COST ESTIMATION OF FLUDIZED BED COOLING TOWER BY SIMULATION APPROACH TO REDUCED MAINTENANCE TIME

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Abstract

In present study, Numerical simulations of cooling tower with different shaped fluidized bed are used to identify the temperature distribution with variation in mass fraction in nanofluid (ZnO). Within it has been found out Different mass fraction levels have also been found out at different fluidized bed in the cooling tower. The model of the fluidized bed cooling tower has been created in unigraphics 8.0 and analysis has been performed using ANSYS 15.0. The simulation has been done for both temperature and effectiveness. Obtained results have been validated with the available base paper experimental work.

The maximum amount of heat transfer is achieved on numerical simulation as the results obtained with respect to temperature on different mass fraction of nanofluid, thus 6.8% of average temperature is obtained on circular shaped fluidized bed and 13% average effectiveness is obtained in circular shaped fluidized bed, hence the results shows convergence to base paper experimental investigation, The cost evaluation has been evaluated in present study for determination of breakeven cost and payback period..

Keywords. *Fluidized Bed, Cooling Tower, CFD, Nano fluid, Concentric Shaped Bed, Effectiveness, Cost Reduction, Payback Period.*

I INTRODUCTION

A cooling tower is a specialized heat exchanger in which air and water are brought into direct contact with each other in order to reduce the water's temperature. As this occurs, a small volume of water is evaporated, reducing the temperature of the water being circulated through the tower. Water, which has been heated by an industrial process or in an air-conditioning condenser, is pumped to the cooling tower through pipes. The water sprays through nozzles onto banks of material called "fill," which slows the flow of water through the cooling tower, and exposes as much water surface area as possible for maximum air-water contact. As the water flows through the cooling tower, it is exposed to air, which is being pulled through the tower by the electric motor-driven fan. When the water and air meet, a small amount of water is evaporated, creating a cooling action. The cooled water is then pumped back to the condenser or process equipment where it absorbs heat. It will then be pumped back to the cooling tower to be cooled once again. Cooling towers are a special type of heat exchanger that allows water and air to come in contact with each other to lower the temperature of the hot water. During the cooling tower working process, small volumes of water evaporate, lowering the temperature of the water that’s being circulated throughout the cooling tower. The hot water is usually caused by air conditioning condensers or other industrial processes. That water is pumped through pipes directly into the cooling tower. Cooling tower nozzles are used to spray the water onto to the “fill media”, which slows the water flow down and exposes the maximum amount of water surface area possible for the best air-water contact. The water is exposed to air as it flows throughout the cooling tower. The air is being pulled by an motor-driven electric “cooling tower fan”. When the air and water come together, a small volume of water evaporates, creating an action of cooling. The colder water gets pumped back to the process/equipment that absorbs heat or the condenser. It repeats the loop over and over again to constantly cool down the heated equipment or condensers. For more knowledge and learning about cooling towers visit Cooling Tower Fundamentals by SPX Cooling.

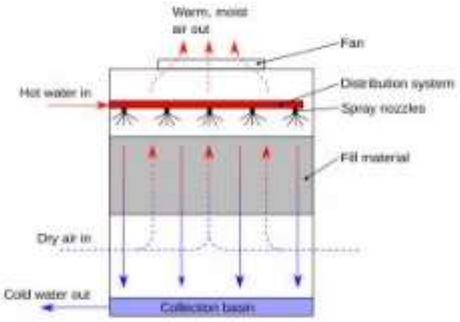

Figure1.1 Basic Component of Cooling Tower

II COST REDUCTION

Cost reduction is the process used by companies to reduce their costs and increase their profits. Depending on a company’s services or product, the strategies can vary. Every decision in the product development process affects cost. Companies typically launch a new product without focusing too much on cost. Cost becomes more important when competition increases and price becomes a differentiator in the market.

III REAL-TIME SIMULATION

In a real time simulation the simulation is performed in a discrete time with constant step also known as fixed step simulation as time moves forward in equal duration of time, other techniques having variable step are used for high frequency transients but are unsuitable for real time simulation. In a real time simulation the time required to solve the internal state equations and functions representing the system must be less than the fixed step. If calculation time exceeds the time of the fixed step, an over run is said to have occurred. In simple words, real-time simulation must produce the internal variables and output within the same length of time as its physical counterpart would. Configuring models to run in real time enables you to use hardware-in-the-loop simulation to test controllers. You can make design changes earlier in the development process, reducing costs and shortening the design cycle.

