IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

Impact Factor: 6.252

Volume 2, Issue 7, May 2022

Effects of Twisted Tape V-Cut's with Different Tape Configuration on Heat Transfer in Heat Exchanger

Aditya Uday Jadhav, Vedant Sunil Deo, Tushar T. Kapade

Department of Computer Engineering

Matoshri College of Engineering and Research Centre, Nashik

Savitribai Phule Pune University, Nashik, India

Abstract: The convective heat transmission of a water-based Ferro fluid was studied. In the presence and absence of an external magnetic field, water-based Ferro fluid was examined. It's Fe3O4-Water. 2019 R3 simulated and analysed the issue. Single-tube sim This tube contains Ferro. The tube's outer and inner diameters are 28 millimetres apart (di). 700 mm tube length was considered. We used ICEM CFD for Fluent 2019 R3 to construct the mesh's 158776 nodes and 145000 components. This design employs Fluent. The MHD module magnetically fielded the fluent add-on model. A conductor charged with external magnetic field. Local convective heat transfer was measured with and without magnetic fields. Reynolds numbers 250-800 were studied to improve heat transfer. B=500 G was used for a steady external magnetic field. Heat transfer must modify flow patterns. Magnets alter ferro fluid. Thermal and velocity boundary layers rupture under a steady magnetic field. This improves the device's heat transmission rate. Continuous magnetic fields cause flow recirculation. The thermal barrier layer's disintegration and higher flow mixing boost heat transfer rate.

Keywords: Continuous magnetic fields

I. INTRODUCTION

If the heat transfer coefficient is made higher, the heat transfer performance of a system may be made better. Heat transfer augmentation methods are used often in process industries, heating and cooling evaporators, thermal power plants, air conditioning equipment, refrigerators, radiators for space ships and cars, etc. Many attempts have been made to reduce the size of the heat exchanger and speed up the rate of heat transfer while using as little pumping power as possible. By stopping the flow of the fluid and breaking through the viscous and thermal boundary layers, you can speed up the rate at which heat is transferred. Also, the pumping power could increase a lot, which would make the cost of pumping power go up. Because of this, many ways to improve heat transfer have been used in recent years to get the needed heat transfer rate in the current heat exchanger at a pumping power that doesn't cost too much.

Most likely, the ways to improve a heat exchanger fall into one of three groups: active, passive, or compound. The passive method doesn't need any power from the outside to help heat move, but the active method does. A compound approach is a hybrid method that uses both active and passive procedures. Because the design is so complicated, the compound approach can only be used for a few things.

Heat exchangers are used in some way in thermoelectric power plants, vehicles, heating and cooling systems, electronic equipment, and spacecraft. In all of these situations, making heat exchangers more efficient could save a lot of money, space, and other resources. Because of this, a lot of research has been done in the past to try to find ways to make heat exchangers work better. In the studies listed above, thermal conductivity, flow pattern, and high-efficiency heat transfer surfaces made from high-conductivity materials are all taken into account. Both single-phase and two-phase heat transfer have been shown to work well with certain strategies. In this study, only single-phase forced convection methods have been looked at. Each year, more than 8,000 scientific articles and reports are published in a wide range of bibliographic reports, reviews, monographs, and edited texts. There are many ways to organise the ways that the literature talks about improving heat transfer, but the most common ones are passive and active. Tubes haven't been used as efficient heat transfer elements in many places where space and weight are important, like in power plants to cool the blades of gas turbines or in the electronics industry to cool electronic parts, for a long time. Because of this, different researchers have looked at how heat and fluids move through the twisted tape tube.

