancement and sensible heat recovery aspects of heat pipe heat exchanger for an air conditioning application. The application of a heat pipe heat exchanger in the conventional air conditioning systems is suggested as efficient resources for energy reserves and dehumidification enhancement to maintain satisfactory room circumstances. It exposes the idea about various parameters and methods that used for dehumidification enhancement and heat recovery application. The use of heat pipe heat exchanger for heat recovery and dehumidification enhancement application makes considerable changes in indoor air quality and energy expenditure. So the use of HPHX is strongly recommended for Air Conditioning applications.

Heat transfer is one of the most complex tasks in thermal management of electronic components and straight influences cost, consistency and performances. Heat pipes are well-organized heat transfer devices used in many applications, e.g. electronic systems, spacecraft's thermal control, energy collectors, power generation, chemical engineering, air conditioning, engine cooling and others. At normal working temperatures all heat pipes have heat transfer limits imposed by the capillary transport capabilities in the presence of high heat fluxes. Typical the wick or capillary structures and common working fluids show compensation in some aspects and disadvantages in others. After a general introduction and a short narration of the history of heat pipes developments, an outline of the current rational property environment and market is existing to identify trends for future developments. Then an indication of recent patents related to heat pipes technology is presented, with particular reference to: flat heat pipes, flexible heat pipes, innovative the wick structures, phase change materials, innovative working fluids. Concerning flat and flexible heat pipes, a number of patents are shown that are characterized by different geometries and materials and, differently from usual cylindrical heat pipes, are mainly suited for use in microelectronics applications. Patents related to innovative the wick structures are shown that are aimed to overcome some limitations associated with usual the wick structures (woven mesh or sintered powder). Patented heat pipes architectures are also described that are calculated to expand the operating temperature range by using suitable phase change materials. In addition, recent patents are shown that utilize the use of binary mixtures as working fluids to improve the heat pipes efficiency compared to predictable pure working fluids.

III. CONCLUSION

This review of heat pipe concludes that heat pipe is very important and versatile device to have efficient heat transmission over a wide range of applications. In the current market scenario applications of heat pipe has been increased

to get the desired cooling effect as per discussion which may increase the demand of heat pipe in the coming future.
Heat pipe has been encouraging advantages when it is used in energy recovery application. It is also relevant for cooling in automobile, air conditioning, electronic component etc. Heat pipe also used in solar application for power generation or water heating application. It is also accomplished that the use of heat pipe in any function gives better thermal performance as well as economic benefit.

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