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Thermal Performances in Air Conditioner with Varying Heat Transfer in Pipes with Flow of Nano Fluids Compared to Their Base Fluids

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Abstract:

Heat transfer in pipes is a distinctive kind of procedure employed in heat exchanger which transfers great deal of heat because of the impact of capillary action and phase change heat transfer principle. Late improvement in the heat pipe incorporates high thermal conductivity liquids like Nano liquids, fixed inside to extricate the most extreme heat. This paper audits, impact of different factors, for example, thermal pipe tilt edge, charged measure of working liquid, nano particles sort, size, and mass/volume part and its impact on the change of thermal proficiency, thermal exchange limit and decrease in thermal protection. The Nano liquid arrangement and the examination of its thermal attributes likewise have been investigated. The retained sun oriented vitality is exchanged to the working liquid streaming in the pipe. The execution of the framework is affected by thermal exchange from tube to working liquid, with least convective misfortunes, which must be considered as one of the essential plan factor. In tube and channel streams, to improve the rate of heat exchange to the working liquid, detached enlargement methods, for example, contorted tapes and swirl generators are employed from the fluid flow path. The variation of heat transfer coefficient and pressure drop in the pipe flow for water and water based Al2O3 Nano fluids at different volume concentrations and twisted tapes are studied.

1.0 Introduction:

In the emerging world, the field of electronics is one of the quick creating sciences and its commitment to the innovation is quickly developing step by step. Amid the finish of twentieth century, the vast majority of the electronic gadgets were bigger in size and they had been embraced with fan or smaller scale blade cooling framework. These cooling systems owned remarkable volume and didn't work successfully at whatever stage heat dispersal is large and this motivated high section temperatures that influences the usage of electronics. Because of the headway in innovation, conservative gadgets were created to disperse extensive measure of heat and one such gadget is a heat pipe. The heat channels are reasonable gadgets for the cooling reason and it was first presented by Gaugler in 1942. Facilitate advancements were made by Groove in 1964 at Los Alamos logical research centers the plan was additionally adjusted and a few parameters were changed to enhance the execution of heat scattering to the working liquid and utilizing a working liquid of high heat exchange execution will expand the productivity of authorities. For over 10 years, specialists had performed many examinations in the past to indicate improved properties of Nano liquids and will come about a specific increment in the heat move qualities in tube stream. But, thermal convection attributes in functional heat trade components should likewise be contemplated. Many scientists have centered exploratory and numerical examinations for constrained convection thermal move considers in a pipe with various material and centralization of nano particles, supplements and limit conditions in turbulent and laminar stream administration. In plain tubes, considered the convective heat exchange coefficient and touch variable in rectangular smaller micro stations utilizing Al2O3 water/ethylene glycol (50:50) Nano fluid using various concentrations.

Heat pipe and its limitations:

A heat pipe Includes three Distinct Segments; an evaporator at one end, a condenser towards the other Finish and an adiabatic Segment in-between the schematic arrangement of a heat. The field of electronics is one of the quick creating sciences and its commitment to the innovation is quickly developing step by step. Amid the finish of twentieth century, the greater part of the electronic gadgets was bigger in size and they had been received with fan or small scale blade cooling framework. These cooling strategies involved significant volume and did not pipe Heat pipe is essentially a fixed tube having a wick structure on the internal surface and loaded with a liquid at soaked state. Evaporator is, where thermal is consumed by the liquid which makes temperature and along these lines thickness distinction. In the condenser segment, thermal is rejected to the encompassing medium. The adiabatic segment is remotely secured with a protection layer and it is simply going about as a stream entry with no heat misfortunes from the working liquid. The Growth and expulsion of heat from the evaporator and condenser segments Individually, instigates a Fat distinction in this Manner prompting vapour Flow from evaporator into condenser That the liquid is retracted to the evaporator due to the capillary pressure in the wick structure and the Procedure repeats the maximum heat Transfer capacity of a Heating pipe is Affected by 2 impediments; one that prompts thermal pipe disappointment and the other that does not.