The phrase "heat transfer enhancement technique" refers to a way to make heat transfer systems work better. In recent years, more work has gone into making heat exchange equipment that is more efficient. This is because the cost of energy and materials has been going up. The most important thing to do when building a heat transfer is to reduce the amount of pumping power and increase the amount of heat transfer. As a design factor, the growth of heat transfer in heat exchangers is getting a lot of attention. Enhancement methods improve convective heat transfer by making the heat exchanger have less thermal resistance. Different ways of improving heat transmission can be used to make it better. Approaches can be passive, active, or a combination of both. Passive methods are those that use inserts or other devices to change the surface or shape of the flow channel. These methods don't use power from outside the system. Instead, they use power from inside the system, which causes a drop in fluid pressure. When the flow is interrupted or changed, the heat transfer coefficient goes up. Some passive ways to improve heat transfer include treating surfaces, making surfaces rough, making surfaces bigger, and adding inserts. Mechanical help, surface vibration, fluid vibration, electrostatic fields, suction, and jet impact are all examples of active heat transfer systems. Compound enhancement is when two or more methods are used together to increase heat transfer more than any of them could do on their own.

II. OBJECTIVES

The project will be guided by the objectives listed below.

Using an in-tube system to examine heat transfer coefficients and pressure decreases Heat exchanger for ferro fluids. A magnetic field is being used to study the heat transfer rate of ferro fluids. to study the effects of twisted tape and magnetic fluid on the rate of heat transfer in the presence of a magnetic field When a magnetic field is adjusted, the pressure drop may be observed. Inflow conditions with a Reynolds number in the range of 700-1000 will be investigated in these configurations. Water will be given at a consistent temperature throughout this investigation by utilising an inner tube. Computational fluid dynamics (CFD) will be employed as well as an experimental approach in the investigation.

III. LITERATURE REVIEW

Ferromagnetic nanoparticles are suspended in a non-magnetic liquid in a ferro fluid. Research into the magnetic properties of magnetic fluids has been ongoing since the 1930s, but it really took off in the 1960s and 1970s, when commercially practical magnetic fluids were available (Elmore 1938). (1988) Bashtovoy and Vislovich A number of studies on the properties of Ferro fluids are available now, including those by Rosensweig (1979), Bashtovoy & Vislovich (1988), and Blums et al. (1989). If the magnetic moments of the individual particles in the fluids are not aligned, there is no net magnetization in Ferro fluids. They are now more generally referred to as "super paramagnets" rather than "Ferro magnets," as a result (Albrecht et al. 1997). The fluid becomes magnetised as a consequence of the particles aligning themselves with the magnetic field. Magentic properties are influenced by a variety of factors, including the applied field strength, the surrounding temperature and magnetic particle concentrations. A fluid that has been magnetised will gravitate toward a stronger magnetic field as the Kelvin force increases. In this study, only the thermal and magnetic fields will be examined since the concentration of magnetic phase is expected to remain constant. If the usual period of interest convection flows is much shorter than the magnetic fluid segregation, the Soret effect or solid particle thermophoresis-induced magnetic fluid segregation could support this claim (Shliomis & Smorodin 2002). So we may deduce that there is no influence on Ferro fluid magnetization from the fluid's magnetic susceptibility, which is a ratio of fluid magnetization to applied magnetic field strength. This is due to the fact that ferro fluids are paramagnetic and hence obey Curie's rule and grow less charged with rising temperature. It's convection that causes a Ferro fluid's magnetic buoyant force to be activated, and this movement is known as convection. Flow convection is a fundamental process for mass movement and heat transfer in fluids. Convectional thermodynamics Huang et al. (1997) investigated the thermos convective instability of an unbounded no conducting horizontal layer of paramagnetic fluid heated from below under a uniform oblique magnetic field using a linear stability analysis of the Naiver- Stokes equations supplemented with Maxwell's equations and taking into account the magnetic body force. Consequences of convective instability occur when convective roll axes line up horizontally with the magnetic field. Two-dimensional vortices in ferromagnetic fluid heated from the top were examined by Russell et al. (1999) for large critical wave numbers. Nonlinear asymptotic description of the vortex pattern that occurs above the critical point in the parametric space where instability first occurs was studied by Belyaev and Smorodin (2010) in a flat vertical layer of ferrimagnetic fluid under transverse temperature gradient in a uniform magnetic field perpendicular to the plates. The stability of flow was explored in relation to three-dimensional disturbances. According to the authors, the Suslov et al. reported stationary and two wave modes were really true (2008). In terms of magnetic susceptibility, Prandtl number, and Langevin parameter, thermomagnetic waves may occur in a wide range of values. Suslov et al. (2008) found this enormous wavenumber and defined the upper and bottom boundaries of the Prandtl number range. Suslov et al. investigated theoretically and experimentally the thermal convection patterns in a vertically differentially heated layer of nonconducting ferromagnetic fluid in a uniform transverse magnetic field (2012). Experiments conducted by Suslov and coworkers confirmed that the authors' predictions of oblique thermomagnetic waves were correct (2008). Thermodynamic, gravitational, and magnetic processes all contribute to three types of instability. The physical basis of all three modes is explored in great detail, and the most noticeable characteristics are emphasised. This will assist guide future studies. These wavenumbers were discovered to be substantially influenced by the magnetic field and the temperature difference between the layer. The disturbance energy balance analysis was used to detect whether thermomagnetism and thermogravitational processes are responsible for a flow instability. Magnetic reconnection and the Grashof effect were determined to be the catalysts for such a shift. Grashof numbers are comparable in size.

