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Design and Manufacturing of Heat Pipe to Improve Heat Transfer to Road Surface

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Abstract: *In cold climate, the formation of ice on roads can create serious problems impacting the safety of personnel. In this project we design a setup consisting of heat pipes and temperature sensors. When roads get covered in ice by using heat transfer principle we are making a provision of melting ice. We will arrange the setup of heat pipe under the roads such that when the heat pipe will start working the heat will be transferred to the road surface with the help of copper plate. The ice starts melting from one degree Celsius thus we will attain a temperature of heat pipe between 15-20 degree Celsius. This temperature is normal and humans as well as vehicle tyres will not be affected by this temperature. This temperature will be managed by temperature sensor.*
Keywords: *Thermosyphon, heat pipe, temperature sensors, Melting ice,*

I. Introduction

The deicing system is the representative capital dense system, and it needs to be invested by large scale manpower, material resources and financial resources in the process of development, construction and operation. At present, the usual snow-melting and deicing technologies mainly include manual snow and ice removing, chemical snow and ice melting, mechanical snow and ice removing and physical snow and ice removing technology. The manual deicing method could remove ice and snow with better effect. The chemical deicing technology is to bestrew chemical medicaments on the highway surface to reduce the melting point and melt snow and ice, and accordingly remove snow and ice, and this method is a sort of highway surface ice and snow removing measure in international common use. The mechanical deicing technology is the method which utilizes machines to remove snow and ice from the highway surface.

The physical deicing technology mainly includes following aspects at present.

(1) Energy storage highway deicing technology is to establish the energy storage cycle system which could heat the highway surface through the flow of heat liquid stored in the cycle pump in ice and snow weather, and accordingly achieve the effect of removing snow and ice.

(2) Electrothermal process highway surface deicing technology is to lay heating resistance wire or electric materials and electrify and heating the highway surface to deice when ice and snow come.

(3) Heating mechanical composite deicing technology is to combine mechanical method with heating method, exert their own advantages and increase the efficiency of removing ice and snow.

Highway network combination has special characters. So we should seriously select proper snow-melting and deicing technology to realize the optimization of benefit and cost. Under general situation, the bridge surface spreading is smaller than 10cm. So, it is very important that the adopted heating mode or radiating materials don't influence the normal work status of bridge surface, and the spreading of heating system should not influence the using performance of waterproof and use of bridge surface. The construction of bridge surface heating system needs special technical requirement, and at the same time, the bridge is exposed in air, and it has multiple radiating surfaces, and the air circulates quickly, and the heat consumption is much larger than pure highway surface, and the utilization rate of heat efficiency or heat is much lower than the highway surface, so we need develop the control system which can automatically adjust the energy supply tension according to exterior environment temperature and air flow speed. Because the bridge temperature fields induced by heating are different, so the temperature difference between bridge surface and girder bottom will induce additive temperature stress. Therefore, the bridge surface deicing system design will face more limitations.

II. Objective

The objectives to study performance of heat pipe and two phase thermosyphon heat pipe charged with Methanol is as follows,

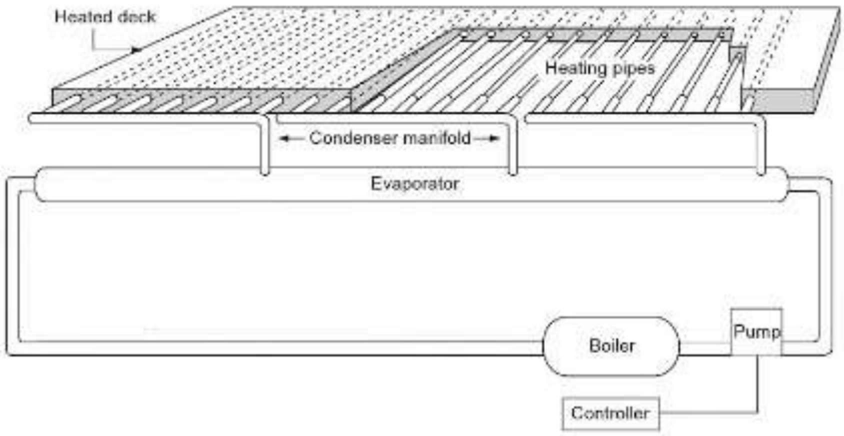
1. To implement a thorough literature study on heat pipe and thermosyphon, and explore the possible efficient working conditions for both pipes.

