iJRASET
International Journal For Research in
Applied Science and Engineering Technology

# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

**Volume:** 11 **Issue:** II **Month of publication:** February 2023

**DOI:** https://doi.org/10.22214/ijraset.2023.49075

# Heat Exchanger Performance Improvement through Double Pipe Counter Flow type by using Different Nano Fluids

Aashish Rangari[1], Gouraw Beohar[2]
*Mechanical Department, Shri ram Institute of Technology, Jabalpur, India*

***Abstract: The main purpose of present research work is to improve performance of double pipe heat exchanger performance. In this present work two types of nano fluid s taken :$Al_2O_3$ and CuO with a mixture of water and Ethylene Glycol as a base fluid. $Al_2O_3$ and CuO nanoparticles of concentration 0.05%, 0.15% and 0.3% were added to the base fluid. Overall performance is done by using ANSYS Fluent. The overall heat transfer coefficient, heat transfer rate, and temperature decrease are the basic characteristics that are taken into account while evaluating the results.***
***Keywords: Heat Exchanger, CFD, Nano Fluids, $Al_2O_3$ and CuO.***

## I. INTRODUCTION

Heat exchanger is most significant equipment in all industries and double pipe heat exchanger counter flow is known as most efficient heat exchanger in all type. In all process industries it is known for transferring heat in different processes. The main objectives of designing of heat exchanger are to improve heat transfer, reducing total time to achieve heat transfer and increase total energy of the process. These efforts related to increases in efficiency, is created by direct and indirect methods.

E.J. Onyiriuka et al [1] investigate turbulence in double pipe heat exchanger with nano fluids, casted by bark of mango tree. Basically it is contrcuted through bark with 100 nm particles. By this two phase mixute is obtained and analysis is done by Finite Element. Consideration with turbulent flow number which is associated with Reynold there is more than two third rise in heat coefficient number which is known as Nusselt Number. By comparsion researcher directly showed more than 200 percent increment while using nano particles. In continuation to this the Nusslet number can be decresed by 0.76 percent when researcher increases the 1 percent of volume. This will help in increasing heat transfer of liquid.

L. Syam Sunder et al [2] investigates the different volume of nano fluid of ferros oxide with help of double pipe heat exchanger. There were different type of pitch coil ratios, and effectiveness of heat exchanger is evaluated. By investigation different particles concentration as per volume of fluids. Test results showed different pitch ratios with varied volume like 0.005, 0.01, 0.03, and 0.06 percent with different pitch ratio 1 to 1.8. results showed increment in nusslet number upto 10 % with 0.06 percent volume of nano material. The values of Nusselt elevated with 26% and 38% with other values of concentration for respective reynold number values 16540 and 28950 respectively

## II. MATERIALS & METHOD

The double pipe heat exchanger used widely in researches with various utility like cooling the hot fluid. The use of nano fluids in different aspects of present analysis, where heat transfer analysis done by different concentration of Nano fluid. Present analysis concentrated on overall heat transfer variation, the mass flow rate is taken constants in this present research work.

The present study carried out with fluid module of ANSYS,, the module is kknown as FLUENT.

Present research work carried out the design parameters associated with different research references, the reference made in this research of double pipe heat exhcnager is given in Table 3.1 . this type of heat exchanger is single pass heat exchanger.

Table 1 The Specification of Double Pipe Heat Exchanger

| Sr.No. | Description | Unit | Value |
|---|---|---|---|
| 1. | Outer Pipe Diameter | mm | 66.0 |
| 2. | Inner Pipe Diameter | mm | 34.0 |

| | | | |
|---|---|---|---|
| 3. | Outer/Tube length | m | 1.26 |
| 4. | Area of Outer Pipe | $mm^2$ | 427 |
| 5. | Area of Inner Pipe | $mm^2$ | 226 |
| 6. | Thickness of the Pipe | mm | 4.2 |

## III. CFD ANALYSIS

Present CFD modeling done by making geometry with mesh and boundary conditions . the first part associated with the initial condition and mesh modeling.

