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Research Article

Numerical investigation of effect of different parameter on heat transfer for a crossflow heat exchanger by using nanofluids

Mustafa KILIC*,[1], Atta ULLAH[2]

[1]*Department of Mechanical Engineering, Adana Alpaslan Turkes Science and Technology University, Adana, Turkey*
[2]*Department of Chemical Engineering, Pakistan Institute of Engineering & Applied Sciences, Islamabad, Pakistan*

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ABSTRACT

The heat loads on electronic systems of an unmanned air vehicle are a significant problem. So enhancing heat transfer is a critical key to solve these thermal problems. This study is focused on increasing heat transfer rate in a crossflow heat exchanger by using nanofluids numerically. Effects of different Reynolds number of hot fluid (Re = 6000, 8000, 10000, 12000), different inlet velocity ($V_{air,inlet}$ = 30, 45, 60, 90 m/s) of cooling fluid, temperature of cooling air at different altitude ($T_{air,inlet}$ = 15, 10, 4, –17°C) and different types of nanofluids (Cu-H_2O, CuO-H_2O, TiO_2-H_2O, H_2O) on heat transfer were studied numerically. Realizable k-ε turbulence model of ANSYS FLUENT computational fluid dynamics code was used for numerical analysis. It was obtained that increasing Reynolds number from Re = 6000 to 12000 causes an increase of 44.65% on average Nusselt Number. Increasing inlet velocity of cooling air from 30 m/s to 90 m/s causes an increase of 6.96% on average Nusselt number. Increasing or decreasing air inlet temperature at different attitude does not cause any significant change on average Nusselt number. Using Cu-H_2O nanofluid, which shows the best performance, causes an increase of 6.63% on average Nusselt number according H_2O. Numerical results were also compared with experimental results at literature. It was obtained that numerical model can represent experimental results in a good level.

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INTRODUCTION

Unmanned aerial vehicles (UAVs) are frequently used to collect data in the fields of real estate photography, mapping & surveying, agriculture, atmospheric studies and so on. Due to compact size of UAVs, thermal management holds a unique and important position UAV design. The procedure of thermal management generally involves circulation of coolant which would collect heat from distributed parts in the UAV and transfer it either to the fuel or to a heat exchanger. The rugged environment and altitude of UAV along with high speed makes the heat transfer process

***Corresponding author.**
*E-mail address: mkilic@atu.edu.tr

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complicated which in turn has an effect on the temperature control of electronic equipment [1]. Thermal management of electronics in a UAV is generally achieved by forced convection of external air. However, with increased complexity, it becomes important that thermal management systems are carefully designed system based on air-moving devices [2]. A major bottleneck which poses problems in efficient heat transfer is low thermal conductivity of process fluids [3]. This constraint limits the compactness and effectiveness of heat exchangers. One way to enhance properties of process fluids is to prepare slurries of suspended particles. It is expected that the thermal conductivities of fluids having metallic, non-metallic or polymeric suspended particles will be higher than those of ordinary process fluids.

A nanofluid is defined as a suspension of solid particles which have 1-100 nm size in a base fluid. These nano sized particles have much larger surface areas and thus have great potential for heat transfer enhancement. Interactions and collisions between particles cause to increase turbulence intensity in hydrodynamic boundary region. Turbulence intensity and large surface area enables more heat transfer. Nanoparticles carry 20% of their electrons at the surface that makes them ready to heat transfer. Another advantage of using nanofluids is the particle agitation which cause micro-vortexes to enlarge hydrodynamic boundary layer and decrease thickness of the thermal boundary layer to increase micro-convection between layers of fluid and heat transfer.

