Design, Fabrication and Testing of Heat pipe Heat-Exchanger

Tala Jons[1] Sanghani Alpesh[2] Sanghani Akshay[3] Tailor Akshay[4] Bharat Khalasi[5]
[1,2,3,4]Student [5]proessor
[1,2,3,4,5]Department of Mechanical Engineering
[1,2,3,4,5]PSE, Surat

Abstract— Heat pipes are suitable or appropriate in order to effectively control thermal heat transfer rate. It can easily be installed in Heat Exchangers. Working fluid plays an important role in heat pipes for conducting heat transfer rate. Heat pipe heat exchangers are widely used for heat recovery in different ranges due to its simple construction, high flexibility and high reversibility. We are going to conduct various tests on different property of working fluid of heat pipes and will search best working fluid for heat pipes. Fluid used nowadays can transfer limited amount of heat but in this paper we will find working fluid which will increase heat transfer rate without heating of heat exchanger.

Key words: Heat pipe, Heat-Exchanger, Working Fluid, Heat transfer

I. Introduction

Heat exchanger, which transfers the heat from one medium to another, is the most common thermal equipment in various industry sectors. It's widely used in chemical, energy, machinery, transportation, refrigeration, air conditioning and aerospace fields. Apart from assuring the certain technological processes and necessary conditions, heat exchanger also provides solutions to the heat recovery and energy conservation of the industry secondary energy.

As a kind of heat exchanger, heat pipe heat exchanger (HPHE) often has a rectangular shell with many finned heat pipes mounted inside. In the middle of the shell, there is a diaphragm, which partitions the shell into two channels, high-temperature fluid channel and low-temperature fluid channel. When the two flows pass through their respective channels simultaneously, the heat energy is transferred from the high temperature fluid to the low one by the heat pipes. Because of its simple structure, high heat exchanging efficiency and low pressure loss, HP heat exchanger has won a good graces and extensive market of many industries.

Heat exchangers made of heat pipes are one of the most effective devices for waste heat recovery. The advantage of using a heat pipe over conventional methods is that large quantities of heat can be transported through a small cross-sectional area over a considerable distance with no additional power input to the system.

A HPHE is a liquid coupled indirect heat transfer type heat exchanger and employs a number of individually sealed or groups of heat pipes or thermosyphons as the major heat transfer means from the high temperature to the low temperature fluid. Each heat pipe is lined with a wicking structure in which a small amount of working fluid is present and can be divided into an evaporator or heat addition section and a condenser or heat rejection section. When heat is added to the evaporator section, the working fluid present in the wicking structure is heated, vaporizes and flows to the cooler section, condenses and, in so doing, giving up its latent heat of vaporization. The capillary forces in the wicking structure then pump the liquid back to the evaporator.

The advantage of using a heat pipe over the other ordinary methods to heat transfer is that a heat pipe can have an extremely high thermal conductance in steady state operation. Hence, it can transfer a high amount of heat over a relatively long length with a comparatively small temperature difference. A heat pipe with liquid metallic working fluid can have thermal conductance much more than the best solid metallic conductor such as copper.

A heat pipe is a simple device that can quickly transfer heat from one point to another. They are often referred to as the "superconductors" of heat as they possess an extra ordinary heat transfer capacity & rate with almost no heat loss.

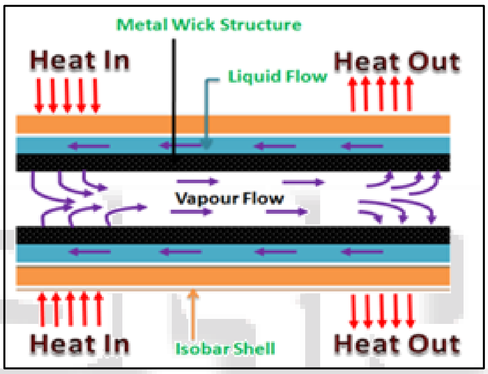

Fig. 1:

II. Problem Definition

The aim of our project is to carry out various tests to calculate heat transfer rate of working fluids used in heat pipes and to find out the best among all. This will increase the performance of heat pipe heat exchanger and will remove the difficulty faced due to working fluid in heat pipe heat exchanger. And also will reduce the high cost of working fluid.

III. Objective

- To improve the performance of heat pipe.
- To find the best possible working fluid for heat pipe heat exchanger.
- Reduce the use of costly working fluid for heat pipe

IV. Literature Review

K.S.Ong[1]:*

Heat pipe heat exchanger could be employed as run-around coils in air conditioning systems for dehumidification and cooling. It reviews some of the work conducted on the cooling and dehumidification aspects in many air conditioning system. They have been proved to be effective in enhancing dehumidification and reducing air conditioning costs.

EhsanFirouzfar and Maryam Attaran[2]:

Heat pipes are two phase heat transfer devices with high effective thermal conductivity. Due to the high heat transport capacity, heat exchangers with heat pipes has become much smaller than the traditional heat exchangers in handling heat fluxes. With the working fluid in heat pipe, heat can be absorbed on the evaporator region and transported to the condenser region where the vapour condensed releasing the heat to the cooling medium. Heat pipe technology has found increasing application in enhancing the thermal performance of heat exchangers in microelectronics, energy saving in HVAC systems for operating rooms, surgery centers, hotels, clean rooms etc, temperature regulating systems for the human body and other industrial sectors. Development activity in heat pipe and thermosyphon technology in Asia in recent years is surveyed. Some new results obtained in Australia and other countries are also included.