Inquiry into Experiments

The high-velocity fan's output will be channelled into the cylinder housed inside the duct. The perforations in the surface will be used to bring in a stream of low-temperature, high-pressure air. Because of this, the heater for the flow channel has been turned on to give the necessary thermal power. The steady state conditions will be determined by monitoring the temperature data (Ts, Tc, Ti). • The required measurements will be taken after the weather has normalised.. STEP iv will need to be redone if any changes are made to the fluid's temperature or flow velocity. The results of the analysis and comparisons. Heat transmission away from a cylinder's surface will be studied using experimentation and computational fluid dynamics (CFD) data. Because of their thermal properties, ferro fluids have been suggested as a new working fluid in industrial applications. This article focused on the convective heat transfer in Fe3O4-Ferofluid 66. Using CFD, it is possible to examine ferro fluid in a magnetic field of 0–500 G. For a parabolic trough solar collector, the working fluids are the ferro fluid (1-4%) and the ferro fluid 66 (66%) (the base fluid). Analysis of numerical data is followed by an in-depth assessment of the impact of the magnetic field on a range of parameters. The output temperature of the collector may be raised, as well as the heat transfer coefficient and thermal efficiency, by applying a magnetic field to the collection tube. Increasing the magnetic field intensity and the volume percent of nanoparticles in the base fluid also increased collector performance. Wind, sun, and hydropower are all examples of this kind of electricity.

The Scientific Process of Experimentation

There were a total of six different tube designs built and tested for the five different Reynolds values. U-tube manometers were fitted to the test section's inlet and outlet to measure the difference in pressure at the inlet and exit. The change in the head of the U-tube manometer is used to measure the reduction in pressure. The manometer data was used to calculate the pressure drop for each tube's Reynolds number. The data may be used to determine the fluid's average temperature (i.e., surface temperature and fluid temperature). The density and thermal conductivity of water are two examples of water properties. It is possible to determine the fluid's dynamic viscosity by considering the fluid's average temperature. The pressure drop and heat transfer coefficient readings were used to complete the final computations.

IV. RESULTS

ANSYS Fluent is used to resolve the governing equations. Using a single-phase hydrothermal model, researchers were able to explore the effects of a magnetic field on a fluid. A three-dimensional steady state turbulent k– RNG model

IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

Volume 2, Issue 7, May 2022

Impact Factor: 6.252

and conventional wall functions are used to represent heat transport in the receiver tube. Non-equilibrium wall functions may provide excellent forecasts for a pipe using the RNG-derived k-model. As a direct result, the SIMPLEC solution approach and the k– RNG turbulence model have been modified to work with the parabolic trough receiver arrangement. The upwind second-order differencing technique is used to solve equations involving motion and energy. The convergence limit for solving equations involving motion and mass is set at 103, whereas the limit for solving equations involving energy is set at 106. The C programming language was used to generate a user-defined function code that incorporated the Ferro fluid characteristics and magnetic field effects to the simulation. Solar collector thermal efficiency may be determined using various meshes for the receiver tube's mesh sensitivity in this stage. Data in Table 2 comes from testing the mesh's sensitivity at 2300 degrees Celsius with a smooth absorber. A discretization of around 4.5 million cells has been found to be appropriate for application. In the same way as ferro fluid is utilised as a working fluid in volume fractions of 1%, 2%, and 4%, It is possible to magnetise nanoparticles by passing an electric current via a wire that is near to the collection tube. Temperature and velocity are shown in Figure 4 for departure of the base fluid, Therminol 66, if the intake temperatures are 503 K and Re are 15000 and 3 1000, respectively.