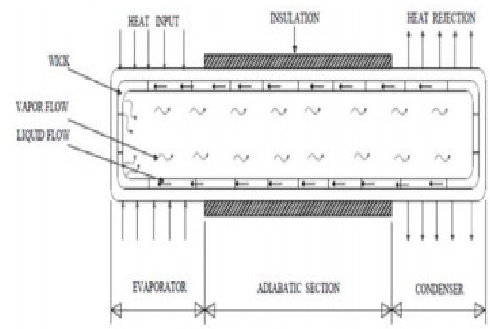

Figure:Heat pipe

Constraints that outcome in thermal pipe disappointment are described by inadequate fluid stream to the evaporator for a given thermal input, in this way bringing about dry out of the evaporator area. The breaking points sorted under heat pipe disappointment are narrow utmost, boiling farthest point and entertainment confine. However impediments not bringing about thermal pipe disappointment do require that the heat pipe work at an expanded temperature for an expansion in thermal information. As far as possible are viz. thick utmost, sonic cut off and Condenser constrain. Hairlike weight is the weight distinction made between the liquid– vapour interfaces that are fundamental for the vitality transportation in the thermal pipe. Some of the time, the main impetus is inadequate to move the fluid from condenser to evaporator and evaporator dry out may happen, called scapillary limit point of confinement. A productive thermal pipe dependably keeps up the greatest fine weight higher than the aggregate weight misfortunes inside

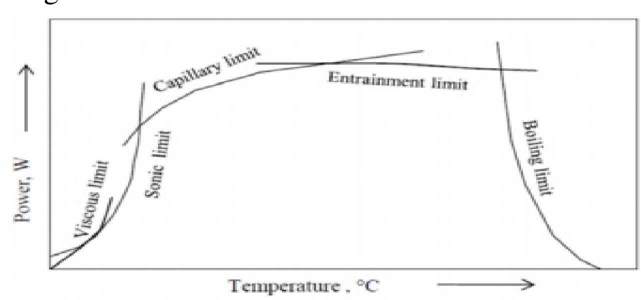

Figure:Limitations of a heat pipe.

Once the applied heat flux from the evaporator contributes to boil, vapour bubbles are made from the evaporator which might partly block the liquid stream coming out of the condenser. This causes dry out condition in the evaporator, known as bubbling breaking point. As the vapor goes in the counter stream heading to the fluid, high shear powers are produced. This entrains the fluid and bringing about deficient fluid stream to the wick structure, known as entertainment restrict. Operation of thermal pipe at low temperatures makes low vapour weight which might be lacking to help the expanded vapour stream. This condition is called thick point of confinement. Stifling of heat pipe may happen because of low vapour densities and this is the sonic furthest reaches of thermal pipe. In a perfect world, the connected thermal motion in the evaporator ought to be equivalent to thermal dismissal from the condenser, which is controlled by convection and radiation to the surroundings and this is called condenser limit.

Application of Nano fluids:

Nano liquids can be utilized to enhance thermal exchange and vitality productivity in an assortment of thermal frameworks. A significant part of the work in the field of Nano liquids is being done in national labs and the scholarly community and is at a phase past disclosure investigate. As of late, the quantity of organizations that see the capability of Nano liquid innovation and are in dynamic advancement work for specific industrial applications is rapidly increasing in the automotivefield.

- Heat-transfer Nano fluids.
- Tribological Nano fluids.
- Surfactant and coating Nano fluids.
- Chemical Nano fluids.
- Process/extraction Nano fluids.
- Environmental (pollution cleaning) Nano fluids.

