

Numerical and Heat Transfer Investigation in Heat Exchanger Packed with CuO Embryonic Fluids

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ABSTRACT

The improvement of this research work is to conclude the investigation on the strength of embryonic fluids, enhancement of the thermal conductivities, the viscosity, and mainly on the thermal performance characteristics of CuO-based embryonic fluids. The numerical formulae designed with the representation of shell and cylinder thermal exchanger using GAMBIT software and analyzed it using ANSYS FLUENT 18.1. SEM photographs of CuO embryonic fluids suspension with different concentration is studied for suitable to do research. The CuO embryonic particle varied in the range of 10 to 400 nano meters to set up embryonic fluids, and the observed enhancement in the thermal conductivity below 50 %.

Key Words: Gambit, CuO-Embryonic Fluids; ANSYS; Heat Transfer, Heat exchanger

1. INTRODUCTION

In the thermal field, embryonic fluids play an vital role in enhance the performance of the system. Habib-Olah Sayehvand and Amir Basiri has deliberated that the theoretical analysis of the thermophoresis and Brownian motion effects on MHD embryonic fluids flow and thermal exchange between comparable plates partially filled with a permeable medium [1]. Ahmed Kadhim Hussein has reviewed that the embryonic fluids enhance the efficiency of the thermal pipe solar collectors [2]. Lian Duan et.al has experimentally investigated that the in thermoelectric refrigeration with CNTs/Al₂O₃ embryonic fluids coolant improve the performance of system[3]. Gargee.A. Pise et.al has deliberated that thermal heat pipe collector using embryonic fluids for tilt angles (18.53, 33.5, 40, 50 and 60°) and surfactant [4]. Adrian Ciocanea et.al has deliberated that the effect of the vibrations enhance the efficiency of solar water heating collectors, [5]. Hussein et.al has reviewed that the use of nano fluid in the heat pipe solar collector improve the efficiency considerably [6]. Sumit Malik and Nayak has established that computational visualization technique Case-I the right vertical wall has the higher heat transfer rate compared to Case-II, for higher Re; Ra and ϕ [7]. Senthilkumar et.al has cogitation that the the heat pipe using copper 40 nm and the concentration of copper nanoparticle in the nanofluid is 100 mg/lit as working fluid improve the thermal productivity [8]. Jouhara et.al has evidenced that the modelling side of heat pipes [9]. Bayat et.al has demonstrated that the adding CuO and Al₂O₃ NePCM to paraffin PCMs increase the finned heat sink performance [10]. Sharma et.al has deliberated that the Novel solution with microfins, PCM reduced temperature by 10.7 °C (15.9%); n-PCM by 12.5 °C (18.5%) [11]. Taoufik Brahim and Abdelmajid Jemni has deliberated that 2-dimensional numerical model for the packed sphere heat pipe utilizing the Al₂O₃ and CuO [12]. Hassan et.al has deliberated that deposited layer of 1, 2 and 3 vol% alumina nanoparticles on the wick mesh surface has the considerable changes in thermal pipe performance[13]. The heat

transfer through heat exchanger using Al_2O_3 and CuO nanofluid at different concentrations is examined [14-21].

2. MATERIAL CHOICE

The material selection is mainly based on the resistance to corrosion and long life of the system improvement. The tube material choice use the passive heat transfer technologies and the important parameter to enhance the thermal efficiency and performance of the system. The temperature different between the heat exchanger and embryonic fluids is measured by J type thermocouple. The flow meters used to control the flow of embryonic fluids and value control it maintain periodically. CuO -embryonic fluids is taken work in order to reduce the cost and easily availability in the market.

2.1. PROBLEM SCRUTINY

In inside the tube area formation of hot area traps occurs which disturbs the system performance as shown Fig. 1. When the fluid running through the tube, the air formation occurs which removed by the pressure relief valves.

2.2. SOLUTION METHODOLOGY

With water as the base fluid and CuO -based embryonic fluids is taken as working fluid in the thermal exchanger. 20 nm- CuO -based embryonic fluids as a coolant with concentration up to 2 vol.% has been used in a typical flat shell and tube heat exchanger. Water has been chosen as heat transfer base fluid. CuO -embryonic fluids are cheap and free from toxian. The embryonic fluids varied in the range of 20 to 400 nano meters to prepare nano fluids, and the observed enhancement in the thermal conductivity is 42% to 50%. 20 nm- CuO -based embryonic fluids is best suitable for the research.

