ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 14, Issue, 07, pp.21927-21930, July, 2022
DOI: https://doi.org/10.24941/ijcr.43787.07.2022

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

REVIEW ARTICLE

REVIEW: CFD SIMULATION OF TAPERED COIL BY USING SILICON DIOXIDE AND ZINC OXIDE NANOFLUID WITH WATER AND ETHYLENE GLYCOL AS ITS BASE FLUID

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ARTICLE INFO

Article History:
Received 19th April, 2022
Received in revised form
15th May, 2022
Accepted 24th June, 2022
Published online 30th July, 2022

Key words:

Helical Coil, Tapered,Nano-fluid, Heat Exchanger, CFD, Pressure Drop, Temperature Distribution.

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ABSTRACT

Helically coiled heat exchangers are globally used in various industrial applications for their high heat transfer performance and compact size. Nanofluids can provide the excellent thermal performance in helical coil heat exchangers. Research studies on heat transfer enhancement have gained serious momentum during recent years and have been proposed many techniques by different research groups (1). A fluid with higher thermal conductivity has been developed to increase the efficiency of heat exchangers. The dispersion of 1-100nm sized solid nanoparticles in the traditional heat transfer fluids, termed as nanofluids, exhibit substantial higher convective heat transfer than that of traditional heat transfer fluids. Nanofluid is a heat transfer fluid which is the combination of nanoparticles and base fluid that can improve the performance of heat exchanger systems. In this present paper the efforts are made to understand that how to simulate the heat transfer rate in Copper taperedhelically coiled tube heat exchanger using Silicon Di-Oxide and Zinc OxideNano fluid by studying research papers of various authors.

Citation: ***Vishal Kumar and Vijaykant Pandey.*** **2022**. "REVIEW: CFD Simulation of Tapered Coil by using Silicon Dioxide and Zinc Oxide Nanofluid with Water and Ethylene Glycol as its base fluid..*". International Journal of Current Research*, 14, (07), 21927-21930.

INTRODUCTION

In most of the Industries, the designing and thermal evaluation of heat exchangers is generally carried out in order to reduce cost, material and energy and to obtain maximum heat transfer. The main challenge in heat exchanger design is to make it compact and to get maximum heat transfer in minimum space. The passive enhancement technique using coiled tube has significant ability in enhancing heat transfer by developing secondary flow in the coil. Due to enhanced heat transfer the study of flow and heat transfer in helical coil tube is of vital importance. Through the growth of thermal engineering and industrial intensification, the need of efficient and compact heat transfer systems has been increased. In wide-ranging, the heat transfer enhancement methods are classified into two groups. Active method is the method which requires external power, whereas passive method does not require any direct external power. Helically coiled tube heat exchangers (HCTHE) as well as nano-fluids are regarded as passive heat transfer enhancement methods. The HCTHEs are widely used in many applications, such as electricity generation and nuclear industries, HVAC, piping systems, chemical reactors and refrigeration systems due to its high thermal efficiency and compactness (low volume to surface ratio).

The curvature of helical coil which persuades secondary flow, in combining with more heat transfer area, contributes to the heat transfer enhancements of HCTHEs. Numerous studies have indicated that helically coiled tubes are superior to straight tubes when working in heat transfer applications. The centrifugal force induced due to the curvature of the tube results in the secondary flow development which enhances the heat transfer rate. This phenomenon can be valuable, especially in the laminar flow regime. 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. Forreduce 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. Nanop articles are occupied as the fresh group of materials which having potential applications in the heat transfer area.

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.