2.0 Literature review:

Kang, S., Wei, W., Tsai, S. and Yang, S.,(2006). Explored micro station cooling system utilizing Al_2O_3/water Nano fluids The large thermal conductivity of nanoparticles is just demonstrated to boost the single-phase heat transport coefficient, particularly for laminar flow. Greater heat transfer coefficients were attained mostly from the entry region of micro stations. On the other hand, the improvement was poorer in the fully developed area, demonstrating that nanoparticles have a significant impact on thermal boundary layer growth. Higher concentrations also generated higher sensitivity to heat. Regardless of this improvement, the general heating potency of nanoparticles was rather miniscule due to the large axial temperature increase associated with the diminished specific heat to the Nano fluid in contrast to the liquid. For two-phase cooling system, nanoparticles cause catastrophic failure by depositing to large clusters close to the channel exit as a result of localized evaporation after boiling commenced.

KyoSikHwang ,SeokPil Jang , Stephen U.S. Choi, (2009). Nano liquids explore are being connected to the cooling of programmed transmissions Dispersed CuO and Al_2O_3 nanoparticles into motor transmission oil. The trial stage was the transmission of a four-wheel-drive vehicle. The transmission has a propelled turning sharp edge coupling, where high neighbourhood temperatures happen at high pivoting speeds. Consequently, enhanced heat exchange rates from the transmission liquid were vital. The temperature dissemination on the outside of the turning edge coupling transmission was estimated at four motor working paces. Hence, enhanced heat exchange rates from the transmission liquid were essential. The temperature conveyance on the outside of the rotational cutting edge coupling transmission was estimated at four motor working paces (400, 800, 1200, and 1600 rpm), and the ideal arrangement of Nano liquids with respect to thermal exchange execution was examined.

SyamSundar, L., Sharma, K.V., (2008). Researched laminar stream convective heat exchange through roundabout tube with steady divider temperature limit condition for Nano liquids containing CuO and Al_2O_3 oxide nanoparticles in water as base liquid The trial device comprising of a test load developed of 1 m annular tube with 6 mm breadth internal copper tube and With 0.5 millimeter thickness and 32 millimetre space across outside stainless steel tubing. Nano liquid streams inside the inward tube while immersed steam enters annular area, which makes consistent divider temperature limit condition. The liquid in the wake of finishing through the test area enters thermal exchanger in which water was utilized as cooling liquid. The trial comes about accentuated that the single stage relationship with Nano liquids properties (Homogeneous Model) was not ready to foresee thermal exchange coefficient improvement of Nano liquids. The examination between test comes about acquired for CuO/water and Al2O3/water Nano liquids demonstrated that heat exchange coefficient proportions for Nano liquid to homogeneous model in low focus were near each other however by expanding the volume division, higher heat exchange upgrade for Al2O3/water was watched.

Raja Sekhar Y, Sharma, K.V.Naik, M.T.SyamSundar, L. (2012). Directed a test contemplate on investigation of heat exchange coefficient of CuO/water Nano liquid utilizing twofold pipe thermal exchanger In this examination, the Nano liquid was set up by scattering CuO of 27 mm particles in deionized water. The after effect of this examination demonstrates that the convective heat exchange coefficient and nusselt number of Nano liquids were expanded contrasted with base liquid i.e. water Conducted an Experimental investigation on a shell and helical curl thermal exchanger utilizing cool and boiling water for the shell and loop sides. In this examination three distinct loops tried, shifting in pipe breadth and pitch. The tube and shell side stream rates were estimated and the bay and outlet temperatures for both. It is watched that the liquid properties were assessed at their mean temperature. The external heat exchange coefficients were computed utilizing the Wilson Plot technique. A sum of 75 external heat exchange coefficients ascertained in view of five distinctive shell side stream rates, prompting an aggregate of 15 figured internal heat exchange coefficients.

