Effect of Nano Fluid on Process of Condensation and Evaporation of Heat Pipe to Determine Temperature by using Finite Volume Method

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Abstract — The version has been simulated the usage of Ansys software program on fluent domain 15.Zero workbench so that you can take a look at diverse parameters affecting the thermal and segment transformation overall performance of heat pipe. Different varieties of glass substances of heat pipe were used with exceptional profile i.e. The simulations have been completed at a variable temperature w.R.T. Time. The simulation of the soda lime silicate glass evacuated tube offers better cost of temperature. It has additionally been discovered that at soda lime silicate glass evacuated tube 0.0005mm wall thickness of copper pipe fabric have interaction with glass cloth configuration shows better convergence compared to preceding configurations. The effects are verified with mentioned base paper results. The configuration of soda lime silicate glass material gives most convergence on all parameters among all the configurations used.

Keywords— *Heat pipe, Temperature, Borosilicate, soda lime silicate, copper pipe, octadecane*

I INTRODUCTION

The Evacuated tube collector consists of a number of rows of parallel transparent glass tubes connected to a header pipe and which are used in place of the blackened heat absorbing plate we saw in the previous flat plate collector. These glass tubes are cylindrical in shape. Therefore, the angle of the sunlight is always perpendicular to the heat absorbing tubes which enables these collectors to perform well even when sunlight is low such as when it is early in the morning or late in the afternoon, or when shaded by clouds. Evacuated tube collectors are particularly useful in areas with cold, cloudy wintry weathers. Evacuated tube collectors are made up of a single or multiple rows of parallel, transparent glass tubes supported on a frame. Each individual tube varies in diameter from between 1" (25mm) to 3" (75mm) and between 5′ (1500mm) to 8′ (2400mm) in length depending upon the manufacturer. Each tube consists of a thick glass outer tube and a thinner glass inner tube, (called a "twin-glass tube") or a "thermos-flask tube" which is covered with a special coating that absorbs solar energy but inhibits heat loss. The tubes are made of borosilicate or soda lime glass, which is strong, resistant to high temperatures and has a high transmittance for solar irradiation. Unlike flat panel collectors, evacuated tube collectors do not heat the water directly within the tubes. Instead, air is removed or evacuated from the space between the two tubes, forming a vacuum (hence the name evacuated tubes). This vacuum acts as an insulator reducing any heat loss significantly to the surrounding atmosphere either through convection or radiation making the collector much more efficient than the internal insulating that flat plate collectors have to offer. With the assistance of these vacuum, evacuated tube collectors generally produce higher fluid temperatures than they're flat plate counterparts so may become very hot in summer..

II HEAT PIPE EVACUATED TUBE COLLECTORS

Heat pipe evacuated tube collectors, a sealed heat pipe, usually made of copper to increase the collectors efficiency in cold temperatures, is attached to a heat absorbing reflector plate within the vacuum sealed tube. The hollow copper heat pipe within the tube is evacuated of air but contains a small quantity of a low pressure alcohol/water liquid plus some additional additives to prevent corrosion or oxidation.

This vacuum enables the liquid to vapourise at very lower temperatures than it would normally at atmospheric pressure. When sunlight in the form of solar radiation hits the surface of the absorber plate inside the tube, the liquid in the heat pipe quickly turns into a hot vapour type gas due to presence of the vacuum. As this gas vapour is now lighter, it rises up to the top portion of the pipe heating it up to a very high temperature. The top part of the heat pipe, and therefore the evacuated tube is connected to a copper heat exchanger called the "manifold". When the hot vapours still inside the sealed heat tube enters the manifold, the heat energy of the vapour is transferred to the water or glycol fluid flowing through the connecting manifold. As the hot vapour looses energy and cools, it condenses back from a gas to a liquid flowing back down the heat pipe to be reheated.