IV MODELING AND ANALYSIS

For increasing the cooling effectiveness we have considered the bench mark of a cooling tower with dimension 13m×10m×14m and evaluating two different designs reticular and wavy plane which was identified the best performance on base paper. After evaluation we suppose to calculate the application feasibility and calculate cost.

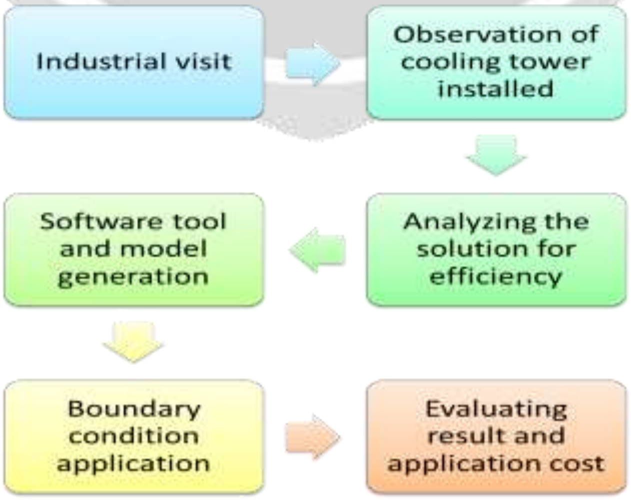

Figure 4.1 - Flow chart of methodology on cooling tower.

The procedure for resolving any problem is:

- Create the geometry.
- Meshing of the domain.
- Set the material properties and boundary conditions.
- Obtaining the solution

Table 4.1: Geometric Parameters of Fluidized bed cooling tower

Diameter of Fluidized bed cooling tower(mm)	Height of Fluidized bed cooling tower (mm)
160	400

Figure 4.2 - Block diagram of ANSYS process.

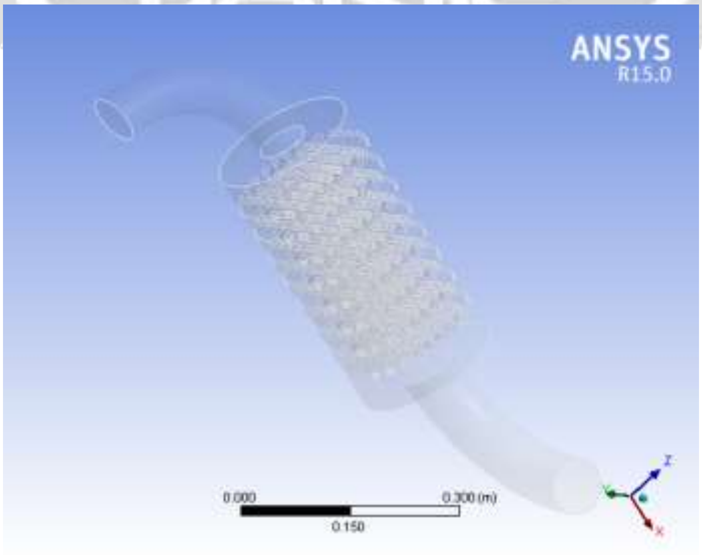

Figure No.: 4.3 Metal reticular shaped fluidized bed cooling tower.