3.0 Experimental setup and procedure:

An Experimental test arrangement has been made to look into the convective heat transfer and friction factor behavior of water established Al2O3 Nano fluids at a horizontal round tube exposed to constant heat flux boundary condition. The schematic diagram of the experimental arrangement and twisted tape is displayed in Figure 1a and 1b respectively. The liquid is permitted to course through a copper container of 0.012 m measurement taking after the riser container of sun powered level plate authority. The stream circuit comprises of a chiller, gathering tank, and a capacity tank associated with a pump. The copper tube is thermaled consistently by wrapping it with two chrome radiators of 20 measure, having a protection of 53.5 ohms for each meter length and 1000 W greatest rating, and the whole test segment is liable to a steady thermal couple limit condition. The space between the test segment and the external packaging is protected with shake fleece to limit thermal misfortune. The test area of 1.5 m long is given five K-type thermo couples in which three were brazed to the surface at separations of 0.375, 0.75, 1.125 m from passage and two situated to gauge the working liquid gulf and outlet temperatures. Every one of these thermal couples have 0.10 C resolutions and are adjusted before settling them at the predefined areas and the exactness is inside 0.40 C. Trials are led with refined water with a view to test the precision of the outcomes. The viewpoint proportion of the test segment is adequately expansive for the stream to be hydro-progressively created. The liquid from the capacity tank is constrained through the test segment with the guide of a draw associated with the suction side of the tank. The liquid is Warmed in the Evaluation Segment and hot Fluid is permitted to cool by passing it through a chiller.

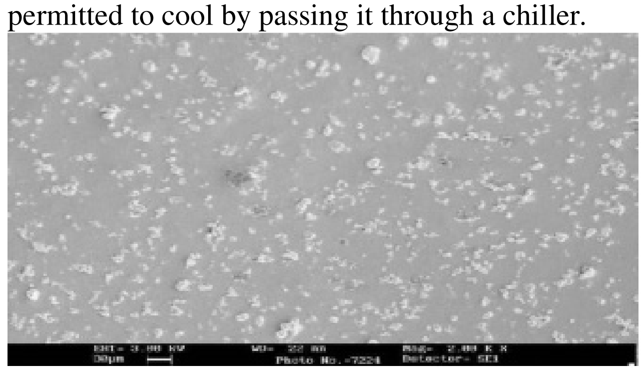

Figure: SEM image of Al2O3 nanoparticles

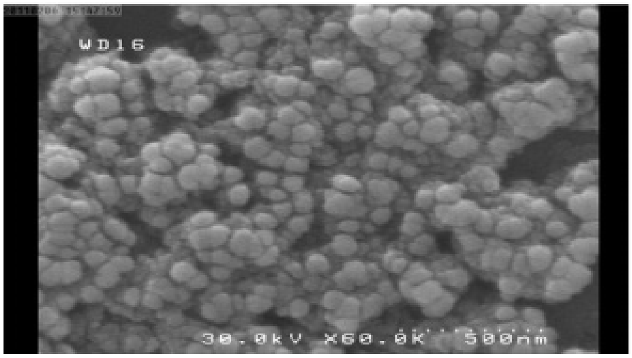

Figure: FESEM image of nanoparticles after dispersion.

The Supply of This chiller helps to Attain The continuous inlet fluid temperature. The flow rates are calculated by collecting the fluid in a gathering vessel over some stretch of time with the assistance of an exact estimating container and stop watch. At the finishes of the test segment 3mm gap is bored with the assistance of boring machine to tap the weight over the test area. One end of the manometer is associated with the channel tap, and the opposite end of the monometer is associated with the outlet tap. The readings of the level in the U-tube are noted down and made equivalent. Because of the working liquid weight, the liquid level in the U-tube changes and the distinction in stature of the levels are estimated. The liquid line associations are checked for spills in the wake of filling the capacity tank with the working liquid (water and Nano liquids). The Reynolds number of stream of the working liquid streaming in the test area is estimated from the mass stream rate.