### *A. Geometry*

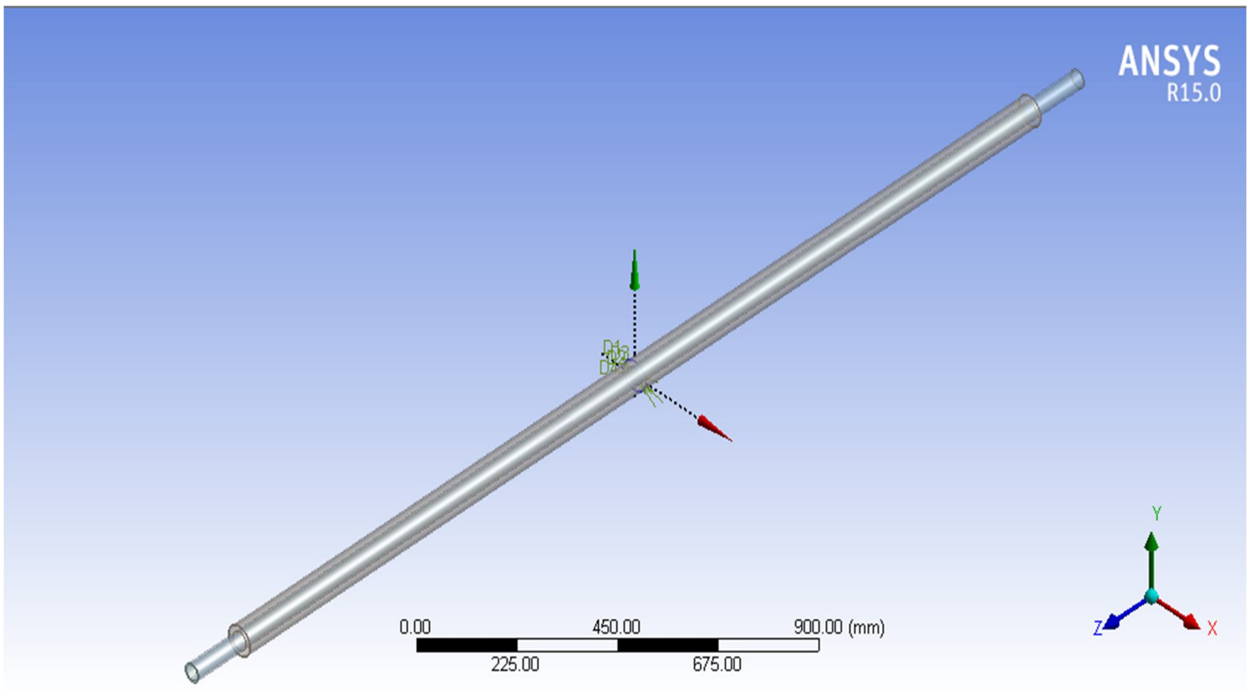



Figure 1 Geometry of the Double Pipe Counter FlowHeat Exchanger.

The present heat transfer design geometry done in ANSYS workbench, then it is simplified with symmetric plane. The design stated it is double pipe heat exchanger with counter flow, where two side of tube is constructed with separate idea of inlet in inner and outer tube sides

### *B. Boundary Conditions*

In investigation of research work in current model there are defined physical boundaries related to inlet and outlet conditions. Velocity at inlet condition is also defined as the Reynolds number theory where hydraulic number is taken with the constant temperature viscosity. The overall boundary conditions is taken in Table 3.2 with different coupled and no slip conditions.

Table 1 Boundary Condition of research Work

| | Boundary Condition | Outer Tube | Inner Tube |
|---|---|---|---|
| Outlet Pressure | Outlet | 1 bar | 1bar |
| Wall | No slip condition | No heat flux | Coupled |

*ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538*
*Volume 11 Issue II Feb 2023- Available at www.ijraset.com*

## IV. RESULT AND DISCUSSION

Figure 2 and 3 shows the general fluid flow of Hot and Cold fluid in the double pipe counter flowheat exchanger.