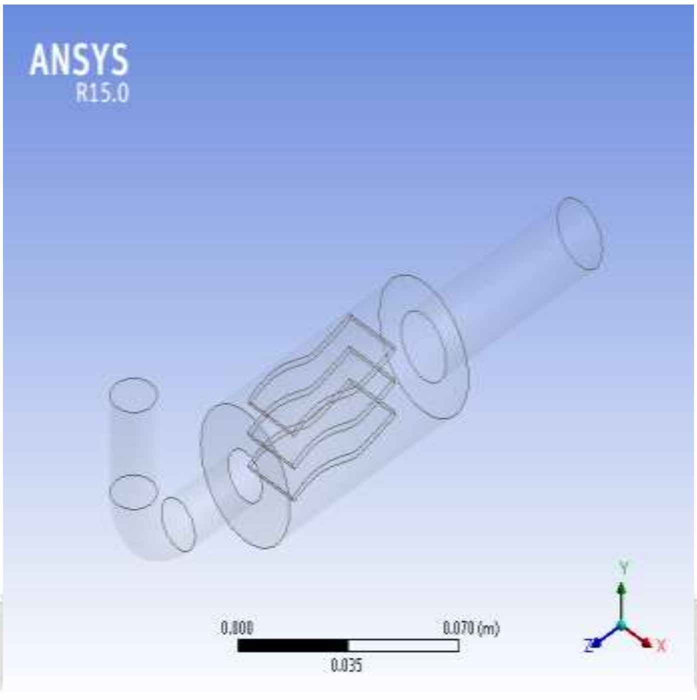

Figure No.:4.4: 3D Model of Metal wavy planes shaped fluidized bed cooling tower.

Meshing Domain of cooling tower

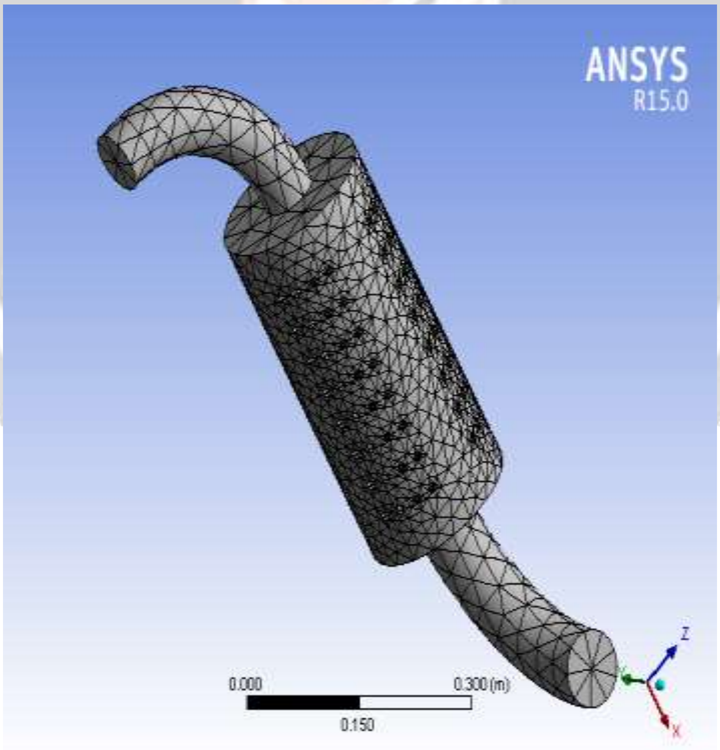

Figure No.: 4.5 Metal reticular shaped fluidized bed cooling tower.

V RESULT AND DISCUSSION

5.1 Temperature distribution on cooling tower with different fluidized bed

A three-dimensional model has been developed to investigate heat transfer in the fluidized bed cooing tower for heat and mass removing process. A series of numerical calculations have been conducted using commercial

CFD code FLUENT 15.0.The results are presented in order to show the effects of temperature distribution with respect to mole fraction in the fluidized bed cooling tower

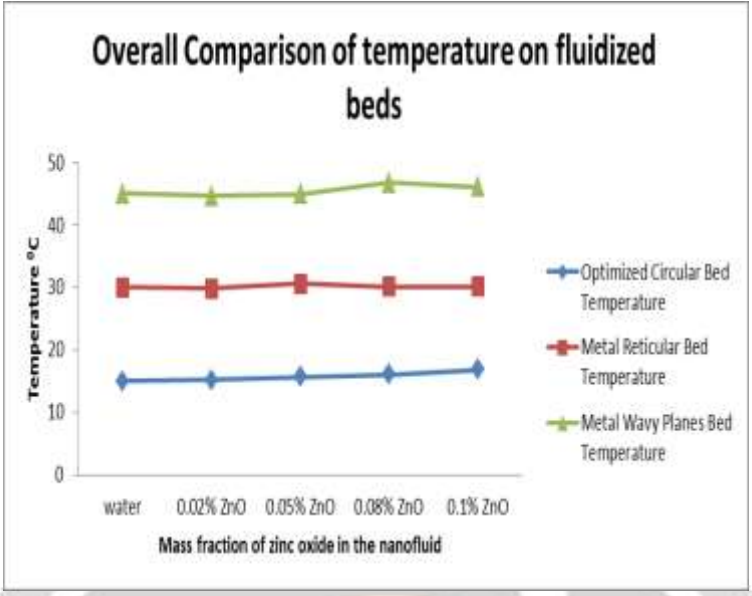

Figure 5.1 variation in temperature for the fluidized bed cooling tower with different mass fraction of nano fluid

