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A REVIEW ON “HEAT EXCHANGER IN A FINNED PIPE USING NANO FLUID

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ABSTRACT

The concept of heat exchanger plays a major role in the refrigeration and air conditioning system. The rectangular fin arranged outside the hot fluid pipe & used the Al₂O₃ as a nano fluid to increase the heat transfer rate using counter flow exchanger. Preparing the nano fluid & increasing the heat transfer rate by using Al₂O₃+H₂O. Increase of surface area utilized for heat exchange will ultimately increase the heat transfer rate.

KEYWORDS: Heat exchanger, Counter flow heat exchanger, nano fluid, finned surface area, fin arrangement.

INTRODUCTION

Now a day's heat exchanger has a wide application's from air conditioning, refrigeration up to engine cooling system. Heat exchanger does not cause any harmful effect on environment. The counter flow heat exchanger has more capacity to exchange the heat as compare to parallel floe heat exchanger. The conventional heat transfer fluids have inherently poor thermal conductivity which makes it insufficient for ultra high cooling applications. So many scientists have tried to enhance the inherently poor thermal conductivity of these conventional heat transfer fluid using solid additives. We know that contact surface in heat exchanger plays very important role. As surface area utilized for heat transfer increases ultimately heat transfer rate increases and this can be achieve by providing fin's at pipe from which the heat is going to exchange.

LITERATURE REVIEW

2.1. Practical applications of nano fluids discussed above are decided by the thermo physical characteristics of nano fluids. In the last decade, significant Amounts of experimental as well as theoretical research were done to investigate the thermo physical behaviour of nano fluids. Initial work on nano fluids was focused on thermal conductivity. Measurements as a function of concentration, temperature, and particle size. Measurements of the thermal conductivity of nano fluids started with oxide nano particals (Masuda et al., 1993; Lee et al., 1999) using transient hot wire (THW) method.

2.2. Effect of partical volume fraction: Particle volume fraction is a parameter that has been investigated in almost all of the experimental studies and most of the results are generally in agreement qualitatively. Most of the research reports show an increase in thermal conductivity with an increase in particle volume fraction and the relation found is, in general, linear. There are many studies in literature on the effect of particle volume fraction on the thermal conductivity of nano fluids. Masuda et al. (1993) measured the thermal conductivity of water based nano fluids consisting of Al₂O₃ (13nm), SiO₂ (12nm) and TiO₂ (27nm) nano particals, the numbers in the parenthesis indicating the average diameter of the suspended nano particals. An enhancement up to 32.4% was observed in the effective thermal conductivity of nano fluids for a volume fraction about 4.3% of Al₂O₃ nano particals. Lee et al. (1999) studied the room temperature thermal conductivity of water as well as ethylene glycol (EG) based nano fluids consisting of Al₂O₃ (38.5nm) and CuO (23.6nm) nano particals. In this study a high enhancement of about 20 % in the thermal conductivity was observed for 4% volume fraction of CuO in CuO/EG nano fluid. Later Wang et al. (1999) repeated the measurement on the same type of nano fluids based on EG and water with Al₂O₃ (28nm) as well as CuO (23nm) as inclusions. The measurements carried out by these groups showed that for water and

ethylene glycol-based nano fluids, thermal conductivity ratio showed a linear relationship with particle volume fraction and the lines representing this relation were found to be coincident.

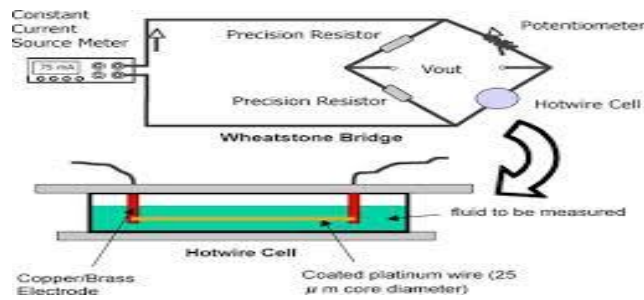
2.3. Effect of partical material: Most of the studies show that particle material is an important parameter that affects the thermal conductivity of nano fluids. For example, Lee et al. (1999) considered the thermal conductivity of nano fluids with Al₂O₃ and CuO nano particals. They found that nanofluid with CuO nano particals showed better enhancement compared to the nano fluids prepared by suspending Al₂O₃ nano particals in the same base fluid. It may be noted that as a material Al₂O₃ has higher thermal conductivity than CuO. Authors explain this behavior as due to the formation clusters of Al₂O₃ nano of particals in the fluid.