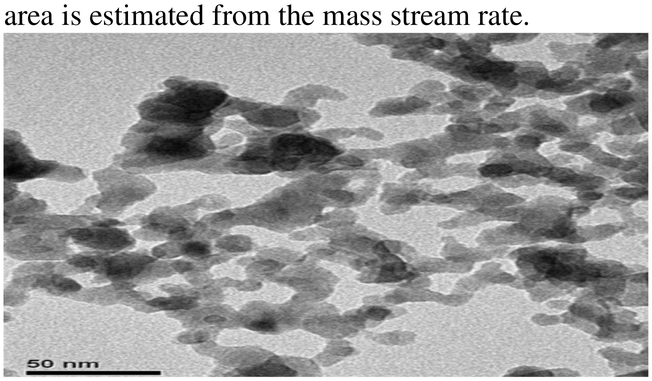

Figure: TEM images of Al_2O_3 nanoparticles.

4.0 Data Analysis:

In In the experiments conducted under constant heat flux boundary condition, temperature of pipe at several places, Voltage and current supplied to the valve and pressure fall is recorded. The heat transfer and the energy balance between the heat provided and energy consumed by the liquid is created using E-for every pair of information along with the experimental heat transfer coefficient is projected with The deviation between the values obtained is significantly less than ± 2.5 percent and the heat loss to atmosphere is neglected.

$$q = V \times I \quad (5) \qquad q = \left(\dot{m} C_p (T_{out} - T_{in}) \right) \quad (6) \qquad h = \frac{q''}{(T_s - T_m)}$$

The net heat input into the evaluation segment is corrected for electric heat input into the fluid by simply calculating the losses through the insulation. The experiments were performed for each run after ensuring the difference between the net heat input and enthalpy rise of the fluid is less than 5%. The enthalpy rise of the fluid is calculated from equation 6. The bulk temperature of the fluid at any axial position of the tube at a distance of from the inlet is calculated by assuming linear temperature variation along the length.

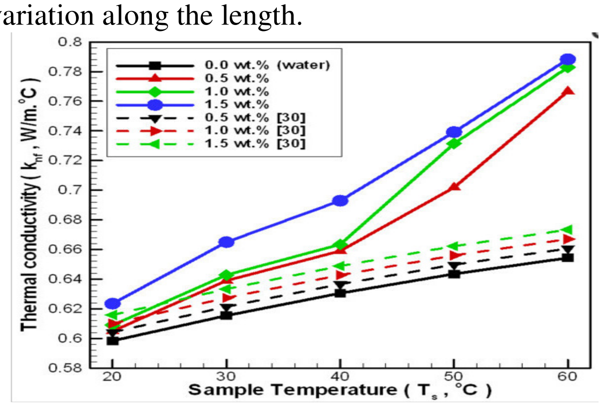

Figure:Thermal conductivity of Al_2O_3/water Nano fluid at various temperatures and concentrations

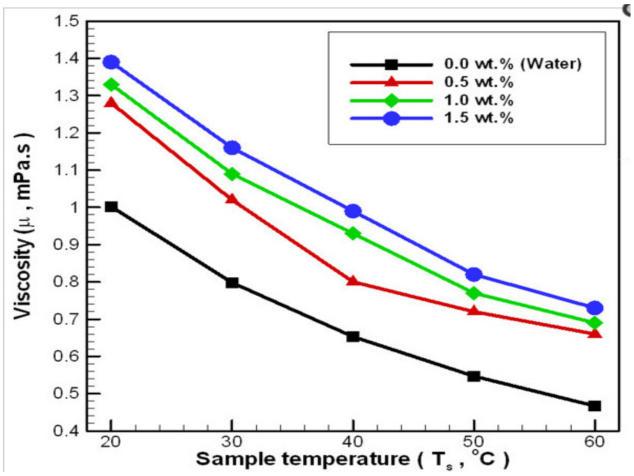

Figure:Viscosity of Al_2O_3/water Nano fluid at various temperatures and concentrations.