There are some studies about investigation of thermal characteristics of nanofluids in the literature. Teamah et al. [4] studied on heat transfer and flow structure caused by the impact of Al_2O_3 nanofluid on a flat plate numerically and experimentally in different Reynolds numbers (Re = 3000-32000) and nanofluid volume ratios (φ=0-10%). As the nanoparticles increased in the fluid, it was observed that the heat transfer from the surface increased according to the situation where only water was used as a fluid, a 62% increase in the heat transfer coefficient could be achieved, and CuO was used as the fluid; It was observed that an increase of 8.9% in the case of using Al_2O_3 nanofluid and 12% in the case of using TiO_2 nanofluid were observed. Manca et al. [5] investigated the effect of limited impinging jets on heat transfer from a flat plate with constant heat flux when pure water and water /Al_2O_3 nanofluid were used. Jet Reynolds number (Re= 100-400) and dimensionless channel height (H/W= 4-10) are the parameters used in the study. It was stated that as Reynolds number and particle concentration in fluid increased, the local heat transfer coefficient and Nusselt number increased. Chien et al [6] studied on the application of nanofluid in the flat plate heat pipe experimentally. It has been determined that the use of nanofluid can reduce thermal resistance by 40% compared to the use of pure water. Sun et al. [7] examined the effect of a single impinging jet on heat transfer using CuO nanofluid. It was determined that there was a significant increase in the heat transfer according to the use of water only when nanofluid was used, there was no significant change in the pressure drop, and a higher heat transfer coefficient was obtained when the circular nozzle was used, and the highest heat transfer was obtained when the jet angle was 90°. Kang et al. [8] using silver nanoparticles and pure water in their experimental work with nanofluids; When using 10 nm nanoparticles according to the use of pure water, it was determined that the thermal resistance was reduced by 50% and when using nanoparticles with 35 nm diameter 80%. Shang et al. [9] examined the heat transfer properties of a closed-circuit vibrating heat pipe with Cu-water nanofluid. Compared to pure water, it was found that the heat transfer capacity of the system could be increased by 83% when this nanofluid was used. Umer et al. [10] in the study; Using CuO-H_2O nanofluid, studied the heat transfer from a constant flowing surface under laminar flow conditions in different volumetric ratios. As a result, as the particle volume ratio increases and the Reynolds number increases, the heat transfer coefficient increases, and the highest increase in the heat transfer coefficient (61%) occurs when the particle volume ratio is 4% and the Reynolds number is Re = 605. Qu et al. [11] examined the thermal performance of the closed-circuit vibrating heat pipe in their experimental studies using Al_2O_3-water as a nanofluid. As a result, they found that the thermal resistance of the system decreased by 32.5% compared to the use of pure water. Kilic and Abdulvahitoglu [12] studied on numerical investigation of heat transfer with nanofluids and swirling jets in a vehicle radiator. As a base coolant Al_2O_3-H_2O nanofluid was chosen for all parameters. It was found that increasing Reynolds number (Re) from 12000 to 21000 results in an increase of 51.3% in average Nusselt number (Nu). Using 1-jet causes an increase of 91.6% and 29.8% on average Nu number according to the channel flow and 2-jet. Using Cu-H_2O nanofluid causes an increase of 3.6%, 7.6%, and 8.5% on the average Nu as compared to TiO_2-H_2O, Al_2O_3-H_2O and pure water, respectively. Yan et al. [13] studied heat transfer for the case where the channel flow and jet flow were applied together. The study was experimental in nature and covered Re = 10 × 103 to 40 × 103 for channel flow and Re 50 x 103 to 20 × 103 for jet flow. Kilic and Ali [14] studied on numerical investigation of heat enhancement and fluid-flow from a heated surface by using nanofluids with three impinging jets. It was found that that increasing volume ratio of suspended particles from φ = 2% to 8% caused an increase of 10.4% on average Nu. Using Cu-water nanofluid resulted in an increase of 2.2%, 5.1%, 4.6%, and 9.6% in average Nu with respect to CuO-water, TiO_2-water, Al_2O_3-water, and pure water respectively. The corresponding convective heat transfer coefficient and friction factor of nanofluids for nanoparticle weight concentrations of 0.025, 0.075, and 0.1% were evaluated in the study of Sadri et al [15]. Akdag et al. [16-18] investigated effect of change of flow characteristics as pulsating Flow conditions on heat transfer by using nanofluids. They obtained that heat transfer performance considerably increased with increasing pulsating amplitude at low frequencies compared with that in steady flow. Nidal et al. [19] investigated; the effect of the amount of surfactant added to the base fluid on the thermal properties of the base fluid and nanofluid numerically. They obtained that the addition of surfactant molecules to the nanofluid increases the thermal conductivity of the structure from 0.741 W/m K to 0.783 W/m K. Vinot and Sachuthananthan [20] investigated effect of CuO/Water (0.3%), Al_2O_3/Water (0.3%) nanofluids and Al_2O_3-CuO/Water (0.3%) Hybrid nanofluid on heat transfer. They obtained that by using hybrid nanofluid, the heat transfer rate enhanced by 4.2% and 5.5% with pentagonal microchannel heat sink when compared to Cuo/Water and Al_2O_3/Water nanofluids respectively. Tekir et al. [21] investigated forced convection heat transfer of Fe_3O_4/water nanofluidflow in a straight pipe under constant and alternating magnetic field experimentally. They obtained that the constant magnetic field offers 13% convective heat transfer enhancement compared to the absence of a magnetic field. On the other hand, the alternating magnetic field increases the convective heat transfer in the pipe up to 35%.