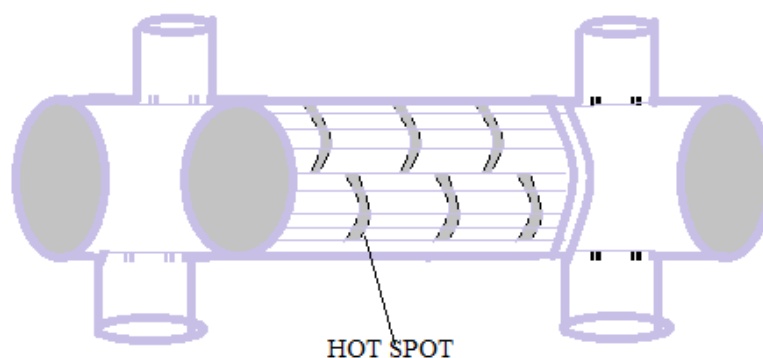


Fig. 1. Flat shell and tube heat exchanger showing air traps

2.3. VOLUME FRACTION OF EMBRYONIC FLUIDS

The thermal conductivity of CuO /water embryonic fluids with various concentrations (0-2% volume fraction) has been calculated by One Step Method as shown in Fig. 2 (a). Fig. 2. (b). Shows the SEM photographs of CuO embryonic fluids suspension with concentration of 0.2 wt %

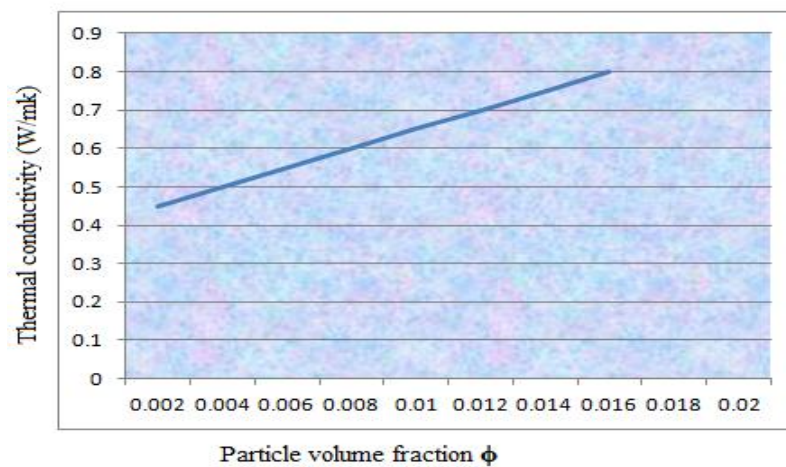


Fig. 2(a) Variation concentration of thermal conductivity W/mk and particle volume fraction ϕ

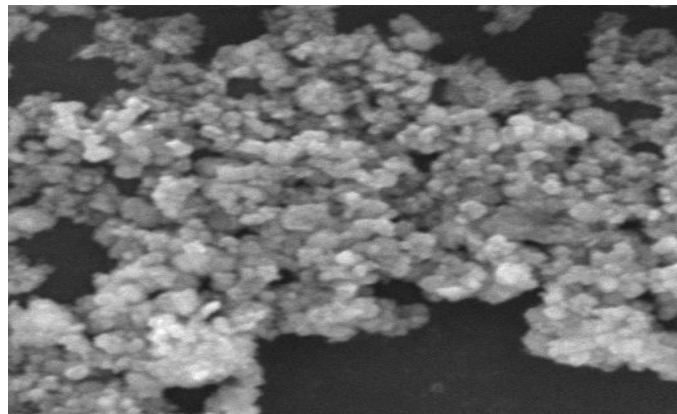


Fig.2.(b). SEM images of CuO embryonic fluids suspension with concentration of 0.2 wt %

2.4. SOLUTION

Absolute viscosity of the CuO embryonic fluids = 1.10 kg/m^2

Density of the CuO embryonic fluids = 3200 kg/m^3

Reynolds number for CuO embryonic fluids = 3500

For water-diesel:

$Q = 200 \text{ kW}$, $\Delta T_{lm} = 40$,

$U = 350 \text{ W/m}^2\text{-K}$

For 2% CuO-diesel:

$\Delta T_{lm} = 48$, $Q = 700 \text{ kW}$

$U = 450 \text{ W/m}^2\text{K}$, $K = 28.4 \text{ W/m-K}$

3. SCHEMATIC SIMULATION OF THE THERMAL EXCHANGER

The system heat exchanger is designed using the gambit software with dimension $200 \times 20 \times 0.20$ mm and analyzed using ANSYS FLUENT 18.1 as shown in Fig. 3. The water temperature flow on tube and shell side are shown in Fig. 4 and 5 respectively. The water temperature flow on tube side without nanofluid and with nano fluid are shown in Fig. 4 and 5 respectively. The water temperature flow shell side without nanofluid and with nano fluid are shown in Fig. 6 and 7 respectively. The streamline flow in the exchanger with water and nanofluid fluid are shown in Fig. 8 and 9 respectively.

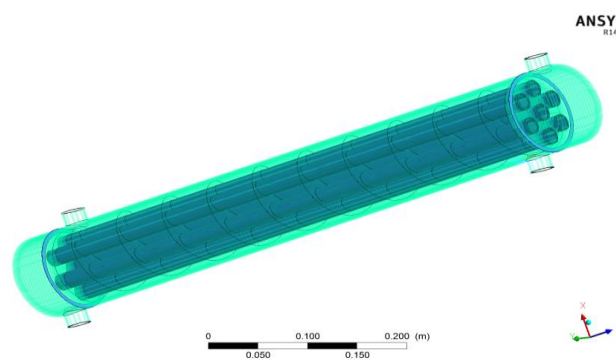


Fig. 3. Schematic sketch of the computational domain presently studied

3.1. TEMPERATURE FLOW ON TUBE SIDE

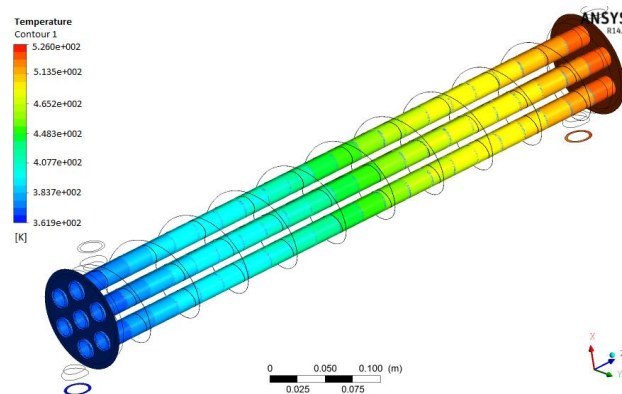


Fig. 4 The computational domain of water temperature flow on tube side

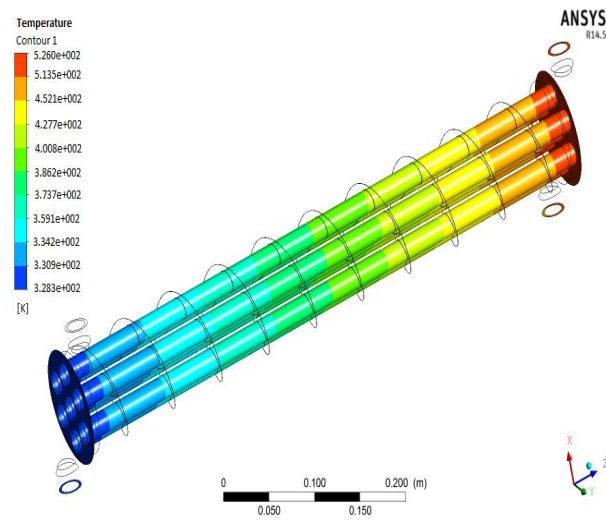


Fig. 5 The computational domain of water temperature flow on tube side *CuO* embryonic fluids

3.2. TEMPERATURE FLOW ON THE SHELL SIDE

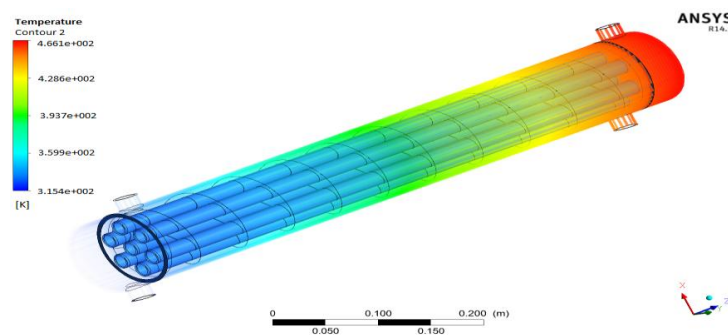


Fig. 6 Water temperature flow on shell side

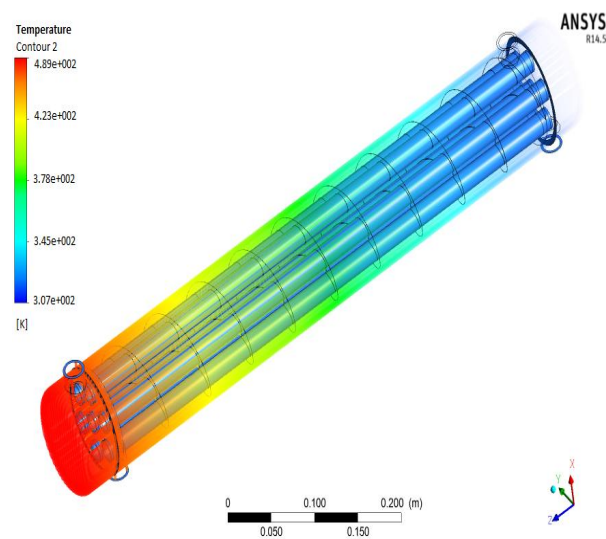


Fig. 7 Water temperature flow on shell side CuO embryonic fluids

3.3. STREAMLINE FLOW IN THE EXCHANGER

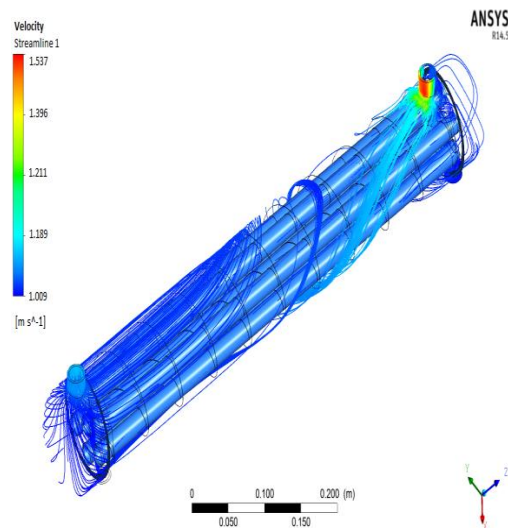


Fig. 8 Streamline flow in the exchanger with water

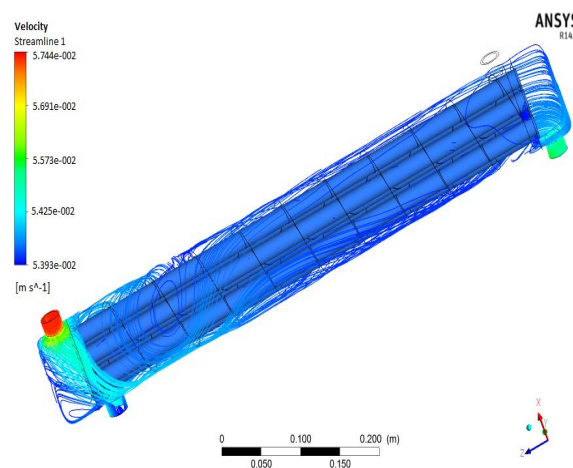


Fig. 9 Streamline flow in the exchanger with CuO embryonic fluids

CONCLUSION

SEM photographs of CuO embryonic fluids suspension with concentration of 0.2 wt % is best suitable for the tube and shell heat exchanger. The overall heat transfer coefficient and thermal conductivity is enhanced when using 2% volume fraction of CuO Nano fluids. The heat transfer rate of the system increased double times using CuO Nano fluids. The thermal conductivity of CuO /water embryonic fluids with various concentrations (0-2% volume fraction) has been calculated by One Step Method is best suitable for this system.

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