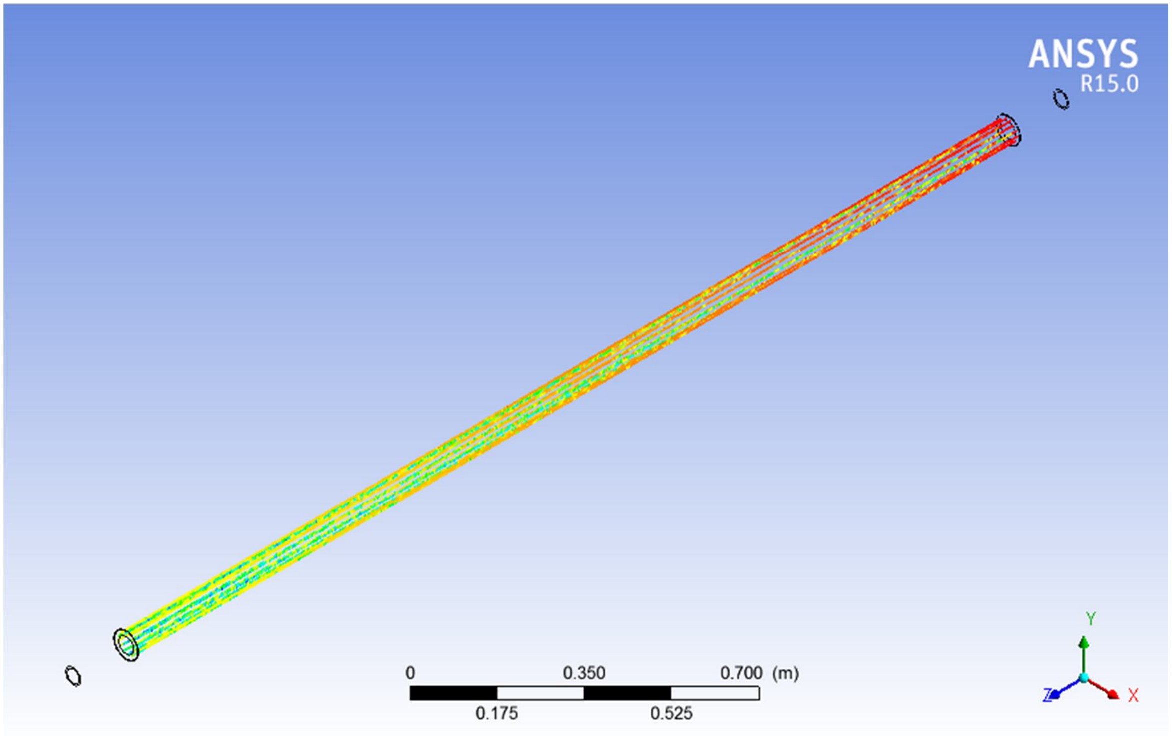



Figure 2 Flow of Hot Fluid in the double pipe counter flow Heat Exchanger.

