Review: CFD analysis of cone shaped coil heat exchanger by using copper oxide nanofluid with ethylene glycol and water as its base fluid in aluminium tube with different mass flow rate.

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ABSTRACT

Waste heat recovery has been a concern for large corporations for decades. These modifications not only make the operation safer for the environment, but also help reduce costs. In addition to this, it can reduce the amount of resources required to power the facility. Many industries have adopted various methods of waste heat recovery. One popular option is to use a heat exchanger. This paper presents a study of copper oxide nanofluid in conical heat exchangers, i.e. aluminium conical heat exchangers. This article attempts to understand how to compare the heat transfer rates of aluminium cone coil tubular heat exchangers using different nanofluid mass flow rates by studying the research papers of other authors.

Keywords: *Cone shaped Coil, Nano-fluid, Heat Exchanger, CFD, Pressure Drop, Temperature Distribution, Aluminium and Mass flow rate.*

1. INTRODUCTION

Heat exchangers are of great use in industrial applications such as power generation, nuclear industry, process plants, heat recovery systems, refrigeration, food industry, etc due to its compact structure and high heat transfer coefficient. Helical coils of circular cross section have been used in wide variety of applications due to simplicity in manufacturing. Flow in curved tube is different from the flow in straight tube because of the presence of the centrifugal forces. These centrifugal forces generate a secondary flow, normal to the primary direction of flow with circulatory effects that increases both the friction factor and rate of heat transfer. The intensity of secondary flow developed in the tube is the function of tube diameter (d) and coil diameter (D). Due to enhanced heat transfer in helical coiled configuration the study of flow and heat transfer characteristics in the curved tube is of prime importance. Developing fluid-to-fluid helical heat exchangers (fluid is present on both sides of the tube wall) requires a firm understanding of the heat transfer mechanism on both sides of the tube wall. Though much investigation has been performed on heat transfer coefficients inside coiled tubes, little work has been reported on the outside heat transfer coefficients

Heat transfer fluid is one of the serious factors as it disturbs the size and cost of heat exchanger systems. Conventional fluids like oil and water have partial heat transfer potentialities. For reduce cost and meet the increasing demand of industry and commerce we have to develop different types of fluids it is our top priority. By chance, the growths in nanotechnology make it possible to get higher efficiency and cost saving in heat transfer methods. Nanoparticles are occupied as the fresh group of materials which having potential applications in the heat transfer area.

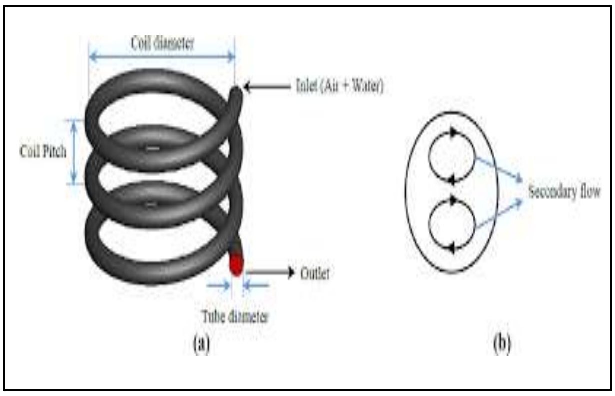

Figure 1 [12]

1.1 Nano Fluid

Nano fluid is nothing but it is a fluid particles which have less than even a micron (9-10 times) smaller in diameter and highly reactive and proficient material which can be used to increase feature like rate of reaction, thermal conductivity of any metal or material and they are that much reactive and strong.
The following benefits are expected when the nano fluid circulates the nano particles: [3]

i. Heat conduction is higher
ii. Stability
iii. Choking not occurs in Micro passage cooling
iv. Probabilities of erosion reduced
v. Pumping power is reducing

2. LITERATURE REVIEW

Helical coil is very compact in structure and it possess high heat transfer coefficient that why helical coils heat exchangers are widely used. In literature it has been informed that heat transfer rate of helical coil is larger than straight tube.

Shinde Digvijay T et. al.[1] has done his analysis on Heat Transfer Analysis of a Cone formed whorled Coil device during this experimental investigation of warmth transfer in cone formed whorled coil device is reportable for varied Sir Joshua Reynolds variety. the aim of this text is to match the warmth transfer in cone formed whorled coil and easy whorled coil. The pitch, height and length of each the coils area unit unbroken same for comparative analysis. The calculations are performed for the steady state condition and experiments were conducted for various flow rates in laminal and flow regime. The coil facet rate is unbroken varied whereas the coil facet rate is unbroken constant. it had been determined that the effectiveness of the warmth money dealer for the cone formed whorled coil is over that for the straightforward whorled coil. Results show that the warmth transfer rates for the cone formed whorled coil area unit relatively more than that of the straightforward whorled coil. it had been found that the warmth transfer rates area unit one.18 to 1.38 times additional for the cone formed whorled coil than that of straightforward whorled coil.