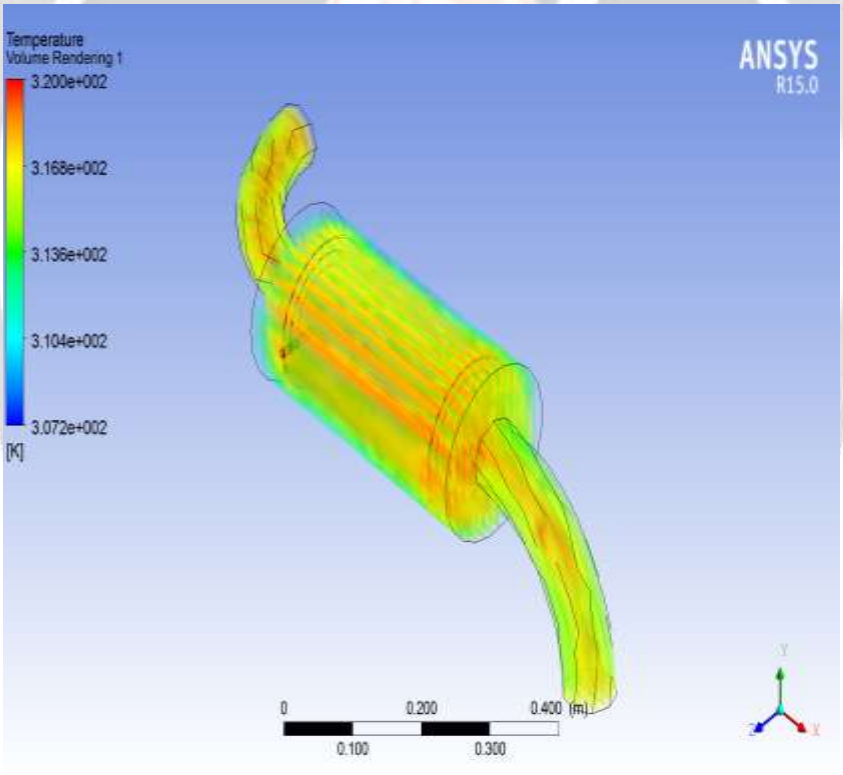

Figure 5.2 Temperature variation in circular shaped fluidized bed cooling tower at variable mass fraction of ZnO nanofluid.

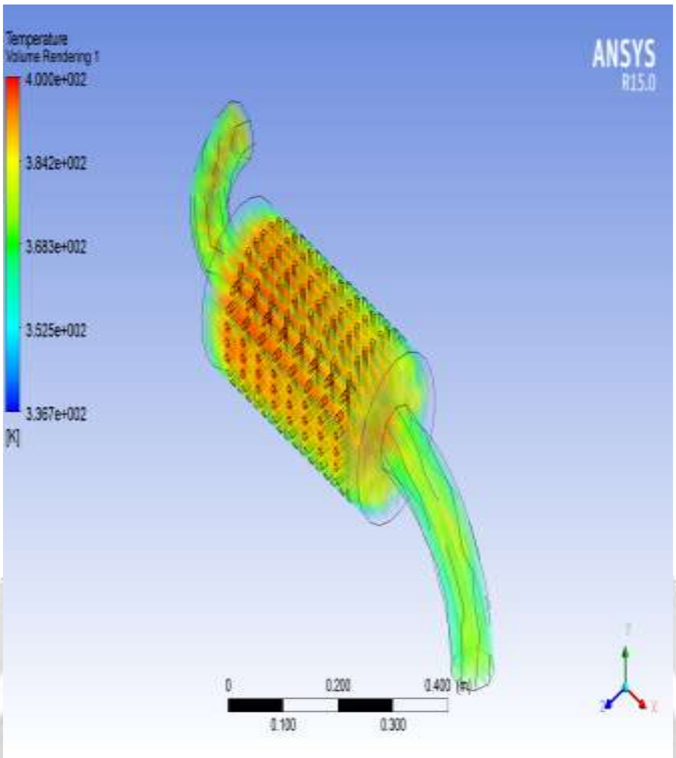

Figure 5.3 Temperature variation of Metal Recticular Bed shape bed of cooling tower.

