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EXPERIMENTAL INVESTIGATION OF NATURAL CONVECTION HEAT TRANSFER AUGMENTATION WITH VIBRATION EFFECT BY USING Al_2O_3 NANOFLUID

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Abstract - *The fluids Such as water, engine oil, ethylene, ethylene glycol, and transformer oil have a lower thermal conductivity of fluid compared to the solid. The base fluid of water and nanoparticles are blended is called nanofluid. The nanofluid is used in different applications like Electronic cooling, commercial, heat exchange, motor car, and biomedical, etc. The nanoparticles are mixed into the base fluid (water) for distinct volume fractions (0.05%, 0.1%, 0.15%, and 0.2%) and supply various heat inputs 30W, 40W, 50W, 60W. The Al_2O_3 nanoparticles are high thermal conductivity then Cuo. The unbalanced motor positioned below the cylindrical surface then its floor is vibrated and its temperature will be increased above the top of the portion. The dimmer stat used to various voltages and frequency 100Hz-190Hz. The fluid at constant in enters gadget then enhancement of heat transfer coefficient increase.*

Key Words: *Local heat transfer, vibration effect and frequency.*

1. INTRODUCTION

The metallic oxides are Al_2O_3 are nano-sized particles 50-80nm, the base fluid of water mixed into the glass breaker by using the magnetic stirrer in 1 hour and ultrasonication process using to without settle within the bottom portion of the square enclosure. The cylindrical surface temperature is measured in axial distance depends on boundary layer thickness because of depends on the cylindrical diameter reduces to temperature increases depends on boundary layer thickness. The local heat transfer rate enhances increases.

2. EXPERIMENTAL SETUP

The experimental setup includes a galvanized cylindrical container and inside a rectangular enclosure and is located inside the brass vertical heater. A vibrator (single-phase vibrator) became bolted at the rigid helping body and it's tightly. The outer galvanized iron cylindrical field consists of L*H*D (265mm*350mm*258mm) and its cylinder fixed at each end became carried on brackets installed at the vibrating strip and receiving vibrations via it. The inner aluminum square enclosure includes l*b (120mm*120mm) and t*h (4mm*300mm) respectively.

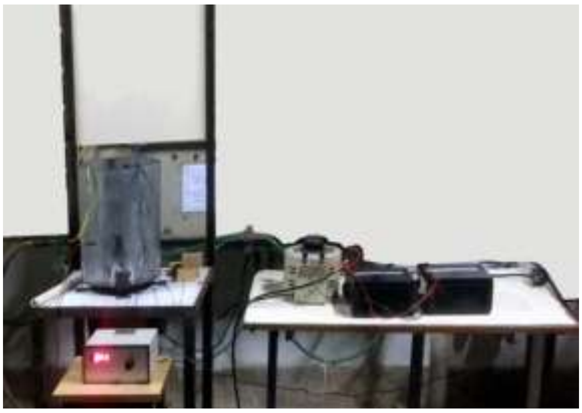

Fig 1 (1)

The cylindrical heater road covered with brass fabric consists of D*l (18.5mm*250mm) and its floor located on Eight K-type thermocouples and its each thermocouple distance is 33.3mm. The 6 point temperature indicator connected to the six okay-kind thermocouples (data received system) and its temperature recorded. A 3 center cable linked vibrator to dime start and its frequency or amplitude tiers growth to decrease. An accelerometer was used to pick out up a vibration sign from the cylinder and transmit the same to a vibration meter that could measure amplitude, pace or acceleration.

Volume fraction % = $\left(\frac{mn}{\rho n}\right)/\left(\frac{mn}{\rho n}+\frac{mf}{\rho f}\right)$

Density of nano-fluid □□$_{nf}$ □ □□$_p$ □ (1□□) □$_f$Specific heat Cp_{nf}□ (1□□)(□C_p)$_f$ □□(□C_p)$_p$

Dynamic viscosity□□□$_{nf}$□ □$_f$(1□ 2.5 □

Thermal conductivity

K_{nf} = K_p+2K_f +2(K_p -2K_f)□□□□□□$_f$

□□□□□□□□□□□□□□□□□□□□□□□□□□$_p + 2K_f – (K_p - 2\ K_f)$ □

Rayleigh number $Ra_L = Gr.\ Pr = g\beta l^3 \Delta T/v^{2.}\ \mu c_{p\ /k}$

Nusselt number $Nu = 0.287\ (Ra_L)^{0.287}$

Local Nusselt number $Nu_L = h\ x/k$

3. EXPERIMENTAL PROCEDURE

Two-step techniques are hired for preparing the alumina nanofluid. Alpha-Al_2O_3 nanoparticles (99.5% purity) were procured from nano labs, India and the manufacturer stated that the purchased alumina debris with common size 50-80 nm had been having particular floor area15-20 m2/g, bulk density of 3.95-4.1 g/cm3. Alumina nanoparticles had been dispersed into the demineralized water inside the required share corresponding to the volume fraction of nanofluid and achieved the magnetic stirring, ultrasonication. The quantity of the nanoparticles introduced to the base fluid for making nanofluid via using below Eq. And display beneath the TEM pictures.

$$\text{Volume fraction \%} = \left(\frac{mn}{\rho n}\right) / \left(\frac{mn}{\rho n} + \frac{mf}{\rho f}\right)$$

1. Natural convection without vibration
2. Natural convection with vibration

The natural convection without vibration in electric input is given to the heater in the cylinder. The water entered into the cylinder ground reaches to have a examine the dominion circumstance. The thermocouples positioned on the heater ground and it's related to the statistics obtained a device. The successive readings of thermocouples were identical, output readings are recorded.

The convection with vibration in an electrical heater has to turn out to be given a random input. The demon stat was the primary set to strength-on function and ranging to power-load function, consequently starting the vibration of the cylinder. The dynamo frequency has become adjusted to the popular diploma. The accelerometer is used to degree the frequencies which have been set up at the bracket sporting the cylinder. After the normal-kingdom turn out to be reached, the temperature difference, frequency, peak to peak values of amplitude, voltage, current-day-day electric energy, and the ambient temperature become the recorded pinnacle to the bottom detail.

4. RESULTS AND DISCUSSION

The Experimental have been executed in diverse warmness inputs inclusive of 30W, 40W, 50W, 60W through regulating the voltage supply inside the help of varies. The surface temperature of the brass vertical cylinder within the axial path for water+ Al_2O_3 because of the medium.

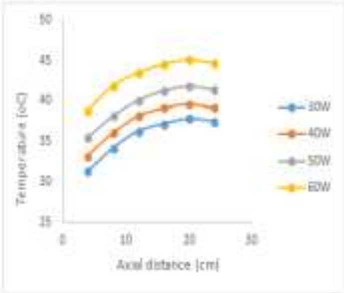

Fig-4.1: Surface temperature of the vertical cylinder along axial distance for without vibrations in the nanofluid

It is observed that for any heat flux the surface temperature of the cylinder is increased in the axial direction due to higher local heat transfer coefficient occur at the bottom portion of the cylinder. All the properties of the fluid are calculated at the film temperature by using the average surface temperature calculated.

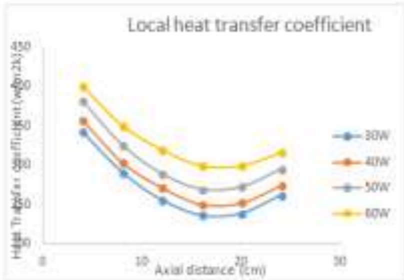

Fig -4.2: Variation of heat transfer coefficient with axial distance various heat input

It is observed that the local heat transfer coefficient is higher at the bottom and lower at the top of the cylinder. The boundary layer thickness is very less in the bottom portion of the cylinder. The heat transfer coefficient will be higher at goes on the top of the head. The boundary layer thickness is more than the local heat transfer rate is less its depends on cylinder diameter ratio.

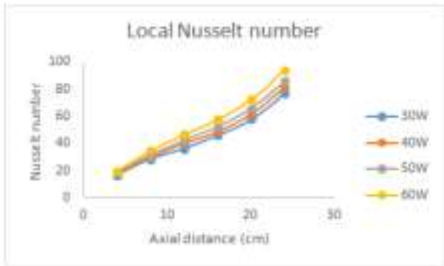

Fig -4.3: Variation of local Nusselt number with axial distance various heats input

It is observed that the local nusselt number increased as the length increases and for all the heat inputs in case of water medium. Similar to that process, the variation of temperatures along radial direction when the medium of water and Al_2O_3 respectively.

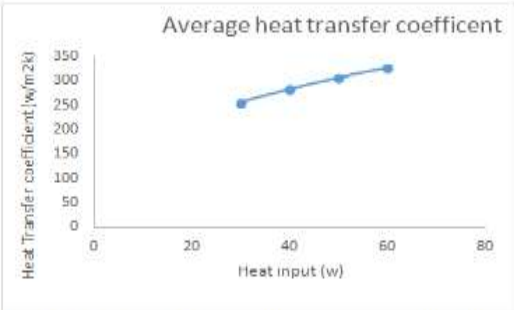

Fig-4.4: Variation of heat transfer coefficient with heat input

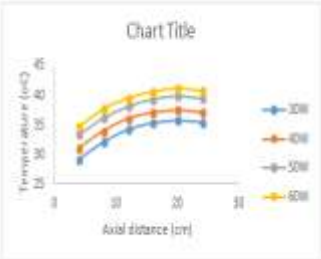

Fig-4.5: Surface temperature of the vertical cylinder along axial distance for with vibrations in the base fluid.

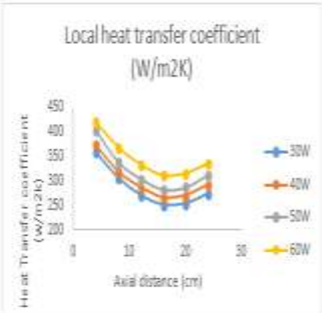

Fig-4.6: Variation of heat transfer coefficient with axial distance various heat input with vibration effect

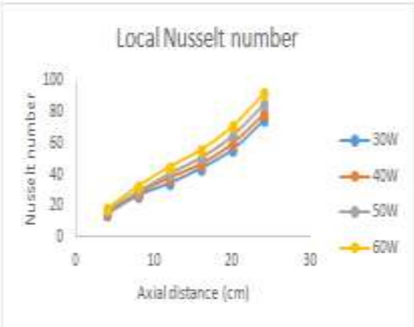

Fig-4.7: Variation of local Nusselt number with axial distance various heat input

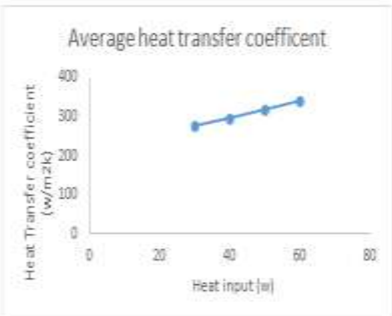

Fig-4.8: Variation of local Nusselt number with axial distance various heat input

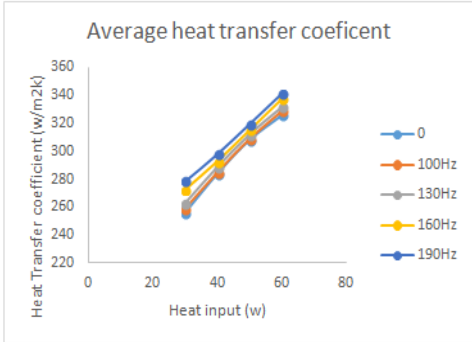

Fig-4.9: Variation of Average heat transfer coefficient with heat input

It is observed that the nearby heat transfer coefficient with warmness enter will increase with a linearly bottom portion to the pinnacle portion. This graph found to compare with or without vibration in the backside component to increases linearly in the pinnacle component. The vibrating frequency increases a hundred-one hundred ninety Hz and it's better to improve the heat switch charge then examine without vibration effect.

CONCLUSIONS

Comparison among with and without warmth transfer charge will increase in 1-dimensional look at glide at a constant warmth flux

1. The axial distance of the boundary layer bottom area to the top area increases slightly.

2. The herbal convection of cylindrical surface decreases with increases in the temperature model.

The vibration effect on natural convective warmth transfer is more perfect with the aid of nanofluid at 60w warmness input has the warmth switch coefficient is extended 316.334 w/m²k to 335.419 w/m²k.

5. REFERENCES

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