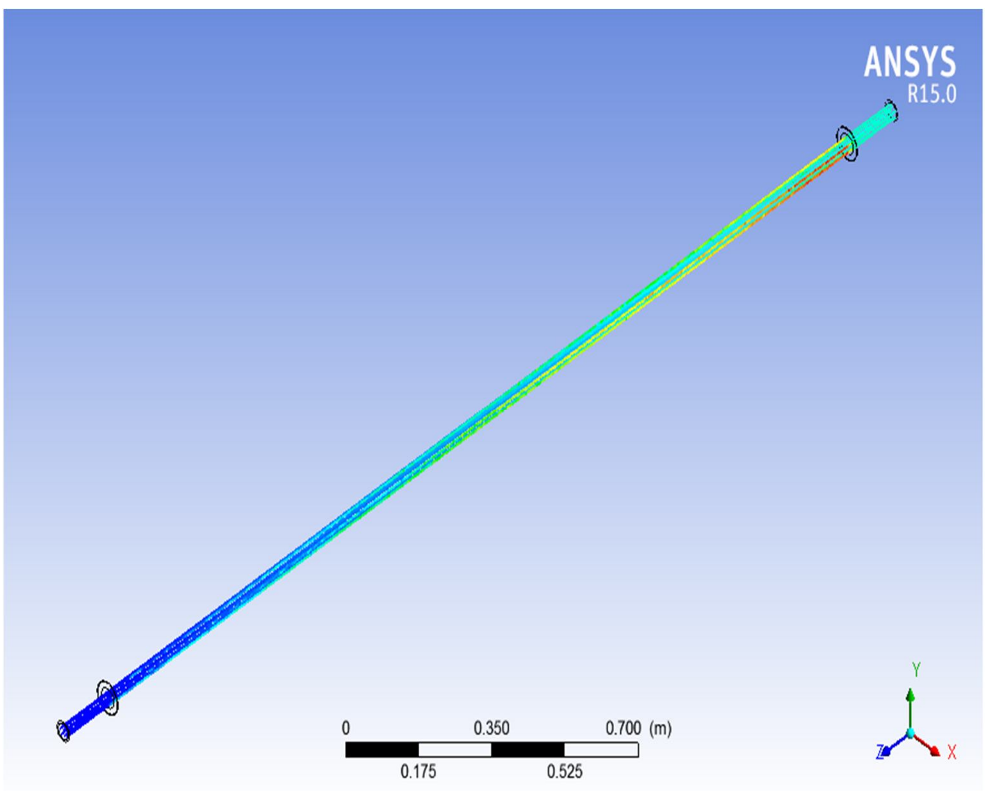



Figure 3 Flow of Cold Fluid in thedouble pipe counter flowHeat Exchanger.

### *A. Overall Heat Transfer Coefficient*

In the heat exchanger where heat transfers from one fluid to another fluid is take place. The rate of energy transfer calculated through higher temperature side which is bulk temperature the heat transfer of one fluid is taken Heat transmission from one fluid to another fluid is critical in engineering process plants when two fluids are separated by a thermally conductive wall.

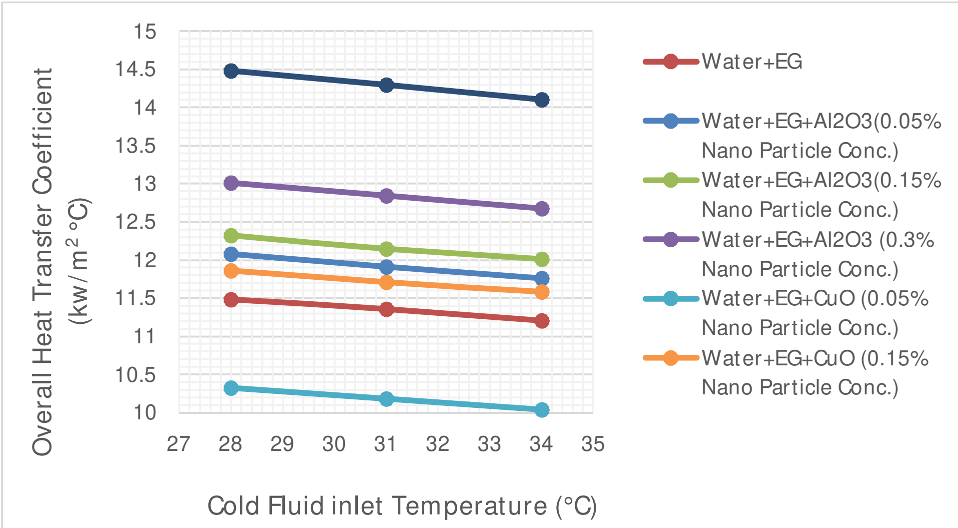



Figure 4 Overall Heat Transfer Coefficient variation with respect to Cold Fluid Inlet Temperature for various fluids.

There is increased in thermal efficiency of Nano fluids, the inlet temperature of given condition is 28°C, 31°C and 34°Cgiven in 4.52 figure. The value of overall heat transfer coefficient is obtained by 0.3% concentration of particles in nano fluids.. For both Nano fluids the overall heat transfer coefficient at a constant hot fluid inlet temperature increases with increasing of the nanoparticles concentration compared to the base fluid only except the condition of having 0.05% nanoparticles concentration of CuO Nano fluid as clearly shown in figure 4.

