INVESTIGATION ON THERMAL PERFORMANCE OF HEAT PIPE BY OPTIMIZING NANO - FLUIDS AND EVACUATED GLASS TUBE MATERIAL

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Abstract

In present work it has been observed that at soda lime silicate glass evacuated tube 10 mm wall thickness of copper pipe material engage with glass material configuration shows higher convergence compared to previous configurations. The results are validated with reported base paper results. The configuration of soda lime silicate glass material gives maximum convergence on all parameters amongst all the configurations used. The (octadecane) Nanofluid on heat pipe. We found that they exhibit optimum temperature distribution and mass transformation in capillary tube of heat pipe. Our analysis found that Erythritol Nanofluid have higher temperature distribution in combination with soda lime silicate glass evacuated tube in heat pipe.

Keywords— *Heat pipe, Temperature, Borosilicate, soda lime silicate, copper pipe, octadecane, Erythritol, Silicon oil.*

I. INTRODUCTION

In the region of the blackened heated temperature absorption plate we saw in the previous flat plate collector, the evacuated tube collector consists of many rows of parallel appearing glass tubes connected to a header pipe. Particularly handy in areas with cold, gloomy winter weather are evacuated tube creditors. Evacuated tube creditors are constructed from one or more rows of obvious, parallel glass tubes that are supported by a frame. Depending on the manufacturer, each person tube has a diameter range of 1" (25mm) to a few" (75mm) and a length range of 5' (1500mm) to 8' (2400mm). Each tube has a thick glass outer tube and a less thick glass inner tube; this type of tube is referred to as a "dual-glass tube" or a "thermos-flask tube," and it is coated with a special coating that absorbs solar energy but prevents heat loss. The shape of these glass tubes is cylindrical. In contrast to flat panel creditors, evacuated tube creditors do not instantly warm the water inside the tubes. Instead, air is removed or evacuated from portions of the tubes' interior spaces, creating a vacuum (thus the name evacuated tubes). Because of this, the angle of the daylight is always perpendicular to the heat-absorbing tubes, allowing these lenders to function effectively even when daytime is low, early in the morning or late in the afternoon, or when it's also cloudy or overcast. The tubes are made of borosilicate or soda lime glass, which is sturdy, resistant to high temperatures, and have a high solar radiation transmittance This vacuum functions as an insulator, reducing any heat loss, particularly to the surrounding environment through convection or radiation, making the collector far more environmentally friendly than the inside insulating that flat plate lenders must give Evacuated tube collectors often yield superior fluid temperatures than their flat plate counterparts thanks to this vacuum, therefore they may also get particularly warm in the summer.

II. HEAT PIPE EVACUATED TUBE COLLECTORS

In heat pipe evacuated tube collectors, a warm-soaking reflector plate is connected to a sealed heat pipe that is often made of copper to increase the creditors' efficiency in cold conditions. Although the tube's hollow copper heat pipe is empty of air, it nevertheless contains a small quantity of a low-pressure alcohol/water mixture along with a few additives to prevent corrosion or oxidation. Due to the vacuum, a liquid can

evaporate at far lower temperatures than it would under normal atmospheric pressure. The liquid inside the heat pipe quickly turns into a heated vapour-type fuel due to the vacuum present when sunlight in the form of solar radiation strikes the bottom of the absorber plate in the tube. Since the gasoline vapor is now lighter, it climbs to the top of the pipe, where it heats it to an extremely high temperature. The evacuated tube is linked to a copper heat exchanger known as the "manifold" from the top portion of the heat pipe. The heat intensity of the vapor is transmitted to the water or glycol fluid running through the connecting manifold when the hot vapors that are still inside the sealed heat tube enter the manifold. The fresh vapour condenses back from a gas to a liquid and flows back down the heat pipe to be heat as it loses power and cools.

III. TYPES OF HEAT PIPES

The following types of heat pipes are employed to reuse the waste heat for useful applications.