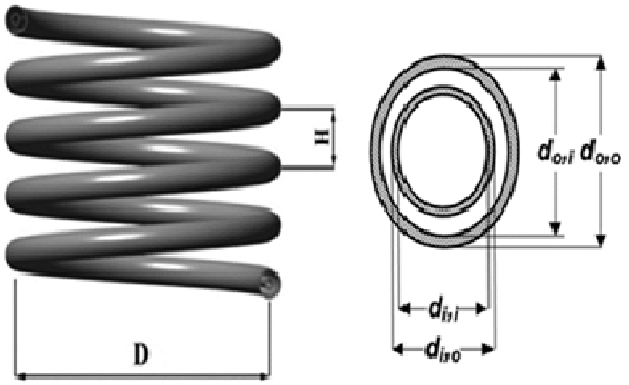

Figure 1 (Korane, 2012)

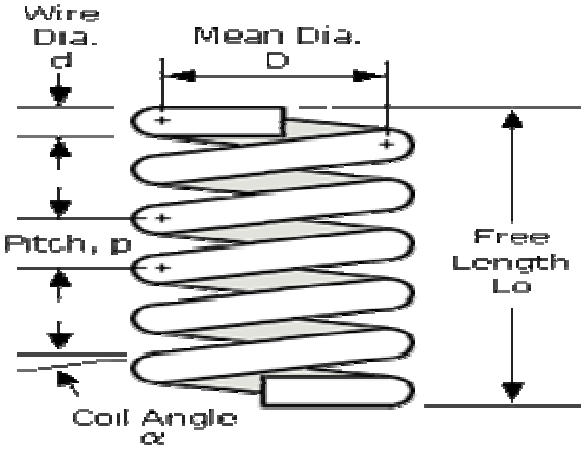

Figure 2 (Jayakumar *et al*., 2010)

The following benefits are expected when the nano fluid circulates the nano particles (Shkan Alimoradi, 2017)

Heat conduction is higher: The thermal interface is directly available if the particles are better than 20 nm and if they carry 20% of their atoms on their surface. The nanoparticle is of μ size so there will be the advantage in the movement of particles and it increased the heat transfer because of micro convection of fluid. When the nano particles having large heat surface area then the large heat transfer is allowable. Dispersion of heat is increasing in the fluid at a faster rate because of large heat transfer. When there will be a rise in temperature then the thermal conductivity of Nano fluid increases significantly.

Stability: Nano fluids have nanoparticle of which is smaller in size (9-10 times smaller) or in μ size, so they are light in weight, that's why the chances of sedimentation are reduced. When sedimentation is dropping it will provide the stability in Nano fluid by settling the nano-particles.

Choking not occurs in Micro passage cooling: For transferring of heat in heat exchanger the Nano fluid is a best option in overall and they can be perfect for micro passage uses where high heat loads are faced. A big area of heat transfer anddirecting fluids will occur by the mixture of micro path and Nano fluid and it cannot be managed with meso or micro-particles because they clog micro passages. Nano particles are smaller in size it is in μ which is very small to micro passage.

Probabilities of erosion reduced: The momentum which is conveyed by a solid wall is minor because nanoparticles are very small. The probability of erosion of components is reducing when the momentum reduces and it occurs in pipelines, pumps and heat exchangers.

***Pumping power is reducing*:** Pumping power is increasing by a feature of ten. When the heat transfer of conventional fluid is increased by a feature of two. If there is a simple increase in fluid viscosity then the pumping power will be increased satisfactory. Thus, a large savings in pumping power can be attained. Thermal conductivity can also be increased by small volume fraction of particles.

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. **N.** Ghorbani *et al*. (2010) carried out experimental look at of thermal performance in shell and Coil heat exchanger in the cause of this text is to get entry to have an an impact on of tube diameter , coil pitch , shell side and tube side mass float price on the changed effectiveness and overall performance coefficient of vertical helical coiled tube heat exchanger. The calculation has been achieved for the constant kingdom and the experiment was conducted for both laminar and turbulent waft interior coil.