### *B. Effects on Heat Transfer Rate*

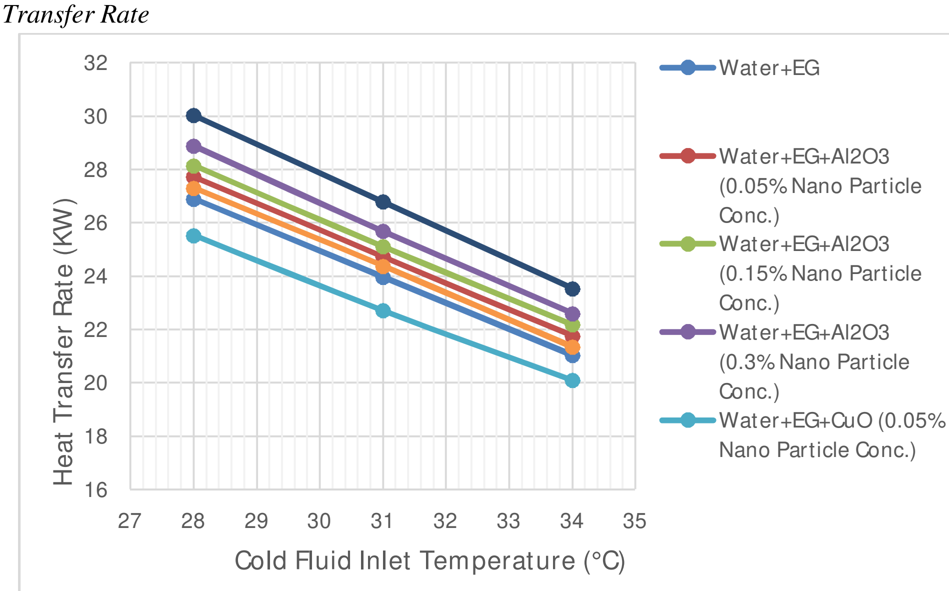



Figure 5 Heat Transfer rate variation with respect to Cold Fluid Inlet Temperature for various fluids.

The Heat transfer rate with different Nano particles for 28°C, 31°C and 34°C cold fluid inlet temperature are presented in Figure 5 . The heat transfer rate increases with the increase of volume concentration of Nano particles. The maximum value of heat transfer rate can be obtained by having 0.3% particles concentration of $Al_2O_3$ and CuO for both Nanofluids respectively.

## V. CONCLUSION

In present research the heat transfer performance of nano fluid mixed with water nano fluid like $Al_2O_3$ mixed with water added in presence of Ethylene Glycol and Copper oxide nano material mixed with water added with Ethylene Glycol is investigated with help of different numerical analysis.

Conclusion were made during the analysis: present research work indicates the heat transfer coefficient is overall varied from 12 $kW/m^2°C$ with the range varied to 12.5 $kW/m^2°C$ when the base fluid is used. Research also suggested the 0.05 percentage concentration of alumina particles with water and ethylene glycol, varied from 11.9 $kW/m^2°C$ and 12.1 $kW/m^2°C$. In this research also alumina oxide value varied from 12.1 to 12.35 $kW/m^2°C$ when it mixed with Water and Ethylene Glycol in 0.15% concentration. In 0.3 percent concentration the value varied from 12.7 to 13.10 $kW/m^2°C$.

## REFERENCES

[1] E.J. Onyiriuka, O.O. Ighodaro. A.O. Adelaja, D.R.E. Ewim. S. Bhattacharyya A numerical. investigation of the. heat transfer. characteristics of. water-based mango bark nanofluid flowing in a double-pipe heat exchanger, Heliyon 5 (2019) e02416.

[2] L. Syam Sundar, N.T. Ravi Kumar, Birhanu. Mulat Addis, P. Bhramara, Manoj.K. Singh, Antonio. C.M. Sousa, Heat transfer and. effectiveness. experimentally-. based: analysis. of wire. coil with; core-rod. Inserted; in. $Fe_3O_4$/water; nanofluid. flow. in a. double pipe.; U-bend heat. exchanger, International. Journal of Mass Transfer andHeat134. (2019) .405–419.