2. Carry out a series of experiments which will lead to a full understanding of working principle of two phase close loop thermosyphon heat pipe and heat pipe
3. To understand overall comparison between the two systems performance.
4. To investigate effect of variable source temperature on resistance and effective thermal conductivity.
5. To evaluate effect of variable mass flow rate on performance of two phase thermosyphon and heat pipe.
6. To compare the performance of heat pipe heat exchanger charged with Nano fluid to that of heat pipe charged with same Nano fluid under same mass flow rate and source temperature.

III. Principle Of Operation

III.1) Working Principle:

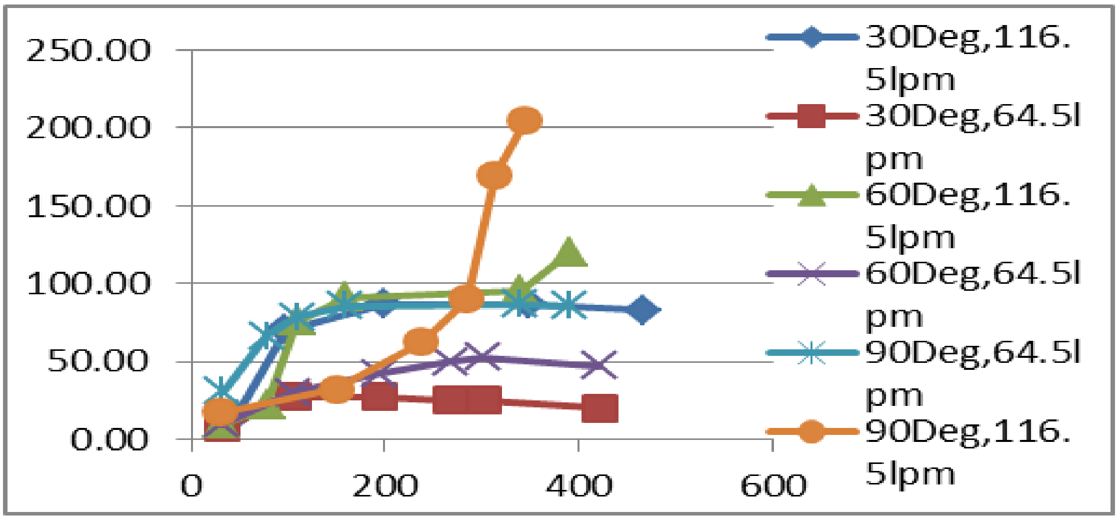
In a thermosyphon, liquid working fluid is vaporized by a heat supplied to the evaporator at the bottom of the heat pipe. The vapor travels to the condenser at the top of the heat pipe, where it condenses. The liquid then drains back to the bottom of the heat pipe by gravity, and the cycle repeats.



IV. Analysis

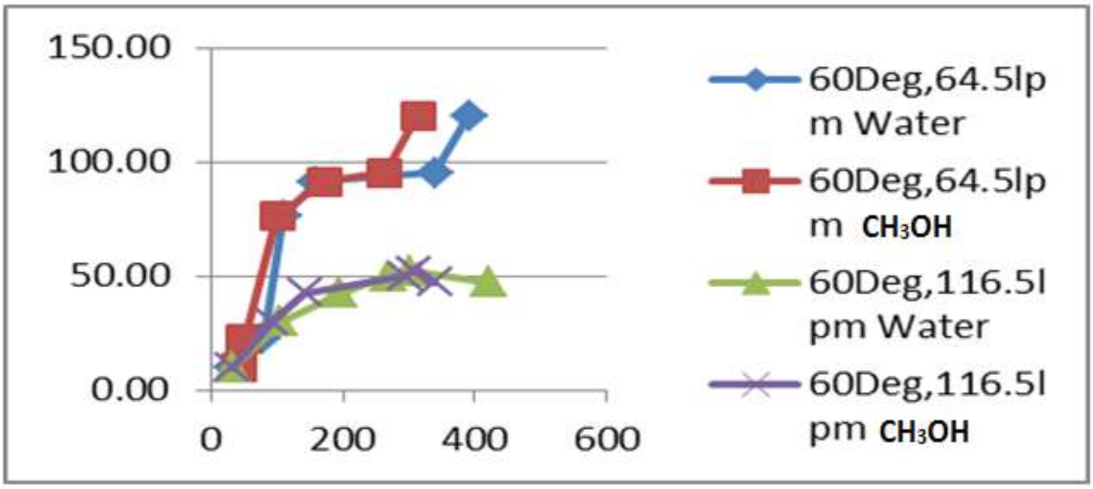
Characteristics curves

The observations and calculations provides us with the distinct values of heat transfer rate with respect to time. Along with this the various other heat transfer parameters are compared to meet the objectives of gathering the result with various inclination angles, varying mass flow rate and the variability in heat transfer property with different working fluids. The graphs are plotted in order to achieve the primary objectives related to the experimentation.

