

e-ISSN: 2319-8753 | p-ISSN: 2320-6710

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International Journal of Innovative Research in SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

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IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 11, Issue 5, May 2022

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 8.118

9940 572 462

6381 907 438

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e-ISSN: 2319-8753, p-ISSN: 2320-6710 www.ijirset.com | Impact Factor: 8.118



Volume 11, Issue 5, May 2022

DOI:10.15680/IJIRSET.2022.1105175

Heat Transfer Analysis of Nanofluid Using Compression Refrigeration System

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ABSTRACT: In the recent durations more heat losses in the refrigeration system, in this work more conductivity of heat transfer is analyzing of nanofluid using compression refrigeration system. Inside the evaporator tank having a spherical coil made of stainless-steel material. The hot water(nanofluids) flows inside the spherical tube and cold water outside the spherical tube, to analysis the heat transfer with different flow rate and performance of the heat exchanger using compression refrigeration system was studied.

KEYWORDS: Assemble, Observation, Calculation, Result.

I. INTRODUCTION

Nanofluids are used in many applications, for example, in, Solar thermal applications, automobiles, medical applications, electronic cooling. In our case increasing the heat transfer rate while also increasing the coefficient of performance using nanofluid, could be very beneficial to the industry since it could save a lot of money and operation time while using less power consumption. Smaller size nanoparticles are better for heat transfer, since it means a larger surface area, so particles can flow smoothly through such channels, in our case we used stationary water.

II. RELATED WORK

The evaporator tank has a coil, which is filled with 15kg of water and nano fluids separately. The temperature of the water is 45°C and the nano fluids temperature is 50°C. The temperature of the liquids is reduced when the heat transfer takes place. **The spherical coil**, which has hot water(nanofluids) flows inside the spherical tube and cold water is outside the spherical tube. The spherical tube is made of stainless-steel material, which is connected to the pump to circulate the fluid in the exchanger. The Monoblock Pump is a mechanical device in which a common shaft contains the rotating parts.

III. METHODOLOGY

Aluminium oxide is a chemical compound of aluminium and oxygen with the chemical formula Al_2O_3 . It occurs naturally in its crystalline polymorphic phase α - Al_2O_3 as the mineral corundum, varieties of which form the precious gemstones ruby and sapphire. Al_2O_3 is significant in its use to produce aluminium metal, as an abrasive owing to its hardness, and as a refractory material owing to its high melting point. **Copper oxide** or Cupric oxide is an inorganic compound with the chemical formula CuO. It is covalent in nature. Copper(I) oxide crystallizes in a cubic structure. It has been prepared by single step, wet chemical precipitation method. The preparation of nanoparticles is carried out by reducing copper chloride with sodium hydroxide as reducing agent. e-ISSN: 2319-8753, p-ISSN: 2320-6710 <u>www.ijirset.com</u> | Impact Factor: 8.118



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IV. EXPERIMENTAL CALCULATION



TabulationCopper Oxide Observation

SL.NO	Time taken for raising the Temperature (sec)	COLD		нот		
		T1(°C)	T2(°C)	T3(°C)	T4(°C)	
1	12.62	2	4	47.6	45.7	0.75
2	37.22	4	6	45.7	41.4	0.8
3	52	6	8	41.4	39.7	0.84
4	151.8	8	10	39.7	34.4	0.88
5	244.8	10	12	34.4	29.1	0.91
6	505.2	12	14	29.1	28.2	0.93
7	571.8	14	16	28.2	27.4	0.94

 \checkmark The temperature of the cold water at initial stage

: 2°C

✓ The temperature of the hot fluid (Copper oxide)at initial stage : 47.6° C

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Aluminum Oxide Observation

SL.NO	Time taken for raising the Temperature (sec)	COLD		нот		
		T1(°C)	T2(°C)	T3(°C)	T4(°C)	
1	8.72	2	4	47.6	44.7	0.78
2	23.32	4	6	44.7	40.2	0.84
3	45	6	8	40.2	35.8	0.87
4	83.4	8	10	35.8	28.6	0.9
5	199.2	10	12	28.6	27	0.93
6	313.8	12	14	27	25.7	0.95
7	505.2	14	16	25.7	24.1	0.96

 \checkmark The temperature of the cold water at initial stage

: 2°C

 \checkmark The temperature of the hot fluid (Copper oxide)at initial stage : 47.6°C

CALCULATION

LENGTH OF THE COIL, L, NEEDED FOR N TURN:

L = $\sqrt{(2\pi r)^2 + \rho^2}$ mm L = $16\sqrt{(2\pi 6)^2 + 997^2}$ L = 1596.36 mm

VOLUME OF RECTANGULAR TANK, V:

 $V = L \times W \times H$

 $V = 300 \times 300 \times 600$

$$V = 54 \times 10^6 mm^3$$

SURFACE AREA OF THE RECTANGULAR TANK, A:

A = 2(LW + LH + WH)

 $\mathbf{A} = 2\{(300{\times}300) + (300{\times}600) + (300{\times}600)\}$

 ${\rm A}=9\times 10^6 mm^2$

WORKDONE BY THE PUMP, W:

$$W = \frac{Q \times H \times g \times \rho}{3960}$$
$$W = \frac{18.6 \times 178.36 \times 9.81 \times 1}{3960}$$
$$W = 8.22 \times 10^3 \text{ J/s}$$

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HEAT TRANSFER OF WATER, $Q_{h(H_2O)}$:

$$Q_h = m_w \times C_p \times \Delta T_e$$
$$Q_h = 4.46 \times 4185.5 \times 2$$
$$Q_h = 3.73 \text{ kW}$$

HEAT TRANSFER RATE OF COPPER OXIDE, $Q_{h(CuO)}$:

 $Q_h = m \times C_p \times \Delta T_h$ $Q_h = 142 \times 83.72 \times 2$ $Q_h = 1.7 \text{ kW}$

HEAT TRANSFER RATE OF ALUMINIUM OXIDE, $Q_{h(Al_2O_3)}$:

 $Q_h = m \times C_p \times \Delta T_h$ $Q_h = 101.96 \times 53.35 \times 2$ $Q_h = 1.5 \text{ kW}$

LOG MEAN TEMPERATURE DIFFERENCE (LMTD):

 $(LMTD) = \frac{(\theta_1 - \theta_2)}{\ln(\theta_1 - \theta_2)}$ $(LMTD) = \frac{45.6 - 42.6}{\ln(45.6 - 42.6)}$

(LMTD) = 2.73

MAXIMUM POSSIBLE OF HEAT TRANSFER, Q_{Max} :

$$Q_{Max} = C_{min} \times (T_{h_1} - T_{C_1})$$
$$Q_{Max} = 1.21 \times 45.6$$
$$Q_{Max} = 55.2 \text{ kW}$$

EFFECTIVENESS OF THE HEAT EXCHANGER, ∈:

$$\varepsilon = \frac{Q_{Act}}{Q_{Max}}$$
$$\varepsilon = \frac{3.73}{55.2}$$
$$\varepsilon = 0.67$$

OVERALL HEAT TRANSFER COEFFICIENT, U

$$U = \frac{Q}{LMTD \times A}$$
$$U = \frac{3.74}{2.457}$$
$$U = 1.51 W/m^2 K$$

e-ISSN: 2319-8753, p-ISSN: 2320-6710 www.ijirset.com | Impact Factor: 8.118



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V. RESULT

Comparison of cold and hot fluids

SL.NO		TEMPERATURE T3(°C)				
	IENIPERATURE		COPPER	ALUMINIUM		
	T1(°C)	WAIEK	OXIDE	OXIDE		
1	2	47.6	47.6	47.6		
2	4	46.6	45.7	44.7		
3	6	43.3	41.4	40.2		
4	8	40.5	39.7	35.8		
5	10	37.2	34.4	28.6		
6	12	35.4	29.1	27		
7	14	32.8	28.2	25.7		

GRAPH:



This plotted graph shows the difference in the temperature of the hot and cold fluid of the compression refrigeration system.

The performance of the aluminium oxide is high, compared to other fluids (water, copper oxide).

VI. CONCLUSION

The heat transfer analysis of the nanofluid in compression refrigeration system was investigated in terms of thermodynamic and energy consumption properties. The outcome revealed that the aluminium oxide nanoparticle, the performance of the refrigeration system with better efficiency.

- > Heat transfer rate of aluminium oxide is, $Q_h = 2.87$ kW
- > Overall heat transfer coefficient is, $U = 1.51 W/m^2 K$

International Journal of Innovative Research in Science, Engineering and Technology (IJIRSET)

| e-ISSN: 2319-8753, p-ISSN: 2320-6710| <u>www.ijirset.com</u> | Impact Factor: 8.118|

Volume 11, Issue 5, May 2022

DOI:10.15680/LJIRSET.2022.1105175

Effectiveness of the heat exchanger is, $\in = 0.67$

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Impact Factor: 8.118





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