2.4. Effect base fluid: According to the conventional effective medium theory (Maxwell, 1873), as the base fluid thermal conductivity decreases, the effective thermal conductivity of a nano fluid increases. Most of the experimental reports agree with the theoretical values given by this conventional mean field model. As per Wang et al.'s (1999) results on the thermal conductivity of suspensions of Al₂O₃ and CuO nano particals in several base fluids such as water, ethylene glycol, vacuum pump oil and engine oil, the highest thermal conductivity ratio was observed when ethylene glycol was used as the base fluid. EG has comparatively low thermal conductivity compared to other base fluids. Engine oil showed somewhat lower thermal conductivity ratios than Ethylene Glycol. Water and pump oil showed even smaller ratios respectively. However, CuO/EG as well as CuO/water nano fluids showed exactly same thermal conductivity enhancements at the same volume fraction of the nano particals.

2.5. Effect of partical size: The advent of nano fluids offers the processing of nano particals of various sizes in the range of 5-500 nm. It has been found that the particle sizes of nano particals have a significant role in deciding the effective thermal conductivity of nano fluids. There are many studies reported in literature regarding the dependence of nano particle size on effective thermal conductivity of nano fluids. Chopkar et al. (2006) studied the effect of the size of dispersed nano particals for Al₇₀Cu₃₀/EG nano fluids by varying the size of Al₇₀Cu₃₀ nano particals in the range from 9 nm to 83 nm. In another study on water and EG based nano fluids consisting of Al₂Cu and Ag₂Al nano particals, Chopkar et al. (2008) also investigated the effect of particle size on effective thermal conductivity of nano fluids. In all these cases it has been found that the effective thermal conductivity of a nano fluid increases with decreasing nano particle size. Also, the results of Eastman et al. (2001) and Lee et al. (1999) support this conclusion drawn by Chopkar et al. (2008) on the particle size effect on the effective thermal conductivity of nano fluids. In another study of the effect of particle size on the thermal conductivity of nano fluids, reported by Beck et al. (2009) in water as well as EG based nano fluids consisting of Al₂O₃ nano particals, the normalized thermal conductivity of nano fluids vary in such a way that it decreases with decreasing the size. Thus conflicting reports have appeared in literature on the dependence of particle size on the thermal conductivity of nano fluids.

2.6. Effect of partical shape: For experimentation, spherical as well as cylindrical shaped nano particals are commonly used for nano fluid synthesis. The cylindrical particles have larger aspect ratio (length to diameter ratio) than spherical particles. The wide differences in the dimensions of these particles do influence the enhancement in effective thermal properties of nano fluids. Xie et al. (2002a) measured the thermal conductivity of water as well as EG based nano fluids consisting of both cylindrical as well as spherical SiC nano particals. It was observed that in water based nano fluids, the cylindrical suspensions had higher thermal conductivity enhancement of about 22.9% than the spherical particles for the same volume fraction (4.2%). Also the theoretical values based on Hamilton-Crosser model (1962) are found to be in good agreement with this comparatively higher enhancement for cylindrical particle suspensions. Another experimental study reported by Murshed et al. (2005) in water based nano fluids consisting of spherical as well as rod shaped TiO₂ nano particals showed a comparatively higher enhancement for rod shaped particles (32.8%) than spherical particles (29.7%) at a volume fraction of 5%. The temperature of a two component mixture, such as a nanofluid, depends on the temperature of the solid component as well as that of the host media. In a nano fluid the increase in temperature enhances the collision between the nano particles (Brownian motion) and the formation of nano particle aggregates (Li et al., 2008a), which result in a drastic change in the thermal conductivity of nano fluids. Masuda et al. (1993) measured the thermal conductivity of water-based nano fluids consisting of Al₂O₃, SiO₂, and TiO₂ nano particals at different temperatures. It was found that thermal conductivity ratio decreased with increasing temperature. But the experimental results of others have been contradictory to this result. The temperature dependence of the thermal conductivity of Al₂O₃/water and CuO/water nano fluids, measured by Das et al. (2003), have shown that for 1 vol.% Al₂O₃/water nanofluid, thermal conductivity enhanced from 2% at 210 C to 10.8% at 510 C. Temperature dependence of 4 % Al₂O₃ nano fluid was much more significant, an increase from 9.4% to 24.3% at 510C. The investigations of Li et al. (2006) in CuO/water as well as Al₂O₃/water reveal that the dependence of thermal conductivity ratio on particle volume fraction get more pronounced with increasing temperature.