The heat pipe and therefore the evacuated tube collectors must be mounted in such a way as to have a minimum tilt angle (around 30o) in order for the internal liquid of the heat pipe to return back down to the hot absorber plate at the bottom of the tube. This process of converting a liquid into a gas and back into a liquid again continues inside the sealed heat pipe as long as the sun shines. The main advantage of Heat Pipe Evacuated Tube Collectors is that there is a "dry" connection between the absorber plate and the manifold making installation much easier than with direct flow collectors. Also, in the event an evacuated tube cracking or breaking and the vacuum becoming lost the individual tube can be exchanged without emptying or dismantling the entire system. This flexibility makes heat pipe evacuated tube solar hot water collectors ideal for closed loop solar designs as the modular assembly allows for easy installation and ability to easily expand by adding as many tubes as you want.

III DIRECT FLOW EVACUATED TUBE COLLECTOR

Direct flow evacuated tube collectors also known as "U" pipe collectors, are different from the previous ones in that they have two heat pipes running through the centre of the tube. One pipe acts as the flow pipe while the other acts as the return pipe. Both pipes are connected together at the bottom of the tube with a "U-bend", hence the name. The heat absorbing reflective plate acts like a dividing strip which separates the flow and the return pipes through the solar collector tubes. The absorber plate and the heat transfer tube are also vacuum sealed inside a glass tube providing exceptional insulation properties.

IV LITERATURE REVIEW

M.S. Abd-Elhady et.al [1] - the research improves the heating functionality of evacuated tubes that incorporates heat pipes. Thermal oil is inserted within the evacuated tube which will improve the rate of warmth switch, such that the mode of heat transfer from the internal surface of the evacuated tube to the warmth pipe becomes convection via the oil, as well as conduction via the established fin. The finned floor has been changed by using a foamed-copper. An experimental setup has been advanced to examine the have an impact on of oil and foamed metals at the performance of evacuated tubes with heat pipes. It has been located that the bulb temperature in addition to the heating performance of the evacuated tube heat pipe has multiplied in case of inserting oil inside the evacuated tube and changing the finned surface with foamed copper. Also, the thermal oil acts as a warmness storage.

Sarvenaz Sobhansarbandi et.al [2]-this investigation to Solar water heaters (SWHs) are a properly-established renewable electricity generation which have been extensively adopted round the sector. In this take a look at we've extensively stepped forward the Evacuated Tube solar Collectors (ETCs) with the aid of utilizing the ‘‘dry-drawable" Carbon Nanotube (CNT) sheet coatings to increase the sun power absorption and Phase Change Materials (PCMs) to boom the heat accumulation for software in sun water warmers. The proposed sun collector makes use of a phase trade material namely Octadecane paraffin, with melting temperatures of 28 C which is categorized as non-toxic with longterm chemical stability PCM. As PCMs specifically in powder shape might not be powerful by using itself because of the poor warmth transfer charge, low thermal diffusivity and thermal conductivity, by using combining CNT layers with the excessive thermal diffusivity and thermal conductivity examine to section alternate materials, we're capable to overcome the shortcomings of PCMs and design an modern

and green solar water heater. With the modern-day era, we are able to provide a near perfect black frame surface, absorbing a most of 98%, between six hundred and 1100 nm, of solar light placing the floor, and offering extra spectral absorption which improves the overall performance of the solar heater. Applying CNT sheets at the side of PCM allows warmness garage without delay on the collector for a extra consistent output, even on a cloudy day and extended output of heat at night time.

S. SivaKumar et.al. [3] - the investigation the Renewable supply of power is the future power source that meets out our call for for electricity. In this solar strength is one of the prime assets. The harnessing of the sun electricity may be done in both approaches Solar (PV), Solar Thermal. Solar thermal finds extra suitable for home desires consisting of Space Heating, Cooling, Hot water systems, drying. Hence the want for generating thermal energy from the collectors is vital. Out of all of the thermal creditors the evacuated tube solar collector (ETSC) is found to have the fine performance with low sun insolation. In this paper the evacuated tube is modelled with warmth pipe for the enhancement of the heat generated from the collector. The objective of this research is to layout and investigate the heat transfer analysis of Heat Pipe Evacuated Tube sun collector is made from Borosilicate glass with length 1.8m and zero.058m and 0.049m diameter of outdoor and interior tubes for the Coimbatore place.