- Thermosyphon
- Variable conductance heat pipe
- Diode heat pipe
- Vapour chamber or flat heat pipe
- Capillary pumped loop heat pipe

Objective

- To change the evacuated glass material with soda lime silicate, phosphate silicate, in replacement of borosilicate glass this is used in base paper.
- To change the Nanofluid of heat pipe with hexacosane, silicon oil, erytrithol, in replacement of octadecane Nanofluid used in base paper
- To define temperature by using different glass materials on heater zone copper pipe on adiabatic wall heat pipe of different materials.
- To determine the combination of glass material and Nanofluid for better heat transfer.
- Comparison between different types of Nanofluid.

IV. RESULTS

EXPERIMENTAL SET-UP

The experimental set-up was constructed in the lab to investigate the impact of different nano - fluids and evacuated glass material in heat pipe for an improvement in heat transfer and various working fluids. The experimental set-up was created to study the enhancement of heat transfer with the impact of glass material on the heat pipe.

The arrangements of flow with nano fluids within the heat pipe are made and different glass material are used for conducting experiments for the heat transfer improvement. The experimental setup is depicted in Figure below includes an electrical heater, pressure measuring gauge, temperature sensor, flow analyzer, display unit, heat pipe, hot and cold water pumps, hot and cold water valves and test section tube.

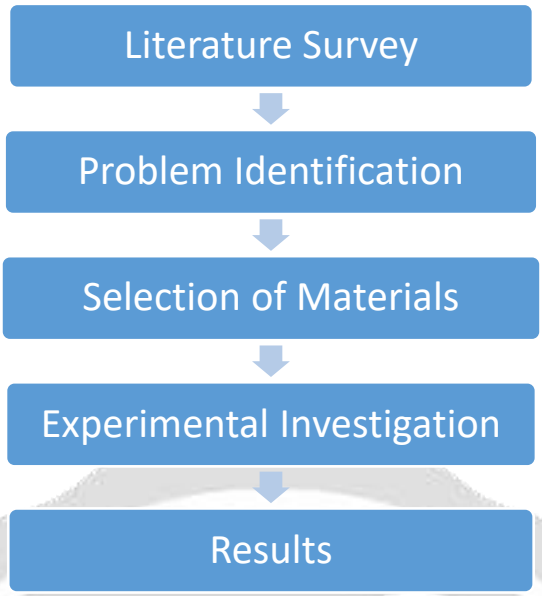
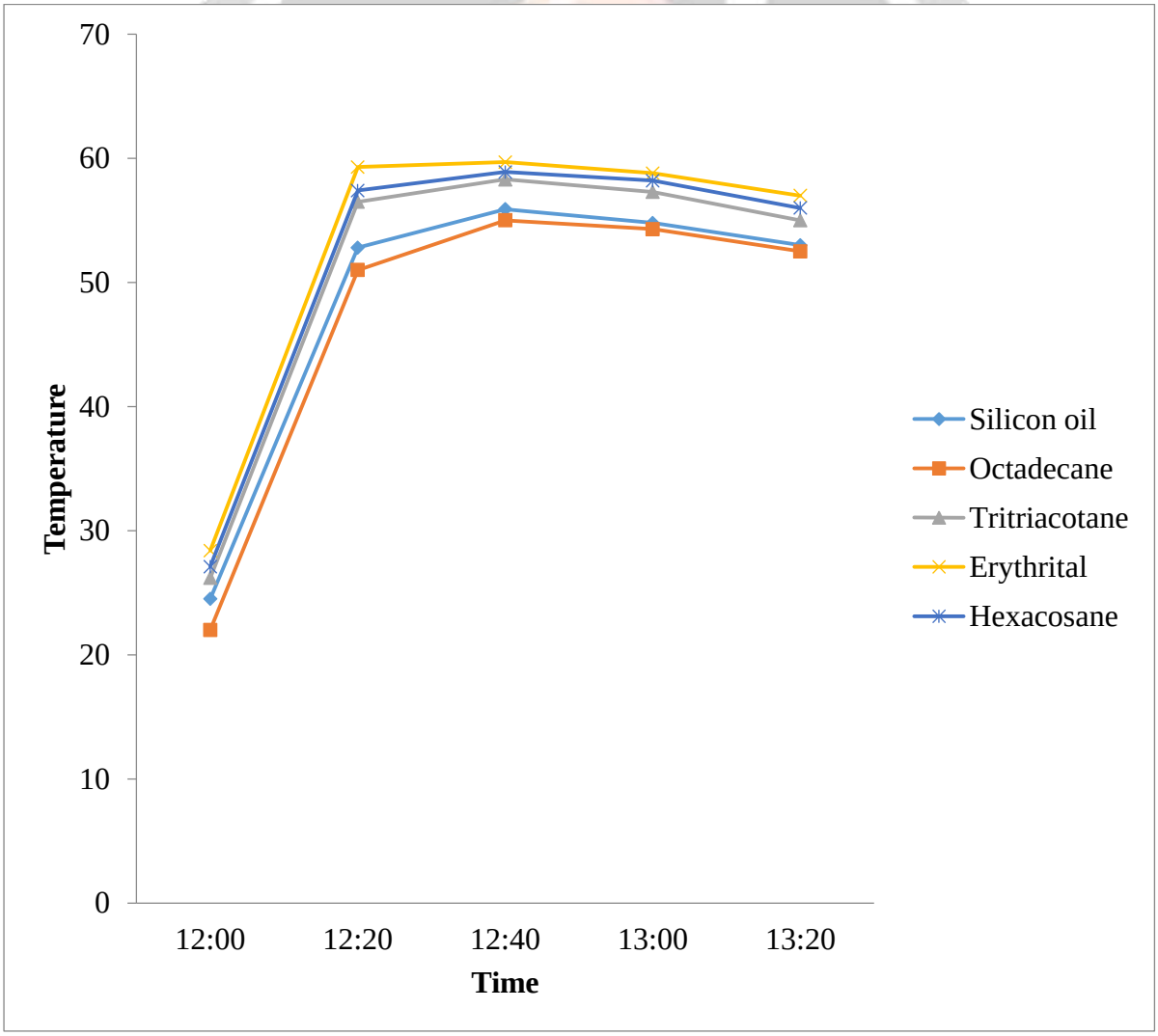
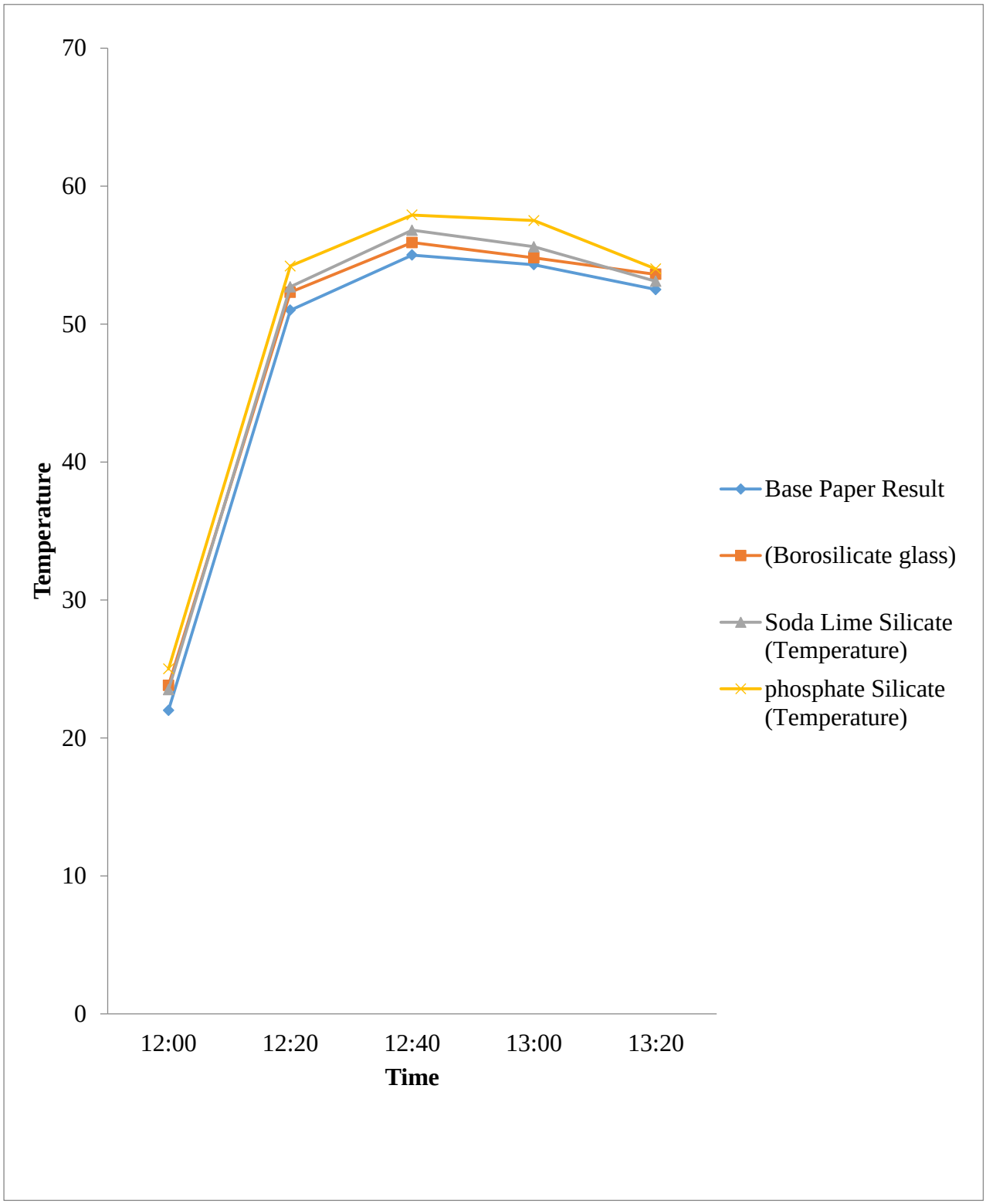


Figure: Schematic diagram of the experimental set-up.

Properties	Borosilicate glass	Soda lime silicate glass	Phosphate silicate
Density, ρ	2230 Kg/m^3	2530Kg/m^3	2585 Kg/m^3
Thermal Conductivity, K	1.14 W/m-K	0.937 W/m-K	0.57 W/m-K
Specific Heat, C_p	830J/Kg-K	720 J/Kg-K	632J/Kg-K

Nano-Fluids	Density	viscosity	Thermal Conductivity	Boiling Point
Octadecane	0.777	-	0.153 W m^{-1} K^{-1}	317 °C (603 °F; 590 K)
Silicon Oil	0.971 g/mL at 25 °C	10,000 c St(25 °C)	0.6 W/m/K	>140 °C/0.002 mmHg (lit.)
Hexacosane	0.8±0.1 g/cm^3		0.23 W/ mK	412.2±8.0 °C at 760 mmHg
Erythritol	1.45 g/cm^3		0.733W m^{-1} K^{-1}	329 to 331 °C (624 to 628 °F; 602 to 604 K)




70
60
50
40
30
20
10
0
Temperature
12:00
12:20
12:40
13:00
13:20
Time
Base Paper Result
(Borosilicate glass)
Soda Lime Silicate (Temperature)
phosphate Silicate (Temperature)

CONCLUSIONS

- Soda lime silicate with copper pipe material shows more convergence than other glass materials of heat pipe (heater zone) thus result shows improvement of 6.8% average deviation on temperature.
- Temperature distribution shows 0.73% average on simulation results than base paper results thus convergence on temperature effect is achieved.
- Thus numerical simulation of heat pipe with respect to different glass materials with copper pipe shows an optimum result on both temperature and mass transfer.
- From results, higher temperature drop is found out for Erytrithol Nanofluid comparison to different Nanofluid of heat pipe.
- Our analysis found Erytrithol nanofluid are higher temperature in soda lime silicate glass evacuated tube in heat pipe.
- The combination of sodalime silicate glass with Erythritol imposes optimum configuration in temperature distribution also this combination is economical.

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