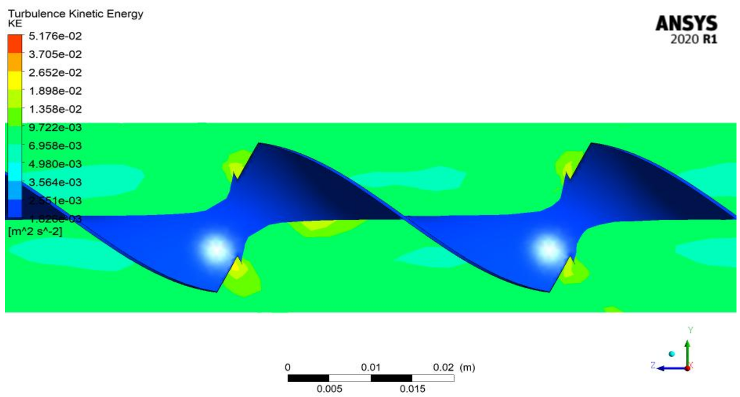

Fig. Turbulent Kinetic Energy (TKE) in Cut region

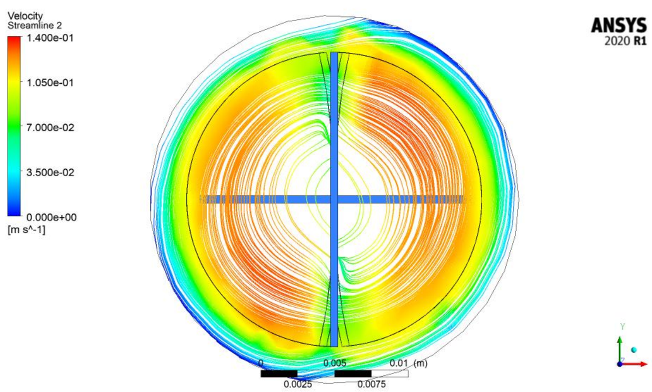

Fig. secondary flow Streamlines across cut region

Effect of Depth ratio (DR)

As DR rises, so does the quantity of nusselts. Fig. illustrates that as the depth of the V cut rises, more fluid mixing occurs and heat transmission is facilitated by an increase in energy fluctuation in the cut area fluid layers. When the

IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

Impact Factor: 6.252

Volume 2, Issue 7, May 2022

Reynolds number is 17500, the Nusselt number rises from 32.18 percent to 115.16 percent when the DR is 0.2 to 0.45. Variable-width ratio instances illustrate that the Nusselt number grows with increasing DR.