2.7. Transient hot wire method.



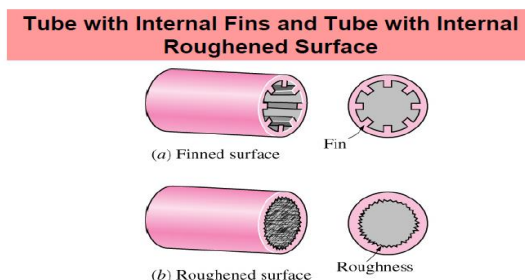
The transient hot wire (THW) method to measure the thermal conductivity of nano fluids has got established itself as an accurate, reliable and robust technique. The method consists of determining the thermal conductivity of a selected material/fluid by observing the rate at which the temperature of a very thin platinum wire of diameter (5-80 μm) increases with time after a step voltage has been applied to it. The platinum wire is embedded vertically in the fluid, which serves as a heat source as well as a thermometer. The temperature of the platinum wire is established by measuring its electrical resistance using a Whetstone’s bridge, which is related to the temperature through a well-known relationship (Bentley et al., 1984). If ‘i’ is the current following through the platinum wire and ‘V’ is the corresponding voltage drop across it, then the heat generated per unit length of the platinum wire is given by,

$$q = iV/l \tag{1}$$

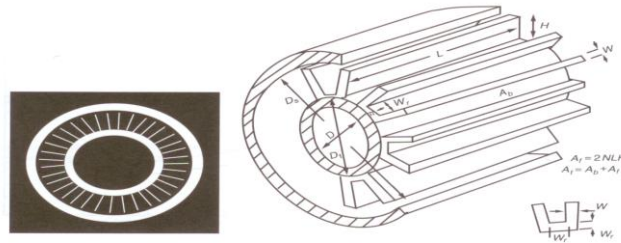
If T1 and T2 are the temperatures recorded at two times T1 and T2 respectively, the temperature difference (T1-T2) can be used to estimate the thermal conductivity using the relationship,

$$K = \{ iV [\ln(T2/T1)] \} / 4\pi(T2 - T1) \tag{2}$$

where ‘l’ is the length of the platinum wire. The advantages of this method are its almost complete elimination of the effects of natural convection and the high speed of measurement compared to other techniques. Role Of Nano fluids In The Heat Transfer Enhancement: Abed et al. (2014) studied numerically the enhancement of heat transfer in the channel V- shaped wavy lower plate using liquid nano fluids. The range of Reynolds number studied is about 8000 – 20000(Re). The effects of different types of nano particals (Al2O3, CuO, SiO2 and ZnO) along with the study fluid are studied. Furthermore, the effects of different volume fractions (range 0- 4%) of these nano particals are studied. It is found that the heat transfer was enhanced with the increase of the concentrations of the nano particles in the base fluids. The SiO2- glycerin has the highest value of Nusselt number. The glycerin based nano fluids have greater heat transfer enhancements . Ali Najah Al-Shamani et al. (2014) conducted an investigation regarding the heat transfer due to turbulent flow of nano fluids (base fluid with nanop articles Al2O3, CuO, ZnO and SiO2) through rib-groove channel. Under constant temperature range, the computations are performed for different types of nano particles with different volume fractions (range 1-4%) using four different rib-groove shapes. The conclusion obtained from the paper is that the trapezoidal with increasing height in the flow direction Rib- Isosceles Trapezoidal groove (Trap + R-Trap G) provides the highest Nusselt number and best heat transfer rate . Iniyani et al. (2014) used a condensing unit of the air conditioner to analyze the heat transfer enhancement performance of nanofluid (Al2O3/ water and CuO/ water). The condenser consists of a tube in tube setup configurations. The cooling medium used in the analysis is nano fluid flowing in the outer side of the tube of condenser. The results from the study are summed up as that the CuO /Water nano fluid has more heat transfer rate than Al2O3/ water nano fluid. The Nusselt number of CuO/ water nano fluid had found to be 39.4% higher than the base fluid.



$$D_e = \frac{4 \times \text{net free area}}{\text{heated/cooled perimeter}}$$



CONCLUSION

- The heat transfer rate can be increased by using the nano fluid.
- The heat transfer rate can be increased by using the finned surface.
- Thermal conductivity is depending upon types of partical material.
- Thermal conductivity can be changed by varying the sizes of nano material.
- Required heat transfer rate can be obtained by using suitable base fluid.

FUTURE SCOPE

- Heat exchanger using different nano fluid can be obtained.
- Metallurgical properties of the nano material used for heat exchanger can be studied.
- The analysis can be done with different pin profile & different arrangement.
- The different types of dimple profiles can be analyzed.

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