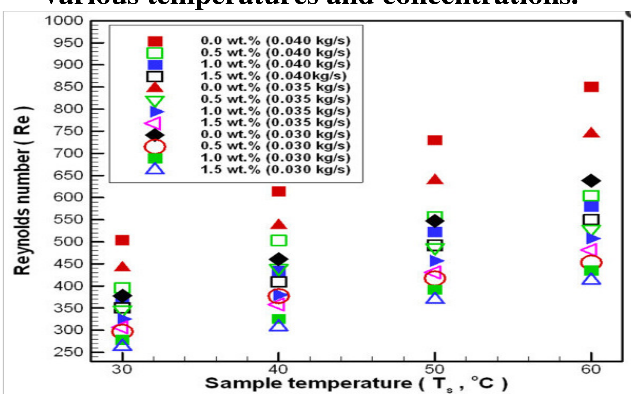

Figure: Reynolds number of Al2O3/water Nano fluid in different concentrations and temperatures under different mass flow rates.

The changes in viscosity for Al_2O_3/water Nano fluid at various temperatures and concentrations In general, the Nano liquid consistency increments with expanding nanoparticle stacking in the base fluid For a centralization of 0.5 wt.% and inside a temperature scope of 20°C to 60°C, the thickness proportion increments by 21.5% to 41.3%. For a convergence of 1.0 wt. %, the consistency proportion increments by 32.7% to 47.8%. For a grouping of 1.5 wt.%, the consistency proportion increments by 38.7% to 56.3%. These outcomes demonstrate that the consistency of Al2O3/water Nano liquid is substantially higher than water. The weight drop of pipeline-related issues must be considered when the Al2O3/water Nano liquid is connected to thermaltrade and flow test comes about. The nanoparticle volume division was changed into the nanoparticle weight portion utilizing the genuine thickness of nanoparticles to bind together the convergence of units Pak and Cho's model was initially acquired with a temperature of 300 K, a molecule size of 13 nm, and a fixation scope of 1.34-4.33 vol.%. Since this model does not join changes of temperature and molecule estimate, it initially acquired at a higher fixation, and its deviation is somewhat higher. However, considering the uncertainty of the experiment in this study, this deviation is within an acceptable range under 20°C to 30°C.

Conclusion:

The recent developments in the field of Nano fluids Preparation, characteristics, and applications of Nano fluids have been discussed in detail. It is essential to say that thermo physical properties fluctuate with the volume focus, temperature, and stream rate. In any case, more research is required to think about the impact of nanoparticle's shape, size, and surface science on the properties of Nano liquids. By and large, the expansion of volume part of the nanoparticles builds the thickness, consistency, and thermal conductivity of the Nano liquid. On account of heat exchange coefficient and Nusselt number, examines demonstrated that there is an utmost to improvement and an ideal volume division exists. The utilization of Nano liquids seems promising in an extensive variety of fields; be that as it may, more work is required in a few regions, for example, the solidness of these Nano liquids in different applications, the utilization of half and half Nano liquids, and impact of working conditions on the properties of these Nano liquids. Be that as it may, grinding factor diminishes with increment of Reynolds number of stream while the Nusselt number increments. Utilizing Nano liquid with a high heat trade can help in lessen the measure of the heat exchanger or with - out expanding the extent of the heat exchanger effectiveness of the framework can be moved forward. Further, utilizing bent tapes and Nano fluids in the pipe flows is advantageous since it is visible from the results that the energy gained with heat exchange is more compared to that of the energy used for pumping power.

Future scopes:

The Nano fluid have high future scope in the field of transportation, environmental control, biomedical applications, directed self-assembly of nanostructures industrial engineering and research the development. The future research should lead to development of new Nano fluids with including biological Nano fluids, complex Nano fluids with polymer additives and some new experimental methods as well as computational methods. Some new critical applications of Nano fluids should be developed. The thermal conductivity is the main characteristic to enhance of heat transfer so that new nanoparticle should be developed which have batter thermal conductivity.

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