S.H. Noie-Baghban, G.R. Majideian[3]:

Research has been carried out on the theory, design and construction of heat pipes, especially their use in heat pipe heat exchangers for energy recovery, reduction of air pollution and environmental conservation. A heat pipe heat exchanger has been designed and constructed for heat recovery in hospital and laboratories, where the air must be changed up to 40 times per hour. In this research, the characteristic design and heat transfer limitation of single heat pipes for three types of wick and three working fluids have been investigated, initially through computer simulation. Construction of heat pipes, including washing, inserting the wick, creating the vacuum, injecting the fluid and installation have also been carried out. After obtaining the appropriate heat flux, the air-to-air heat pipe heat exchangers was designed, constructed and tested under low temperature operation condition using methanol as working fluid. Experimental results for the absorbed heat by evaporator section are very close to the heat transfer rate obtained from computer simulation. Considering the fact that this is one of the first practical applications of heat pipe exchangers, it has given informative results and paved the way for further research.

Eiji Okamoto, Yasuhiro Fukaya, MichiioChikami[4]:

Being a heat pipe heat exchanger where in a group of heat pipes are thereof is petitioned, a high temperature fliud being let to flow into one end and low temperature fluid into other end respectively, so that, by the specific properties of the heat pipes, the heat given from the high temperature fluid is transferred to the low temperature fluid through the sealed in fluid in the heat pipes, a plurality of heat pipes of which those on at least the high temperature fluid passage side are bare pipes are arranged to extend over both passages, and the heat pipes on the high temperatures fluid passage side are inserted in finless outer pipes. At least the outer surface of these finless outer pipes are treated for resistance to corrosion. Also, these finless outer pipes and the heat pipes are joined by a heat conductive material, so that heat pipes can be easily demounted and therefore the efficiency the heat passage cane be varied as required.

Y.H. Yau et al [5] present the application of horizontal heat pipe heat exchangers for air conditioning in tropical climates was conducted. This paper focused on the energy saving and dehumidification enhancement aspects of horizontal heat pipe heat exchangers. It was revealed that although there are a number of valuable researches on the impact of heat pipe heat exchangers on the energy consumption and dehumidification enhancement of air conditioning systems in the tropics, but only limited research work on the application of horizontal configuration heat pipe heat exchangers in air conditioning systems has been carried out in these regions. A literature review was carried out on the application of HPHXs in HVAC systems in tropical climates. This review testifies that HPHXs in both configurations, i.e., vertical (thermosyphon) and horizontal configuration, can be implemented as an efficient energy recovery unit in air conditioning systems to remove heat or coolness and dehumidification purposes. Moreover, literature review on the application of horizontal configuration HPHXs installed with air conditioning systems in tropical climates reveals that although the humidity control is one of the main concerns in indoor comfort quality in tropical climates, but investigations regarding the application of horizontal configuration HPHXs for dehumidification enhancement and energy saving purposes in air conditioning systems are limited and most of the studies have been carried out in sub-tropical climates. For condensate drainage considerations, the horizontal configuration HPHXs are recommended especially in tropical climates.

V. Conclusion

The report on the heat pipe heat exchanger shows that heat pipe heat exchanger is very efficient heat transfer device. This report shows the basic of heat pipe and construction and principle of heat pipe which are used in heat pipe heat exchanger. This study as a whole offers an overview of an analytical method applicable to the design of heat pipe heat exchanger. The design procedure and step by step calculation are introduced in this report. The total heat transfer rate, thermal conductance, heat transfer co –efficient was computed. From the experimental result we conclude that when we increased the hot air inlet temperature the heat transfer rate will be increased and when we increased the mass flow rate of air heat transfer co efficient will increased. The result obtain from experimental procedure we concluded that when we increase the mass flow rate of air, mass velocity will be increased. The examination of heat transfer limits for water as a working fluid showed that the minimum heat transfer is well above the required heat transfer

References

[1] K.S. Ong*, review of heat pipe heat exchanger for enhanced dehumidification and cooling in air conditioning system.
[2] EhsanFirouzfar and Maryam Attaran, vol:2, no:11,2008, A review of heat pipe heat exchanger in Asia.
[3] S.H. Noie-Baghban, G.R. Majideian vol. 20(14):1271-1282, doi: 10.1016/S1359-4311(99)00092-7, 1 October 2000, waste heat recovery using heat pipe heat exchanger (HPHE) for
[4] Eiji Okamoto, Yasuhiro Fukaya, MichiioChikamiaug 27 1985, heat pipe Heat Exchangers surgery rooms in hospitals.
[5] Y.H. Yau, M. Ahmadzadehtalatapeh “A review on the application of horizontal heat pipe heat exchangers in air

conditioning systems in the tropics" Applied Thermal Engineering 30 (2010) 77–84 26 july 2009