It changed into observed that the mass drift charge of tube aspect to shell ratio was powerful on the axial temperature profiles of heat exchanger. He concluded that with growing mass drift charge ratio the logarithmic imply temperature distinction become decreased and the changed effective's decreases with increasing mass go with the flow price. GA Sheikhzadeh *et al*. (2017) has done work on Effect of Al2O3-water nanofluid on heat transfer and pressure drop in a three-dimensional micro-channel after analysis of his work he found that Addition of nanoparticles increased average Nusselt number, which indicated higher heat transfer into the fluids. Thus nano-fluids could be a promising replacement for pure water in micro-channel where there is need to more efficient heat transfer. Ashkan Alimoradi *et al*. (2015) has finished his investigation of exergy performance in shell and helically coiled tube warmth exchangers. He gives exergy evaluation for compelled convection heat switch in shell and helically coiled tube hearexchangers. The effect of operational and geometrical parameters on the exergy efficiency became investigated. Water is chosen as the operating fluid of each facet. Consequences display that, efficiency decreases linearly with the increase of the fluids dimensionless inlet temperature distinction. Primarily based on the consequences, a correlation was evolved to are expecting the performance for wide range of mass float prices ratio (0.1 <Rm< 4), fluids dimensionless inlet temperature distinction (zero < RT < zero. eight), made from Reynolds numbers (3.31E+eight < (Rec. Resh) < 1.32E+nine) and dimensionless geometrical parameters. consistent with this equation it turned into found that, the coil which has the maximum wide variety of turns and minimal diameter is extra green than other coils that have the same length and pitch. Abdul Hamid *et al*. (2019) has done paintings has done paintings on pressure drop for Oil (EG) primarily based Nano fluid.

The Nano fluid is prepared through dilution approach of TiO2 in based totally fluid of aggregate water and EG in volume ratio of 60:40, at 3 volume concentrations of 0.five %, 1.0 % and 1.5 %. The test turned into carried out below aa float loop with a horizontal tube test section at diverse values of glide fee for the variety of reynolds range much less than 30,000. The experimental result of TiO2 Nano fluid pressure drop is in comparison with the Blasius equation for based totally fluid. It turned into located that stress drop growth with growing of Nano fluid quantity awareness and decreases with growing of Nano fluid temperature insignificantly. He determined that TiO_2isn't always extensively increased examine to EG fluid. The working temperature of Nano fluid will lessen the stress drop because of the reducing in Nano fluid viscosity. Palanisamy (2016) investigates the warmth switch and the pressure drop of cone helically coiled tube warmth exchanger using (Multi wall carbon nano tube) MWCNT/water nanofluids. The MWCNT/water nanofluids at zero.1%, 0.3%, and 0.five% particle quantity concentrations have been prepared with the addition of surfactant with the aid of using the 2-step method. The tests have been conducted below the turbulent glide in the Dean number range of 2200 < De < 4200. The experiments were carried out with experimental Nusselt range is 28%, 52% and 68% higher than water for the nanofluids extent concentration of 0.1%, zero.three% and zero.5% respectively. it's miles observed that the strain drop of 0.1%, zero.three% and zero.five% nanofluids are discovered to be sixteen%, 30% and 42% respectively higher than water.

Hemasunder Banka *et al*. (2015) have done an analytical investigation on the shell and tube heat exchanger the use of force convective heat transfer to determine drift characteristics of nano fluids with the aid of various volume fractions and mixed with water, the nano fluids are titanium carbide (TiC), titanium nitride (TiN) and ZnO Nano fluid and different extent concentrations (0.02, 0.04, 0.07 and 0.15%) flowing under turbulent waft situations. CFD evaluation is completed on warmth exchanger by making use of the house of nano fluid with distinct volume fractions to attain temperature distribution heat transfer coefficient and heat transfer . He discovered that heat transfer coefficient and warmth transfer quotes are increasing by means of growing the quantity fractions.

Problem Formulation: In the literature survey we found that so much work had been done to increase the heat transfer rate in heat exchanger. But there is less work has been done on heat transfer rate of comparing the copper tapered helical coil by flowing Silicon Dioxide and zinc oxidenano-fluid using water and ethylene glycol as a base fluid. In my work I am trying to showing the CFD simulation of tapered coil with the help of SiO_2 and ZnONano fluid for the heat exchanger 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 helical coil heat exchanger of PCD 60 mm of length 500 mm the pitch of the coil is 25 mm, the coil diameter is 10 mm and the material of coil is Copper.

CONCLUSION

The different boundary conditions are taken for tapered helical coil heat exchanger for the numerical simulations. The numerical study considers the effect of Nano fluid Silicon Dioxide and zinc oxide, 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 helical coil of 60 mm PCD and 10 mm tube diameter of length 500 mm, the Nano fluid with water and ethylene glycol as its base fluid is flow inside the tube.

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