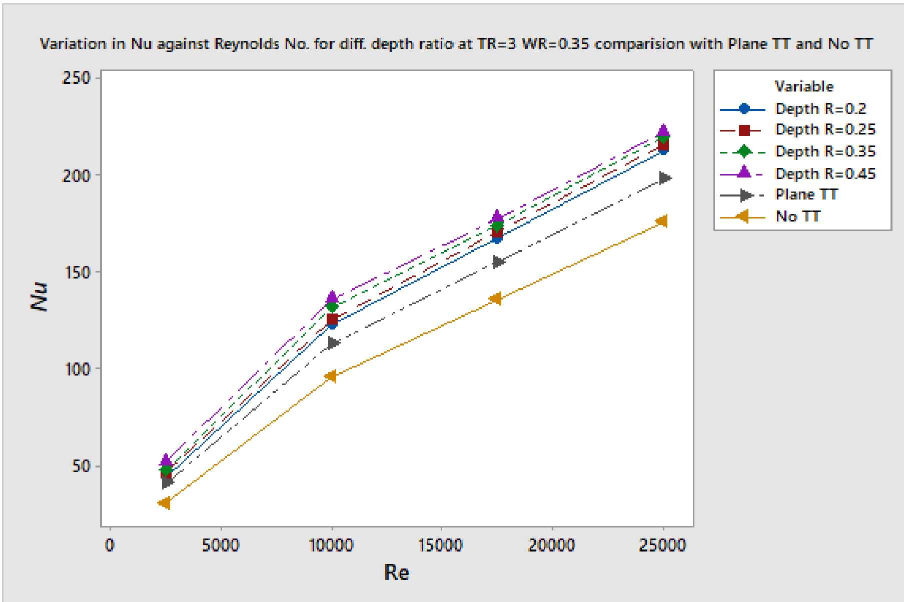

Fig. Variation of Nu against Re for diff. depth ratio at TR=3 WR=0.35 with Plane TT and No

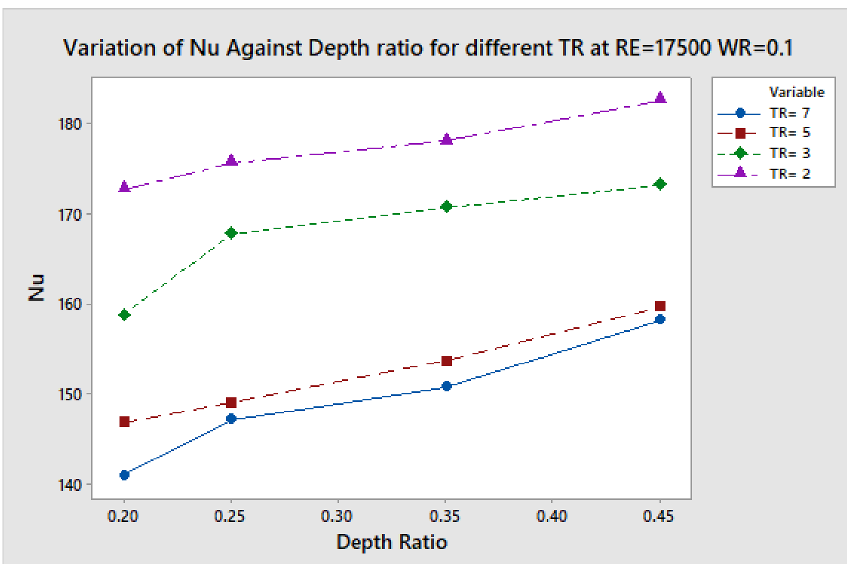

Fig. Variation of Nu against depth ratio for diff. TR

At higher Reynolds numbers, the friction factor does not vary much, but at lower Reynolds numbers, it becomes more sensitive to the effect of the drag ratio. TPF rises from 25.87 percent to 128.78 percent for DR=0.2 to DR=0.45 for

WR=0.25 and TR=2, respectively, as DR increases. All Twist and Width ratios have the same kind of influence on TPF when DR is applied.

At lower WRs, the Nusselt number grows while at higher WRs, the number falls. Twisted tape's ability to generate powerful vortex flow diminishes as the cut width widens, which is why this is the case. In spite of the increased mixing of the flow, the whirling of the flow diminishes as the tape's width grows above WR=0.25. When TR is less than 3, the flow becomes free-flowing at increasing Reynolds numbers.