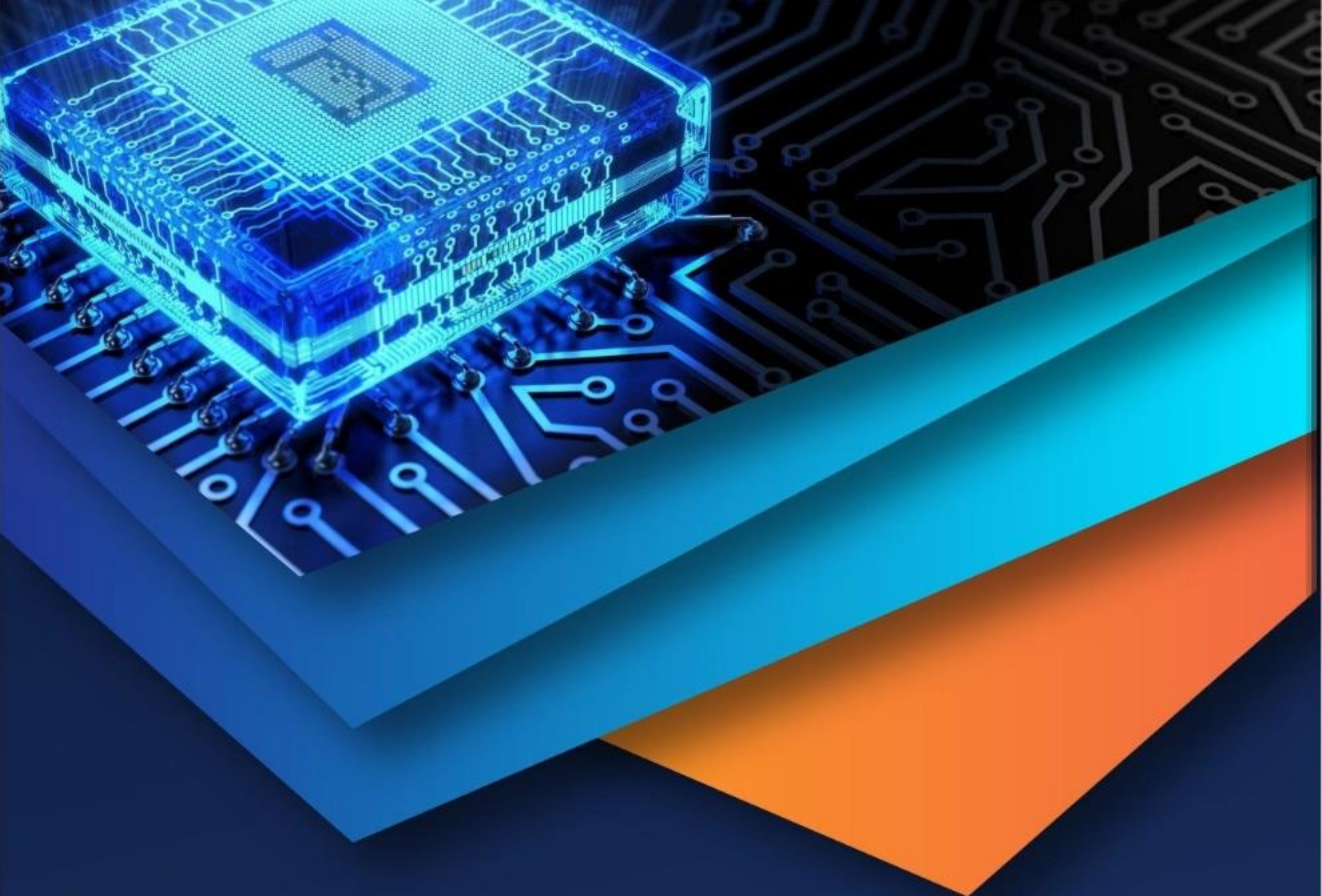
[3] B. Saleh, L. Syam. Sundar, Thermal. performance, embodied. energy and environmental. $CO_2$ emissions; analyses for. double pipe; U-bend. heat exchanger. working with MWCNT/ water. nanofluid, International Journal of Thermal. Sciences 169 (2021) 107094.

[4] M.M. Sarafraz, F. Hormozi; V. Nikkhah; Thermal. performance; of. a counter-. current. double. Pipe. heat exchanger. working. with. COOH-CNT/. water. Nanofluids, Exp. Therm. And. Fluid Sci. 78. (2016.) 41-49.

[5] Iman Bashtani, Esfahani, Kyung.Chun; Kim Javad Abolfazli., Effects. of Oxide.water-aluminum.; nanofluid on; double pipe heat exchanger; turbulatorswith gear disc; An investigation of numerical; Taiwan Journal in theInstitute of. Chemical; Engineers .00 (2021) 1_. 12..

[6] Alhassan Salami. Tijani, Ahmad Suhail .bin Sudirman, Thermos-. physical properties and. heat. transfer characteristics. of water/. anti-freezing and $Al_2O_3$/CuO. based nanofluid. as a coolant for. car radiator., Int. J. of Heat .and Mass. Transfer 118. (2018) .48–57.

[7] B. Kamenik., A. Turgut., E. Begum. Elcioglu, L. Hernandez Lopez, R. Mondragón, L. Lugo,J.P. Vallejo, J. Ravnik, M.H..Buschmann, theanalysis of performance uncertaintyof heat exchangers operated. with nanofluids, International Journal. of Thermo.fluids 14 (2022). 100144



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY