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An effect of nanofluids on enhancement of characteristic of plate heat exchanger

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Abstract

Nanofluid having better properties that make them potentially useful in many application of heat transfer. Nanofluid having higher thermal conductivity and better thermo physical properties can be applied in heat exchanger to increase the heat transfer rate of heat exchanger .In that case we are use aluminium oxide (AL_2O_3),Titanium Oxide (Tio_2),and Silicon Oxide(SiO_2) as a nanoparticles. In that the properties of heat exchanger studied like thermal conductivity ,heat transfer coefficient ,heat transfer rate by applying nanoparticle. The higher overall heat transfer rate occur in case of AL_2O_3 in compare with $Tio_2$and Sio_2.The heat transfer coefficient of the nanofluid increases with increases in volume concentration of nanoparticle(0.3-2%). The convective heat transfer coefficient of nanofluid is slightly higher than that of the base liquid at same mass flow rate and at same inlet temperature.

Keywords: *nanofluid, thermal conductivity, heat transfer.*

1.Introduction

Heat exchanger is a mechanical device use to provide heat transfer between two or more fluid at different temperature. By progressing the technology and increasing the performance of the of heat exchanger by increasing the overall heat transfer[1] .many efforts have been devoted to heat transfer enhancement .among them the price of energy it is must to involved. solid additives are suspended in the base liquid to change transport application of additives to liquids often Aluminium carrying with high thermal conductivity,low density and high strength at low temperature, due to that properties aluminium rate .pair with Tio_2andSio_2.[1]for thermal conductivity the result shows that presence of nanoparticale creates greater energy absorption than pure water at a low flow give better heat transfer in compact heat exchager. Enhancing the heat removal ability of cooling fluids by designing fluids that are more conducting would result in higher heat transfer rate and better heat exchanger performance [2] Heat transfer and thermal conductivity of fluids enhanced by using micro sized particles. Nanofluids as heat conducting fluids, in which nano sized particles are suspended in liquid ,have been intensively studied in order to improve heat transfer characteristic and thermo physical properties of base fluid in heat exchanger.[1]plate heat exchanger with various application such as petrochemical process, gas liquefier , oil and gas processing , automobile radiator , aeronautical and cryogenic systems are one of the most common heat exchanger in industry.[1]In a given presentation focus on nanofluid application in plate heat exchanger, since increasing the heat transfer rate and minimising the pressure drop are considered as the main objective of improving heat exchanger performance, the variation of fluid thermal conductivity ,pressure drop, entropy generation and heat transfer coefficient of the flow is compared for three different nanofluide.

2. Experimental setup

The experimental setup could be used to transfer heat from hot water in heat exchanger to nanofluide stored in separate tank and make temperature calibration for the same by employing two thermocouples also ,flow meters will be installed in pipes carrying nanofluid to check its flow rate. complete system is very dynamic and easy to handal .[2]design is shown in fig 1. It consist of two flow loop a heating unit to heat the nanofluid or distilled water ,and temperature measurement system. The two flow loop carries heated nanofluide or distilled water and other cooling water. Each flow loop incluide a pump with a flow meter, a reservoir and a bypass valve to maintain the required flow rate.

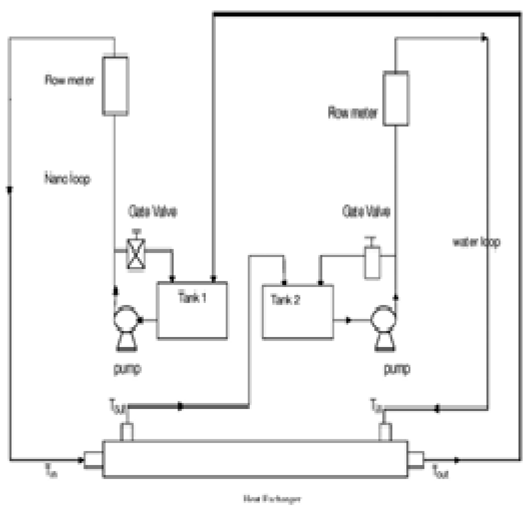

Fig.1 Experimental Setup

2.1 DATA PROCESSING

The nanofluide presented equation are calculated by using correlatio ,which are defined as[1-4]:

a)$\rho nf=(1-\varphi)\rho f+\varphi\rho p$ (1)

where ρ is the density of the nanofluide, φ is particles volume concentration ,ρf is the density of the base fluid and ρp is the density of nanoparticle.

b)The specific heat is calculated as follow:

$(\rho CP)\ nf= (1-\varphi)(\rho CP)f+\varphi(\rho CP)p$ (2)

where(C*P*) *nf* heat capacity of the nanofluid, C*P* f is the heat capacity of base fluid and C*P* p is the heat capacity of the nanoparticles.

c)Heat transfer rate can be defined as

$Q=\dot{m}Cp\Delta T$ (3)

where Q is the heat transfer rate , ṁ is the mass flow rate and ΔT is the temperature difference of the cooling liquid

The logarithmic mean temperature difference:

d)$\Delta Tlm= (Twi-Tno)-(Two-Tni)\ /\ Ln(Twi-Tno)/(Two-Tni)$ (4)

where ΔT*lm* is the logarithmic temperature difference, T*wi* is the inlet temperature of the water, T*wo* is the outlet temperature of water , T*ni* is inlet temperature of nanofluide and T*no* is the outlet temperature of the nanofluide

e)The heat transfer coefficient is

sr	nanoparticle	0.2%	2%
1	Sio2	0.278	2.079kg/s
2	Tio2	0.456	3.861kg/s
3	Al2o3	0.439	3.691kg/s
	density		
1	Sio2	6.107	45.67kg/m
2	Tio2	10.02	84.81kg/m
3	Al2o3	9.647	81.07kg/m

$Q=UAs\Delta Tlm$ (5)

where U is the overall heat transfer Coefficient and As is the surface temperature

f)The thermal conductivity of nanofluid is calculated by correlation recommended by maxwell,

$knf= [kp+2kf+2\varphi(kp-kf)]\ kf/\ kp+2kf-\varphi(kp-kf)$ (6)

TABLE 1.

Thermophysical properties of naoparticles

sr	properties	Sio2	Tio2	Al2o3
1	P	2220	4157	3970
2	C*p*	745	710	765
3	K	1.38	8.4	36

I. RESULT AND DISCUSSION

A).*Mass flow rate* -

mass flux is totally dependent on the mass flow rate,as the volume fraction of nanopatical increases mass flow rate also increses.amoung three of them sio2 carries less mass flux as compair to Al_2o_3&Tio2 .so if mass flow rate is less ,then more will be heat transfer takes plase ,we get more overall heat transfer rate.on the other hand if we divide that three nanopartical with their densities it also depend on the persentage concentration of nanoparticle.if persentage of nanoparticle increses then density also increases in these case also Sio_2 carries less density as compair two both of the nanofluide (Al_2o_3&Tio_2) whch affect in the mass flow rate and it directly afect the heat transfer rate of the system.

TABLE1

Concentretion & density at diffrant concentretions

B)*Thermal conductivity:* -

If we compair the thermal coductivity of nanofluids with different nanoparticle volume fraction,the thermal conductivity of Tio2and AL2o3 nanofluid are almost same and is more than the thermal conductivity of Sio2. If we observe in graph the thermal conductivity increases by increasing the nanoparticle volume fraction in basefluid.Al2O3 gives higher thermal conductivity respeted to both Sio2&TiO_2.

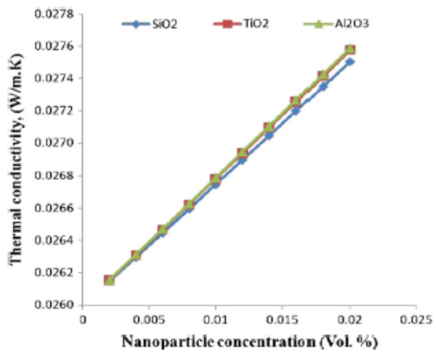

Fig.2 Concentration V/s Thermal conductivity

C) *Heat trnsfer coefficent -*

Heat transfer coefficient will be enhanced with inreasing thermal conductivity by inreasing the particle volume fraction.

Table 2
Mass &Heat Transfer rate

If we see the graph of the nanoparticle volume concentration to the heat transfer coefficient then it looks as fallow:

It shows the heat trnsfer through Sio2 nanofluid has lowest heat transfer rate

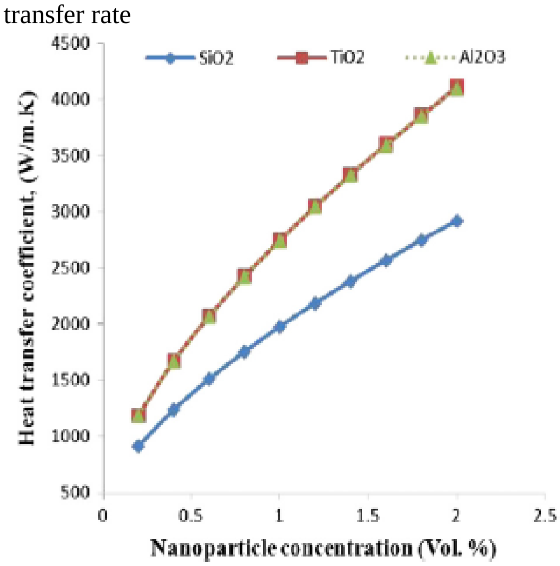

Fig.3 HT Coee.V/s volume concentration

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D) *Overall heat transfer coefficent:*

the overall heat transfer rate will increased if the volume concentration of nanopartical is increased.By adding Al_2o_3 nanoparticle in the basefluid gives higher heat transfer rate about 308.69w/mk at 2% concentration.

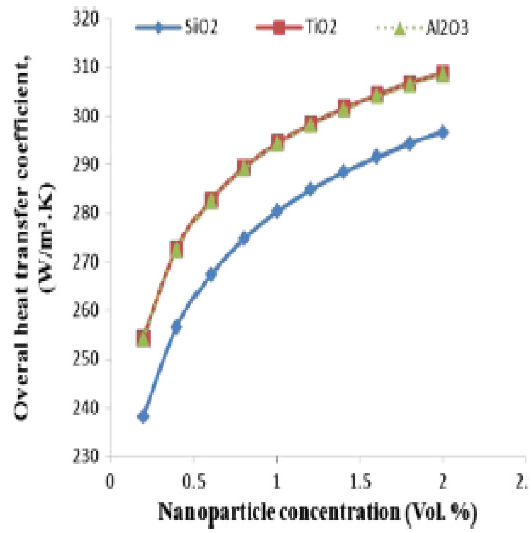

Fig 4. O.H.T.Coee. V/s Volume concentreton

E)*Heat transfer rate:-*

The highest heat transfer rate is obtain for Tio2and AL2o3 in compair to sio2.TIo2and Al_2o_3 carries same heat transfer rate the reason behind that is Tio2 nanofluide has the higher density and Al_2o_3 has higher specific heat .heat

sr	Np	0.2% MF&HTrate	2% MF&HTrate
1	Sio2	0.27&923.4	2.08&2943.9
2	Tio2	0.45&1257	
3	Al_2O_3	0.45&1260	

trasfer rate of sio2 is near about 30%lesser than that of the $Al_2o_3$and Tio2.

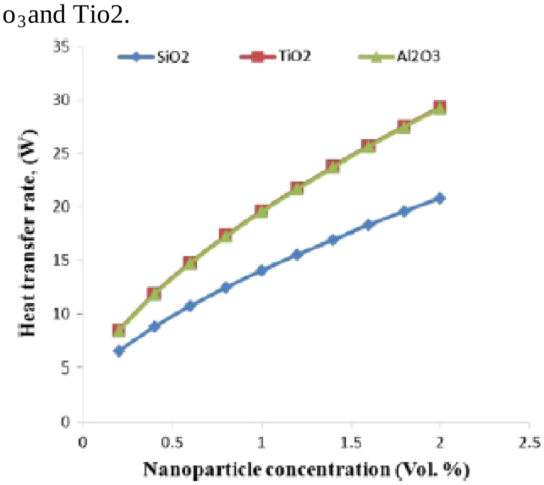

Fig 5 O.H.T rate V/s Volume concentretion

F)*Entropy generation:-*

The entropy generatio is changed by alterning the thermophysical properties of the fluid and the geometry.since the geometry of heat exchanger is fixed ,so using nanofluide can change the entropy by changing the physical properties of the heat exchanger.

The ratio at 0.2%volume concentration is almost same for all that three fluid but in case of 2%volume concentraion the Sio2 shows less entropy generation which is about 25, that of Tio2 gives 40and al2o3 shows 38.7.so it totally depends on volume concentraion of the nanoparticle.

G)*Friction factor:-*

If we use the nanofluide for practicle application,The addition of heat transfer performance of the nanofluide it is necessary to study flow charecterestic.we used nanoparticle in volume concentration of 0.3,0.5,0.7,1,and 2 to find the friction factor for measured value of reynolds number.from certaion experiment we have seen that the friction factor increses with increase in volume concentration of the nanoparticles for a given mass flow tare and decreases in Reynolds number.

The graph wise represention of reynolds number and frictin factor are as follow:

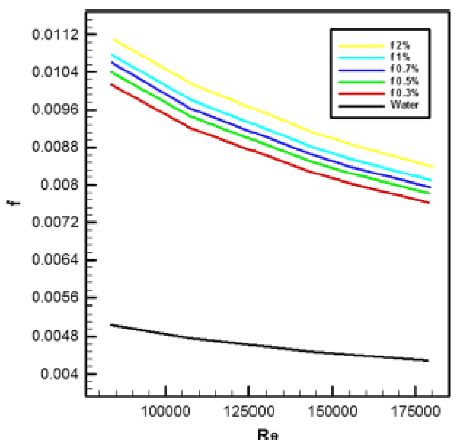

Fig 6 Friction factor V/s Re

conclusion:It clear seen thet the heat transfer coefficient of nanofluide boosts up by increasing the volume concentration of nanoparticles.The thermal conductivty of the base fluid increases by adding nanoparticles.The increase in thermal conductivity of Al_2O_3 and Tio2 is near about same ,and that of sio2 is lessthan both of nanoparticle.By using nanofluid we are enhancing the properties of base fluide likeentopy generation .Frictin factor icreases with in particle volume concentration.becose of the viscosity if we compair Al_2O_3/water and only water we seen that 700.242w/mkand 399.15w/mk reasp.near about 57% of heat transfer rate will increas.Nanoparticle into the distilled water increases the thermal conductivity and viscosity of the nanofluid.

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