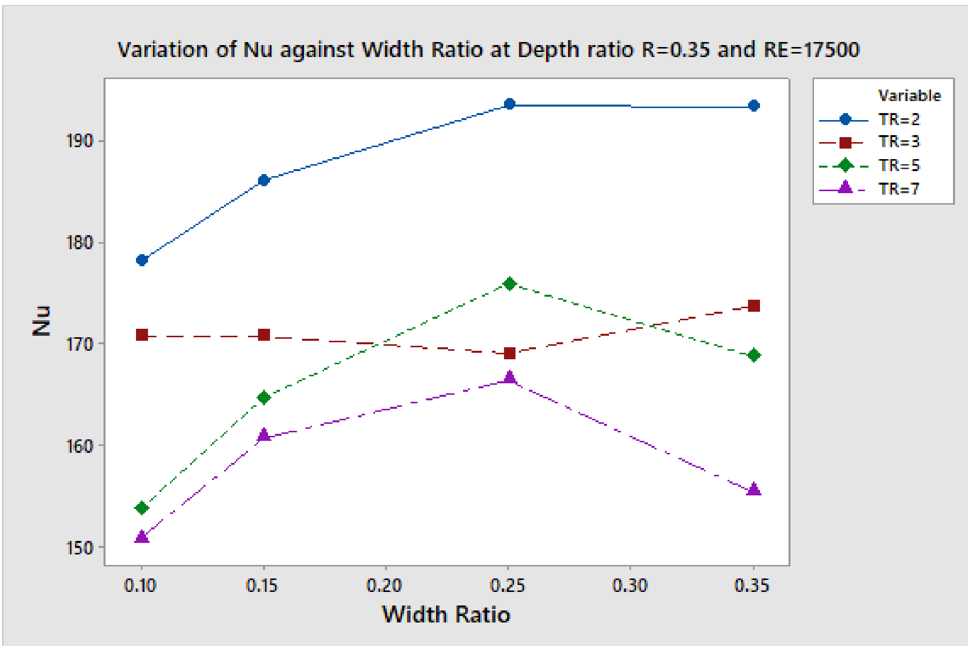

Fig. Variation of Nu against Width ratio for different TR at Re=17500 DR=0.35

V. Conclusion

We decided to carry out some study in order to get a deeper comprehension of the process by which twisted tapes V-TT in a double pipe heat exchanger with twist ratios of y = 2.0, 4.4, and 6.0 transmit heat. According to the findings of prior study, altering P-TT tape by cutting very small holes into it could be able to increase heat transfer and thermal enhancement. The concept behind variant twisted tapes involves creating very small incisions in the region around the tape's perimeter and then using wire nails to secure the tape to the P-TT. Tests are performed in order to discover which method offers the most advantages for use in industry. The results of this research are summed up in the following sections in their respective sections.

REFERENCES

[1]. Khosravi, R. N. N. Koury, L. Machado, and J. J. G. Pabon, “Energy, exergy and economic analysis of a hybrid renewable energy with hydrogen storage system,” Energy, vol. 148, no. C, pp. 1087–1102, 2018.

[2]. Khosravi, R. N. N. Koury, L. Machado, and J. J. G. Pabon, “Prediction of hourly solar radiation in AbuMusa Island using machine learning algorithms,” J. Clean. Prod., vol. 176, no. C, pp. 63–75, 2018.

[3]. Khosravi, L. Machado, and R. N. Oliviera, "Time-series prediction of wind speed using machine learning algorithms: A case study Osorio wind farm, Brazil," Appl. Energy, vol. 224, no. C, pp. 550–566, 2018.
[4]. M. Faizal, R. Saidur, S. Mekhilef, and M. Alim, "Energy, economic and environmental analysis of metal oxides nanofluid for flat-plate solar collector," Energy Convers Manag, vol. 76, pp. 162–168, 2013.
[5]. U.S. Energy Information Administration Office of Integrated Analysis and Forecasting, "International Energy Outlook," 2016.
[6]. Fernandez-Garcia, E. Zarza, L. Valenzuela, and P. M. Erez, "Parabolic-trough solar collectors and their application," Renew Sustain Energy Rev, vol. 14, no. 7, pp. 1695– 1721, 2010.
[7]. E. Kaloudis, E. Papanicolaou, and V. Belessiotis, "Numerical simulations of a parabolic trough solar collector with nanofluid using a two-phase model," Renew. Energy, vol. 97, pp. 218–229, 2016.
[8]. S. Kalogirou, "The potential of solar industrial process heat applications," Appl. Energy, vol. 76, no. 4, pp. 318 337–361, 2003. 319
[9] V. V. Wadekar, "Ionic liquids as heat transfer fluids – an assessment using industrial exchanger geometries," Appl. Therm. Eng., vol. 111, pp. 1581–1587, 2017.