A brief summary of above-mentioned studies, shows the potential of nanofluids. Further, these studies can be classified into two distinct categories. One category focuses on preparation and characterization of nanofluids while the other on application of nanofluids for heat transfer enhancement. The present work can be considered as a contribution to the second category. Different form the literature in this study; cooling performance of a cross flow heat exchanger by using nanofluids in an unmanned air vehicle (UAV) was investigated for different parameters according to the four different scenarios to design new types of heat exchangers. For this purpose, internal flow of a crossflow heat exchangers was simulated for different parameters such as Re, different inlet velocity (Vairinlet) of cooling air, different inlet temperature for different attitude (Tairinlet) of cooling air and different types of nanofluids. So this manuscript is focused on to enhance heat transfer from inner tube by using nanofluids for different parameters. To obtain the effect of nanofluids on effectiveness of a cross flow heat exchanger barely, flow of the inner tube was analyzed. So no fin was used for the air side to enhance heat transfer. The effect of these parameters on heat transfer and heat exchanger effectiveness was investigated computationally.

MATERIALS AND METHODS

In this study, a crossflow heat exchanger is modeled having dimensions of 300 × 37.5 × 22.5 mm (length × width × height respectively). The heat exchanger is shown in **Figure 1. a.**

Hot fluid tube is made up of copper which has higher thermal conductivity for high performance of heat exchanger. The hydrodynamic diameter of the channels through which hot fluid passes is 7.5 mm. The k-ε turbulence model available in ANSYS FLUENT® was used for present analysis.

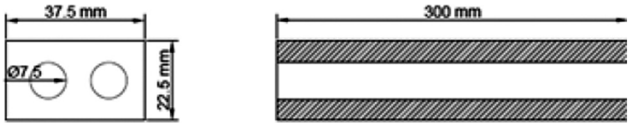

Figure 1.(a) Modal geometry.

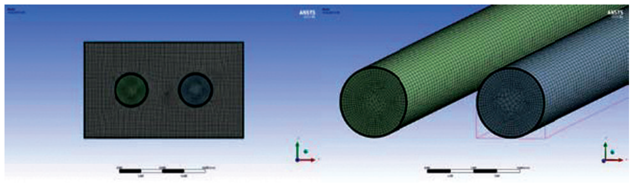

Figure 1.(b) Mesh structure.

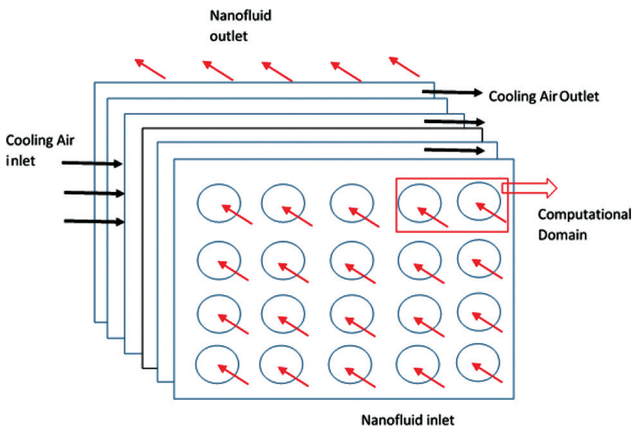

Figure 1.(c) Computational domain.

Table 1. Fluid properties for different altitude

Altitude	Height	Cold Fluid Temperature	Cold Fluid density
Sea level	0 m	15°C	ρ = 1.225 kg/m³
Low-altitude	1000 m	10°C	ρ = 1.111kg/m³
Medium-altitude	2000 m	–4°C	ρ = 0.909kg/m³
High-altitude	3000 m	–17°C	ρ = 0.736kg/m³

A part (two inner tubes) was chosen as a computational domain. **Figure 1.b** shows mesh structure of chosen part of heat exchanger. In the present study, 1.2 million cells were used in mesh structure. Mesh quality based on maximum skewness was 0.66. Number of inflation layers used were 10. Computational domain is shown in **Figure 1c. Figure 2** shows different flight scenarios from the altitude point of view**.** This altitudes were chosen according to the tactical task scenarios. Fluid properties for different altitudes are shown in **Table 1.**

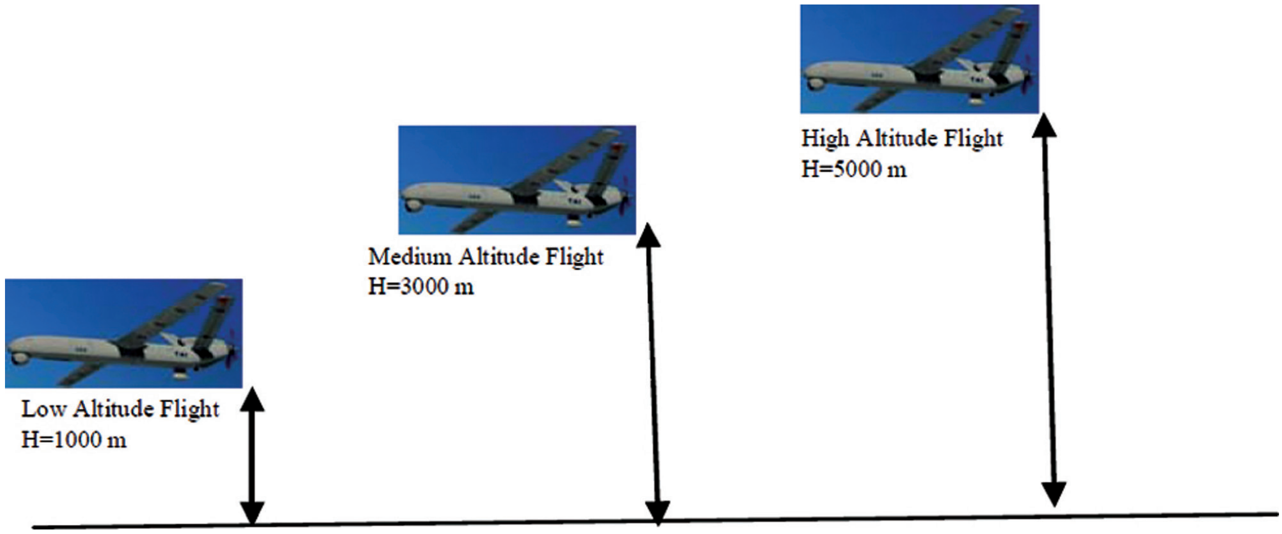

Figure 2. Flight scenarios.

THEORY

Major governing equations used during the simulation are presented (Cengel and Ghajar [22]) below.

$$\frac{\partial \rho}{\partial t}+div(\rho u)=0 \tag{1}$$

$$\frac{\partial(\rho u)}{\partial t}+div(\rho uu)=-\frac{\partial p}{\partial x}+div(\mu grad\ u)+S_{mx} \tag{2.a}$$

$$\frac{\partial(\rho v)}{\partial t}+div(\rho vu)=-\frac{\partial p}{\partial y}+div(\mu grad\ v)+S_{my} \tag{2.b}$$

$$\frac{\partial(\rho w)}{\partial t}+div(\rho wu)=-\frac{\partial p}{\partial z}+div(\mu grad\ w)+S_{mz} \tag{2.c}$$

$$\frac{\partial(\rho i)}{\partial t}+div(\rho iu)=-pdivu+div(kgrad\ T)+\Phi+S_i \tag{3}$$

The most dominant heat transfer mechanism in the current situation is convection. Convective heat transfer is governed by (Cengel and Ghajar [22]);

$$Q_{convention}=h.A.\Delta T \tag{4}$$

Where h is the convective heat transfer coefficient, A is the surface area, ΔT ($\Delta T = T_s - T_{bulk}$) is the difference between the measured surface temperature and the bulk fluid mean temperature. Nu is a dimensionless parameter indicating the ratio of heat transfer with convection to heat transfer with conduction (Cengel and Ghajar [22]),

$$Nu=\frac{(Q_{convention}.D_h)}{(T_s-T_{bulk}).k_{nf}} \tag{5}$$

Where T_s is the measured surface temperature, D_h is the hydraulic diameter of the channel, and k_{nf} is the coefficient of thermal conductivity of the nanofluid. Re number is used to determine for forced convection whether the flow is laminar or turbulent. Reynolds number based on turbulent flow (Cengel and Ghajar [22]);

$$Re=\frac{(\rho_{nf}.V_{jet}.D_h)}{(\mu_{nf})} \tag{6}$$

Where ρ_{nf} is the nanofluid density, V_{jet} is the jet velocity, and μ_{nf} is the nanofluid dynamic viscosity. The heat exchanger effectiveness ε is defined (Cengel and Ghajar [22]) as;

$$\varepsilon=\frac{\dot{Q}}{\dot{Q}_{\max}}=\frac{Actual\,Heat\,Transfer\,Rate}{Maximum\,Possible\,Heat\,Transfer\,Rate} \tag{7}$$

In Eq. 4, the actual heat transfer rate $\dot{Q}$ is calculated from an energy balance on the hot or cold fluids and is expressed (Cengel and Ghajar [22]) as;

$$\dot{Q}=\dot{m}C_{pc}.(T_{cold,out}-T_{cold,in})=\dot{m}C_{ph}(T_{hot,in}-T_{hot,out}) \tag{8}$$

Where C_{pc} and C_{ph} are heat capacity of cold and hot fluids.

The maximum possible heat transfer rate (Cengel and Ghajar [22]) is;

$$\dot{Q}_{max} = C_{min}\left(T_{hot,in} - T_{cold,in}\right) \tag{9}$$

Where C_{min} is the smaller one of C_c and C_h.

Thermal properties of nanofluids are calculated according to the equations which are given below. The density of nanofluids is calculated (Pak and Cho [23]) as;

$$\rho_{nf} = (1-\varphi).\rho_{bf} + \varphi.\rho_p \tag{10}$$

Where ρ_{bf} is the base fluid (water) density, φ is the volume fraction of the solid particles in nanofluid, and ρ_p is the density of the solid particles in the nanofluid. The volumetric ratio of nanoparticles is defined (Pak and Cho [23]) as

$$\varphi = \frac{1}{\left(\frac{1}{\omega}\right).\left(\rho_p - \rho_{bf}\right)} \tag{11}$$

Where ω is the density difference between the fluid and the main fluid (water). The nanofluid specific heat is calculated (Wang et al. [24]) as;

$$C_{P_{nf}} = \frac{\varphi.\left(\rho.C_p\right)_p + (1-\varphi).\left(\rho.C_p\right)_f}{\left(\rho_{nf}\right)} \tag{12}$$

Where $C_{p(p)}$ is a specific heat of particle $C_{p(f)}$ is the specific heat of the base fluid. The effective thermal conductivity of nanofluid (Corcione [25]) is;

$$\frac{k_{eff}}{k_f} = 1 + 4.4 Re^{0.4} Pr^{0.66} \left(\frac{T_{nf}}{T_{fr}}\right)^{10} \left(\frac{k_p}{k_f}\right)^{0.33} \varphi^{0.66} \tag{13}$$

Where Re is the nanoparticle Reynolds number, Pr is the Prandtl number of the base liquid. k_p is the nanoparticle thermal conductivity, φ is the volume fraction of the suspended nanoparticles, T_{nf} in the nanofluid temperature (K), T_{fr} is the freezing point of the base liquid.