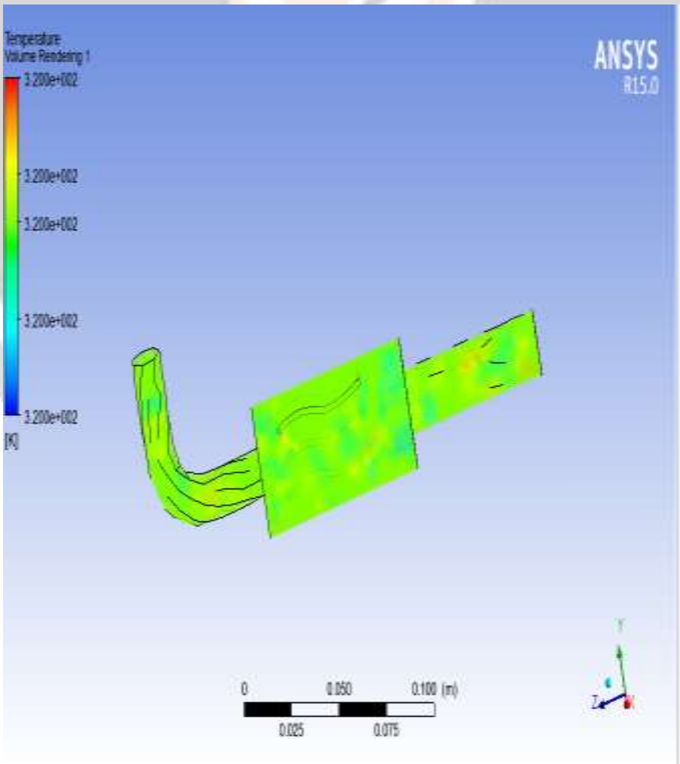

Fig 5.4 Temperature variation of Metal Wavy Planes Bed of cooling tower.

Effectiveness of different shaped Fluidized bed Cooling Tower:

Table 4.2 Variation in Effectiveness of different Fluidized Bed Cooling Tower

Effectiveness of different Fluidized Bed Cooling Tower		
Plane Wavy Bed	**Metal Reticular Bed**	**Optimized bed**
54.6	55	57.8
55.8	57	60.8
55	57.36	60.38
56.9	60	66.9
58.33	62.38	68.3

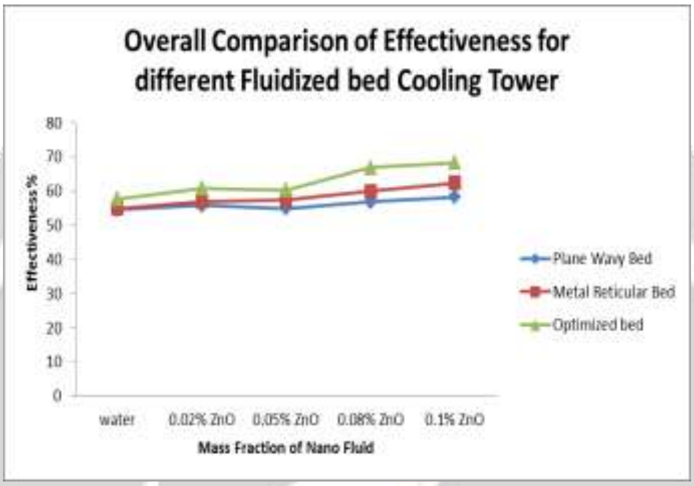

Figure No.: 5.5 Variation in Effectiveness of different Fluidized Bed Cooling Tower

Application feasibility of optimized co-centric fills:

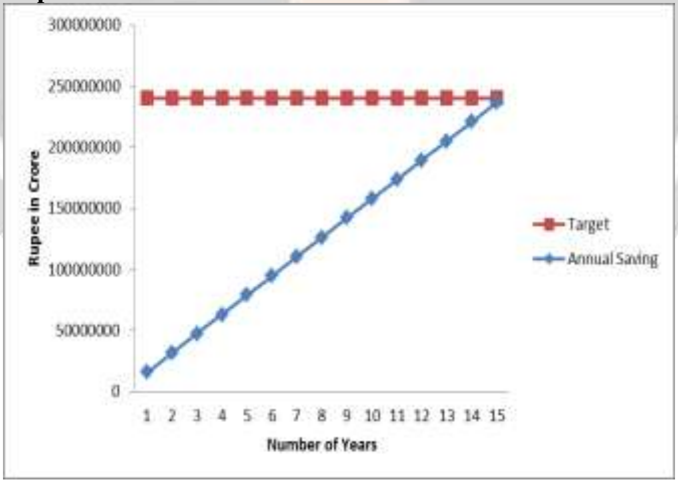

Fig. 5.6 Represents a Breakeven Pointwith respect to total number of years

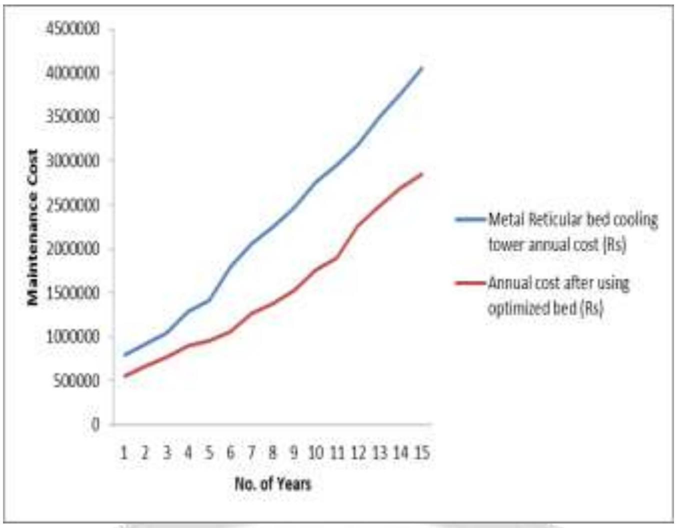

Fig. 5.7 represents an annual cost with benchmark.

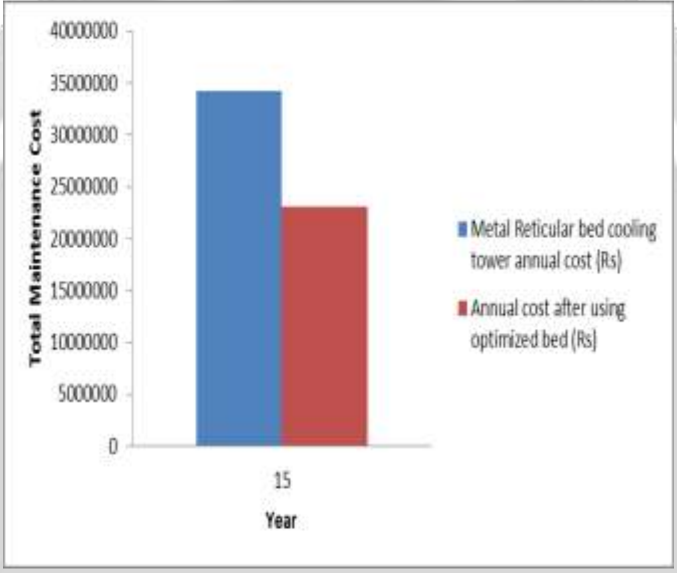

Fig. 5.8 represents a total maintenance cost with total payback period.

VI CONCLUSION

1. Computational model has been developed in CREO 5.0 and analysis has been done in Fluent 15.0.

2. Numerical results are in good agreement with base paper results.

3. The internal consistency of the results confirms the validity of the CFD model.

4. From results, higher value of temperature is found out for metal reticular and plane wavy fluidized bed as compared to circular shaped fluidized bed.

5. Circular shaped fluidized bed shows more convergence than metal reticular and plane wavy fluidized bed thus result shows improvement of 6.8% average deviation on temperature.

6. Effectiveness of circular shaped fluidized bed shows 0.73% average on simulation results than base paper results thus convergence on effectiveness is achieved.

7. Circular shaped fluidized bed shows the minimum wall flux in comparison to other fluidized bed in the 0.02 mass fraction of Zinc oxide in the nano fluid.

8. Thus numerical simulation of fluidized bed cooling tower with respect to mass fraction of ZnO nano fluid shows an optimum result on both temperature and effectiveness..

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