A.E. Kabeel et.al [4] - the investigation Modified coaxial warmth pipes were designed and manufactured to enhance the thermal overall performance of the glass vacated solar collectors. Heat pipes had been made of two concentric copper tubes in order that the annulus extent area between the concentric tubes become charged with refrigerant. In addition, the air as the working fluid at 4 special mass flow charges 0.0051, zero.0062, zero.007 and zero.009 kg/s flows thru the internal tube of the warmth pipe to the drift through the annulus between the heat pipe and glass evacuated solar tubes. The impact of the tilt angle of the evacuated tube on thermal performance of the evacuated solar tube collector was tested to obtain the most beneficial tilt perspective throughout the experiments duration. The influence of filling ratio for the two forms of refrigerant R22 and R 134a on the thermal efficiency of the coaxial heat pipe sun collector at filing ratio variety from 30% to 60% was performed experimentally. Results show that the maximum increased inside the thermal performance reached sixty seven% similar to with out heat pipes at mass flow price zero.009 kg/s. The test consequences confirmed similarity between the 2 refrigerants.

Piotr Felinski and Robert Sekret [5] - this investigation a unique concept of using a section trade material (PCM) to shop thermal electricity immediately inside a warmth pipe evacuated tube collector ready with a compound parabolic concentrator (CPC). The first rate insulating properties of evacuated tubes and using latent warmness are considerable blessings of a PCM integrated evacuated tube collector/storage (ETC/S) over conventional sun water warmers. However, at some stage in the rate cycle of the ETC/S, direct solar radiation only reaches the exposed region of the evacuated tubes, which ends up in uneven heating of the PCM because of a lower energy input within the shaded place. This can be prevented by using a CPC to concentrate the solar radiation at the shaded region of the evacuated tubes, thereby raising the temperature of the PCM and amount of saved warmth. Therefore, a sophisticated, skinny aluminum sheet was used as low price CPC with a awareness ratio of one.2x. Technical grade paraffin with an onset melting temperature of 51.24 C become used as the PCM. The outcomes from this look at showed that the application of the CPC prompted the temperature of paraffin at the shaded side of the evacuated tubes to increase greater rapidly, in particular throughout and after melting of the paraffin. Furthermore, the use of a CPC in a PCM incorporated ETC/S improved the common gross charging efficiency from 31% to 36% and the maximum charging performance from forty% to forty nine%.

Meysam Faegh and Mohammad Behshad Shafii [6] - this research a singular idea of storing the latent warmness of condensing vapor in solar stills by means of segment alternate materials (PCMs) as a thermal garage is experimentally investigated. During the daylight hours, the generated water vapor by way of the sun energy, is performed to an external condenser full of PCM to be condensed. The wasted latent heat is absorbed by PCM and thereby saved. It is really worth noting that there is no direct contact between the salinewater

and the PCM, consequently, the solar energy isn't always immediately stored in the PCM. In the night, the electricity saved inside the PCM is transferred as heat to the saline water via warmth pipes and allows the desalination procedure to hold. Several exams had been run to analyze the performance of the gadget. The consequences found out that the presence of an outside condenser filled with PCM and equipped with heat pipes in a solar nevertheless with evacuated tube creditors, makes the desalination process maintain after the sundown with out causing a decrease inside the yield during the daytime. The yield increases through 86% compared to the yield of the gadget without PCM and reaches to six.555 kg/m2 day with the performance of fifty%.S

Mohamed Hany Abokersh et.al. [7] -This investigation Space and weight requirements coupled with time postpone between energy production and intake represent extraordinary boundaries in the direction of further deployment of normal solar water heating structures in current homes with confined space. Therefore, a brand new compact U-pipe evacuated tube sun collector (ETC) integrated with paraffin wax (ALEX WAX six hundred) for electricity garage is provided within the modern observe. The ALEX WAX 600 is an natural chemical-based phase trade material (PCM) having a median melting temperature of 60 C and a thermal conductivity of zero.21 W/m K. The key issue of the advanced gadget is the removal of whole structures components by way of storing the electricity within the evacuated tube itself through using paraffin wax. Due to the low thermal conductivity of paraffin wax, heat transfer plate (fin) with an area of 0.1251 m2 is integrated inside the proposed system. The gift examine investigates the advanced machine below configurations; un-finned and finned U-pipe evacuated tube sun collector aspect by side with a standard forced recirculation sun water heating gadget (FSWHS) below the identical operation and climate conditions. The operation of the sun water heating structures is studied all through the on-call for operation beneath a simultaneous operation and a actual water consumption profile. The consequences clarify the favorable overall performance of the developed compact sun water over the typical FSWHS at some stage in exceptional operation eventualities and climate situations because of their low thermal inertia. Furthermore, the usage of fin inside the developed machine has a full-size effect on improving the heat switch traits of the PCM and complements the general device stability. During simultaneous operation tests, the entire powerful electricity discharged for the un-finned machine is better than FSWHS by means of 35.Eight% below clear day weather conditions. However, the finned gadget is higher than FSWHS by means of forty seven.7%. The simultaneous longterm predictions based totally on regression modeling show that the common annual efficiency is seventy one.Eight%, eighty five.7% and forty.Five% for the un-finned, finned and FSWHS structures, respectively. During real water intake profile tests, the day by day device performance is, 33%, 26% and 20% for the un-finned, finned and FSWHS structures

Saıf ed-Dın Fertahi et.al. [8] -This paper outlines three studies that had been performed to extend the lifespan of the horizontal storage tank, via the definition of a appropriate material and an top of the line layout. The most important conclusions of the assessment are that the best configuration which avoid the appearance of the stress concentration zones is the configuration (c), in which Ri ¼ 11mm and Re ¼ 14 mm, because the pressure at the tank's shell was higher carried out. Moreover, the impact of the fabric's choice turned into carried out, and it changed into located that stainless steel is the ultimate material. Last however now not least, a hard and fast of simulations have been performed to investigate the tank shell thickness on which the thermo-mechanical constraints have been implemented. The thickness t ¼ 2 mm became supplying an top of the line mechanical behavior with regard to the studied working conditions.

Vahit Corumlu et.al. [9] - this investigation the designated thermodynamic evaluation of an incorporated process primarily based on warmth pipe evacuated tube solar creditors for hydrogen production is furnished for more correctly manner designs. An integrated technique consists of the sun warmness pipe collector, photovoltaic panels, PEM electrolyzer and Linde-Hampson hydrogen liquefaction procedure are considered and analyzed thermodynamically for hydrogen manufacturing and liquefaction goals. The active and exergetic efficiencies of this incorporated process are calculated as zero.2297 and 0.1955, respectively. Based on the

parametric take a look at, the effectiveness of the solar strength based included manner is also tremendously depending on the solar flux and ambient conditions

Guillermo Martínez-Rodríguez et.al. [10] - the research the layout and specification of solar collector networks for the seize of sun radiation and its transformation into thermal strength to be used in low energy depth processes. All glass evacuated tube solar creditors are the sort of technology considered on this paintings. Target temperature and warmth load are the layout goals inside the design of solar collector networks and they're executed with the aid of specification of two layout variables, particularly: a) quantity of creditors in series in a row and, b) variety of rows in parallel. The variability of ambient conditions is accounted for by means of the specification of the vital factor conditions for the layout of the network. From the thermal point of view, the range of solar collectors or heat transfer floor vicinity required to obtain the objectives depends at the ambient conditions selected for the design. The concentrated on approach for the specification of the network structure is based totally on using a thermal model. The numerous layout options to be had to the fashion designer to specify the number of solar creditors in a row, are provided in a graphical way as a feature of mass waft fee, inlet temperature, solar radiation intensity and target temperature.

Tahmineh Sokhansefata et.al. [11] -The investigation a thermoeconomic evaluation of two specific solar hot water structures based on varieties of flat plate collector (FPC) and evacuated tube collector (ETC) are studied under the cold climate conditions of Iran. The annual sun collector power output and the collectors' output temperature are calculated the usage of the TRNSYS16 software. As a end result, it's far determined that the inlet temperature and weather situations are the two primary variables which effect at the collector overall performance. Finally, according to the thermal and monetary evaluation, the overall performance of ETC system is forty one% higher than the FPC structures, and the yearly useful power advantage of ETC is 30% more than that of FPC in bloodless weather. So, making use of ETC in bloodless weather is recommended. Additionally, this simulation may be extendable and applicable for every zone with any climatic situation..

Amir Amin et.al. [12] -Finding a option to shop commercial wasted warmness for later use for you to lessen strength usage has been on the upward thrust in latest years. This paper investigates the capability of latent warmness TES (Thermal Energy Storage) system the usage of PCM (Phase Change Material) to shop/launch a big amount of electricity in a small quantity as compared to sensible heat TES machine. In this work, the problem of the low conductivity of PCMs has been addressed by way of using an embedded finned water-charged heat pipes into the PCM bulk. Both warmness pipes and the PCM tank used in this research had been made of 316 L stainless steel. The PCM used in this work became PLUSICE S89, which has a melting temperature of 89 C and crystallization point of seventy seven C. The evaporator segment of the warmth pipe was heated by means of condensing a steam float. The warmth that turned into absorbed within the evaporator phase changed into then discharged to the PCMs by means of the warmth pipe multi-legged finned condenser. Tests had been conducted for each charging (melting) and discharging (crystallization) of PLUSICE S89. It was found that the thermal resistance posed via PCM at some stage in the discharging degree turned into better as compared to that in the charging procedure.

V MODELING AND ANALYSIS

Design procedure

The procedure for solving the problem is

- Modeling of the geometry.
- Meshing of the domain.
- Defining the input parameters.
- Simulation of domain.

Finite volume analysis Heat pipe

Analysis Type - Fluent and Modal.

Preprocessing

Preprocessing include CAD model, meshing and defining boundary conditions.

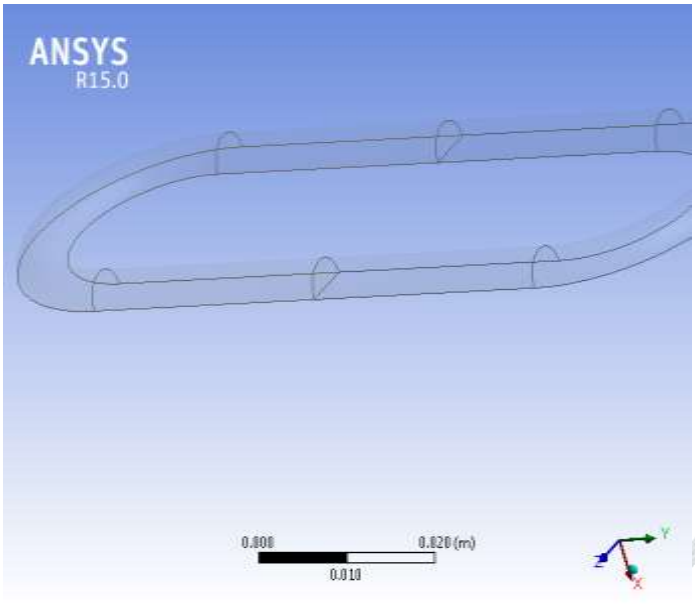

***Figure**: 5.1 CAD model of heat pipe.*

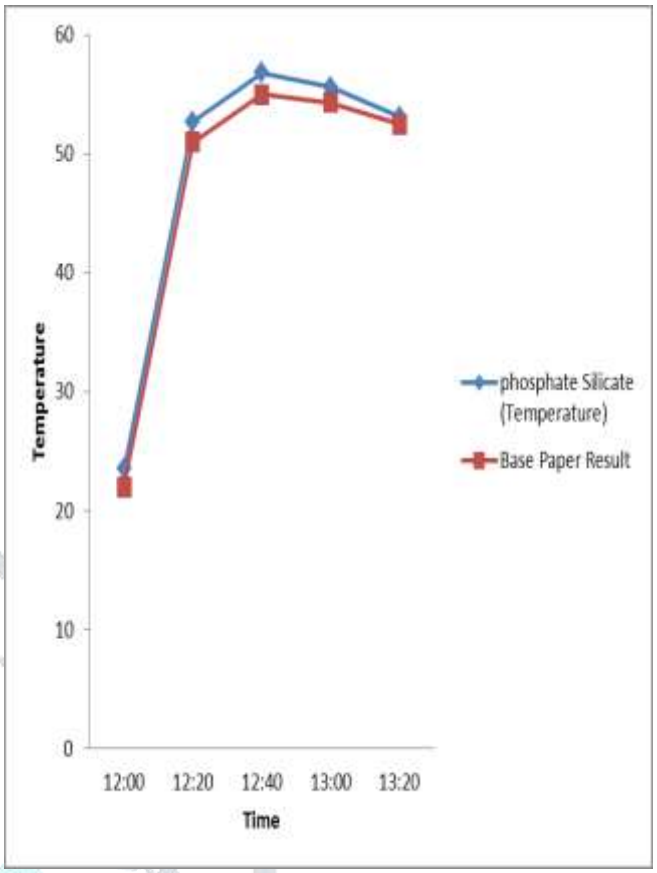

Figure 4.5 Temperature variation of Soda lime silicate glass evacuated tube on time

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VI RESULT AND DISCUSSION

A three-dimensional model has been developed to investigate heat transfer in the heat pipe for heat removing process. A series of numerical calculations have been conducted using commercial CFD code FLUENT 15.0.The results are presented in order to show the effects of temperature distribution with respect to different e material of evacuated glass tube

Temperature distribution on heat pipe with Soda lime Silicate Glass evacuated tube:

Table 4.2 Temperature variation w.r.t. Time of heat pipe

Table shows the simulation results of variation in temperature on heat pipe with Soda lime Silicate material evacuated tube. The simulated results have slightly higher values than base paper values. The deviation is almost constant. These errors may be due to round off, discretization and truncation.

Time	Soda Lime Silicate (Temperature)	Base Paper Result	Percentage Error
12:00	25	22	12.0
12:20	54.2	51	5.9
12:40	57.9	55	5.0
13:00	57.5	54.3	5.6
13:20	54	52.5	2.8

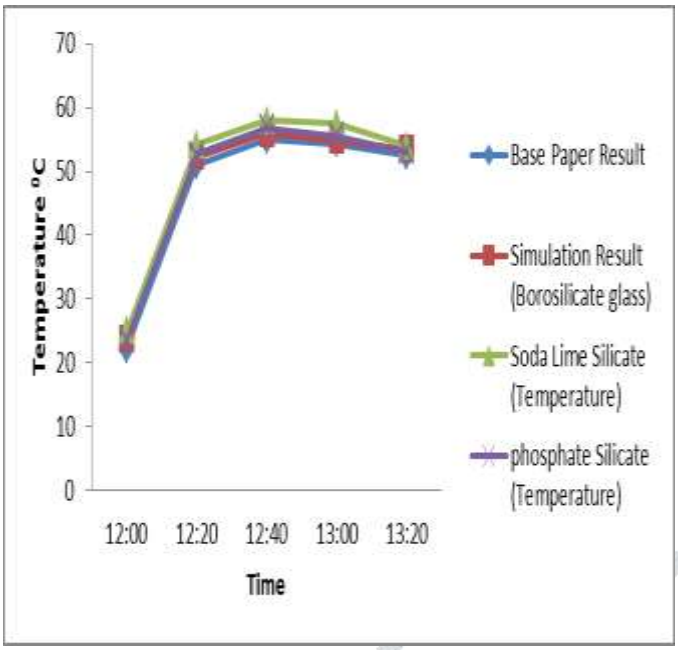

Figure: 6.3 Variation in temperature on heat pipe wr.t. time

VII CONCLUSION

1. Computational model has been developed in UGNX 8.0 and analysis has been done in Fluent 15.0.
2. Numerical results are in good agreement with base paper results.
3. The internal consistency of the results confirms the validity of the CFD model.
4. From results, higher value of temperature is found out for different glass materials of heat pipe.
5. 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.
6. Temperature distribution shows 0.73% average on simulation results than base paper results thus convergence on temperature effect is achieved.
7. 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.
8. From results, higher temperature drop is found out for Hexacosane Nano fluid comparison to different Nano fluid of heat pipe.

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