Mukesh Kumar et. al. [2] done heat Transfer Analysis of Cone formed whorled Coil device of various Pitches and Diameter The calculations are performed for the steady state condition and experiments were conducted for various flow rates in laminal and flow regime. The coil facet rate is unbroken varied whereas the coil facet rate is unbroken constant. it had been determined that the effectiveness of the warmth money dealer for the cone formed whorled coil is over that for the straightforward whorled coil. Results show that the warmth transfer rates for the cone formed whorled coil area unit relatively more than that of the straightforward whorled coil.

V Murali Krishna et. al. [3] has done his analysis on Heat Transfer improvement by mistreatment ZnO Water Nanofluid in a very coaxal Tube device below Forced Convection Conditions. The nanofluids area unit ready at totally different volumetrical concentration (0.1 to 0.5%). For the steadiness of nanoparticles 100 percent of wetting agent is additional to the nano-fluids. The experiment is conducted in a very double pipe device. Before conducting the experiment the warmth money dealer is graduated then ZnO-water nanofluid is distributed through annulus and readings area unit noted down. The nanofluid readings area unit compared with base fluid readings (water). the general heat transfer constant for ZnO water nanofluid is magnified by St Martin's Day with volume fraction zero.5% compared with water. the rise in heat transfer constant is thanks to increase in thermal conduction of water with the addition of nanoparticles, and conjointly thanks to increase in heat transfer to the cold fluid thanks to random motion of nanoparticles suspended in water and availableness of larger area with nano sized particles.

Hemasunder Banka et. al. [4] has done associate organized investigation on the shell and tube device by forced convective heat transfer to see flow physical look of nano fluids by unsteady volume fractions and mixed with water, the nano fluids area unit metallic element inorganic compound (TiC), metallic element compound (TiN) and ZnO nanofluid and dissimilar volume concentrations (0.02, 0.04, 0.07 & 0.15%) flowing below flow conditions. CFD analysis is finished on device by relating the properties of nano fluid with totally different volume fractions to get temperature distribution, heat transfer constant and warmth transfer rate. He found that heat transfer constant and warmth transfer rates area unit growing by additive the amount fractions.

K. Abdul Hamid et. al. [5] has done work on pressure drop for ethanediol (EG) based mostly nanofluid. The nanofluid is ready by dilution technique of TiO2 in based mostly fluid of mixture water and EG in volume quantitative relation of 60:40, at 3 volume concentrations of zero.5 %, 1.0 % and 1.5 %. The experiment was conducted below a flow loop with a horizontal tube check section at varied values of rate for the vary of Sir Joshua Reynolds variety but thirty,000. The experimental results of TiO2 nanofluid pressure drop is compared with the Blasius equation for based mostly fluid. it had been determined that pressure drop increase with increasing of nanofluid volume concentration and reduce with increasing of nanofluid temperature insignificantly. He found that TiO2 isn't considerably magnified compare to EG fluid. The operating temperature of nanofluid can cut back the pressure drop thanks to the decreasing in nanofluid viscousness.

Palanisamy et. al [6] observes the heat transfer and the pressure drop of cone helically coiled tube heat exchanger by (Multi wall carbon nano tube) MWCNT/water nanofluids. The MWCNT/water nanofluids at 0.1%, 0.3%, and 0.5% atom volume absorptions were equipped with the calculation of surfactant by using the two-step method. The investigations were showed under the turbulent flow in the Dean number range of 2200 <De <4200. The tests were attended with tentative Nusselt number is 28%, 52% and 68% higher than water for the nanofluids volume concentration of 0.1%, 0.3% and 0.5% respectively. It is originate that the pressure drop of 0.1%, 0.3% and 0.5% nanofluids are found to be 16%, 30% and 42% respectively more than water.

3. PROBLEM FORMULATION

There is less work has been done on heat transfer rate of conical coil heat exchanger, so in my work I am trying to showing the CFD analysis of CuO Nanofluid with Ethylene glycol and water as its base fluid with different mass flow rate in cone shaped coil heat exchanger by keeping in mind that Nano fluid should produce maximum heat transfer rate with minimum

power consummation. Because some times in the process of improving the heat transfer coefficient we consume more power without knowing the economic cost. Consider the cone shaped coil heat exchanger of PCD 50 mm, length 500 mm the pitch of the coil is 25 mm, the coil diameter is 10 mm and tapered angle is 2^0 & the material of coil is aluminium and mass flow rate is 0.005m/s and 0.02 m/s. In my research I am using CuO as a Nano fluid with ethylene glycol and water as its base fluid.

4. CONCLUSION

The different boundary conditions are taken for cone shaped coil heat exchanger in aluminium with different mass flow rate for the numerical simulations. The numerical study considers the effect of Nano fluid CuO and ethylene glycol and water as its base fluid on the flow and heat transfer characteristics of tube. The thermal properties of fluid are lesser as compared to Nano fluid. We made a conical helical coil of 50 mm PCD and 10 mm tube diameter of length 500 mm, tapered angle is 2^0, and the mass flow rate is 0.005m/s and 0.02m/s inside the tube.

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