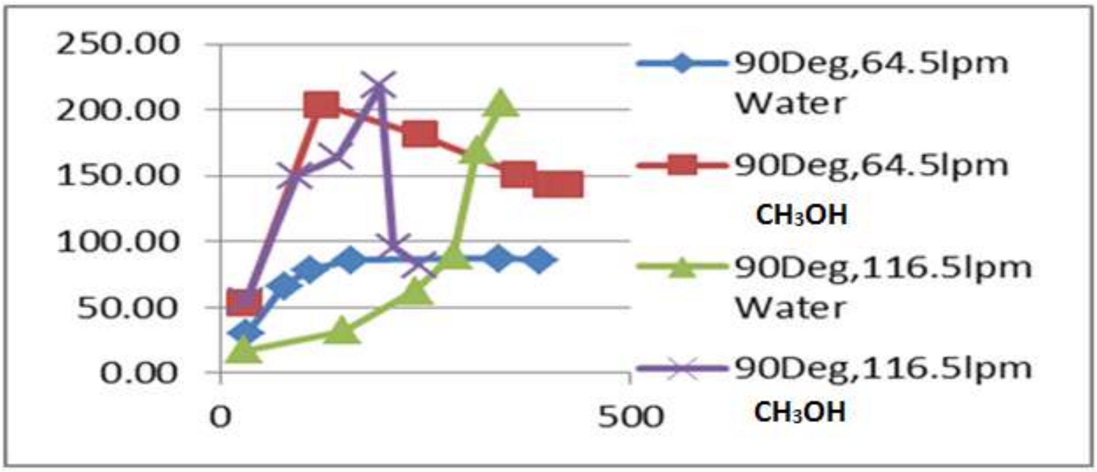


Q vs T

Variation of Heat transfer rate (CH_3OH), with inclination angle & change in mass flow rate



Q vs T
Comparison between the working fluids (CH_3OH, Water) at an inclination angle of 60 Degree



Q vs T
Comparison between the working fluids (CH_3OH, Water) at an inclination angle of 90 Degree

Inclination Angle 90° **Mass Flow Rate 64.5 lph**

Sr No	T(in)	T(out)	T(evap)	T(cond)	Time	Q	K(eff)	Resistance
1	31.3	32.9	40	36.1	41	120.99	0.94	0.03
2	31.3	33.2	45	36.1	50	143.67	0.41	0.06
3	31.3	36.9	50	43.8	100	423.46	0.59	0.01
4	31.3	37.7	55	47.6	171	483.95	0.49	0.02
5	31.3	37.8	58.4	49.5	264	491.51	0.41	0.02
6	31.3	38.2	60	49.6	314	521.76	0.35	0.02

Table: Observations for 90° inclination angle and 64.5 lph mass flow rate

V. Conclusion

Ice and snow have always been a challenge for road administrators in cold climates. Increasing demands on accessibility and safety in rural roads can lead to a costly winter maintenance. The common way of handling ice and snow on a road is to use snow-ploughs and de-icing salt. Salting creates technical and environmental issues such as decreased durability of different types of pavement material and soil saltification along roads. An alternative method for de-icing is to use the HP system using renewable energy. Using HP systems to create sustainable ice free roads could decrease traditional road maintenance costs for instance salting and snow-ploughs as well as increasing the lifetime of the transport infrastructure. Thermosyphons having CH_3OH filled in it. In condenser section, pipe wall temperatures increase towards the end where the coolant outlet pipe was located. The increase was due to the gain of heat by coolant water flowing from inlet to outlet section of condenser.

1) The inclination angle had a significant effect on wall temperatures along the wickless heat pipe. The wall temperature in evaporator section was observed to be lower at inclination angles 0^0 to 20^0, after that wall temperatures increases and reached maximum at 60^0 to 90^0. This trend was observed for all the pipes charged with water and CH_3OH as working fluid.
2) The maximum heat transfer rate was found to be high for CH_3OH compared to water.
3) The heat transfer coefficient was observed to be higher for tilted pipes of inclination angle 10^0-20^0 and poorest for almost horizontal wickless heat pipe.
4) While considering the observations related to inclination angle for both fluids the vertical thermosyphon or inclination angle of 90 º proves to be efficient.
5) In the consideration of varying mass flow rate, we can conclude that, higher the flow better is the heat transfer in the thermosyphon.

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