Nanoparticle Reynolds number is defined (Corcione [25]) as;

$$Re = \frac{2\rho f k_b T}{\pi \mu f^2 d_p} \tag{14}$$

K_b is the Boltzmann's constant. The effective dynamic viscosity of nanofluids defined (Batchelor [26]) as;

$$\mu_{nf} = \mu_{bf}\left(1 + 2{,}5\varphi + 4{,}698\varphi^2\right) \tag{15}$$

Boundary conditions applied in numerical model were shown in **Table 2**.

This study focused on enhancing heat transfer by using nanofluids for a cross flow heat exchanger of an Unmanned Air Vehicle. It was not mentioned the power need like pressure losses. It is assumed that cooling the electronic system and maintaining them is more important than power needs. Additionally, pressure losses of any fluid depends on viscosity of the fluid and friction factor caused by surface roughness. So viscosity of the fluid depends on volume ratio and particle diameter of solid particles for nanofluids. In this study, it is assumed that particle diameter and volume ratio of nanofluids were Dp=20 nm and φ=1%. So effects of solid particles on pressure losses of nanofluids can be assumed negligible and it can be assumed as one phase.

VALIDATION

In order to validate the CFD model, numerical results were compared with experimental results of Sadri et. al. [27] the highest difference between numerical results and experimental results is less than 10%. **Figure 3** shows differences between numerical and experimental results. It was obtained that increasing Re number shows a decrease on

Table 2. Boundary conditions

		U (m/s)	V (m/s)	W (m/s)	T (K)	k	ε
Nanofluid	Inlet	U = 0	V = 0	$W = W_{inlet}$	$T = T_{inlet}$	k = 0	ε = 0
	Outlet	$\frac{\partial U}{\partial x} = 0$	$\frac{\partial V}{\partial x} = 0$	$\frac{\partial W}{\partial x} = 0$	$T = T_{outlet}$	$k = \frac{3}{2}(u_{avg} I)^2$	$\varepsilon = C_{\dots}^{\frac{3}{4}} \frac{k^{\frac{3}{2}}}{l}$
Air	Inlet	$U = U_{inlet}$	V = 0	W = 0	$T = T_{inlet\ air}$	k = 0	ε = 0
	Outlet	$\frac{\partial U}{\partial x} = 0$	$\frac{\partial V}{\partial x} = 0$	$\frac{\partial W}{\partial x} = 0$	$T = T_{outlet\ air}$	$k = \frac{3}{2}(u_{avg} I)^2$	$\varepsilon = C_{\dots}^{\frac{3}{4}} \frac{k^{\frac{3}{2}}}{l}$

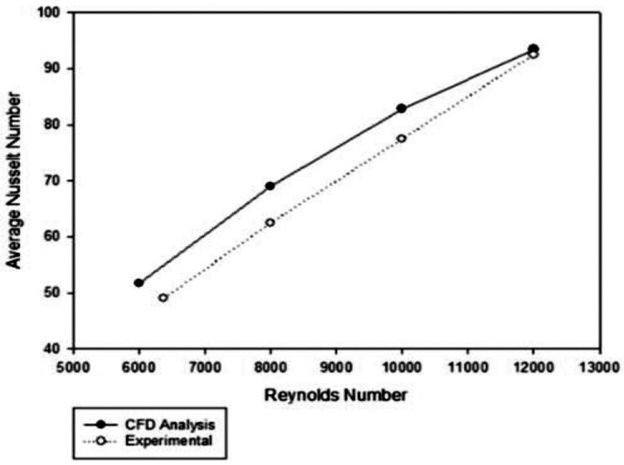

Figure 3. Comparison of numerical and experimental results.

Table 3. Comparison of y⁺ values

	Mesh	y+
Coarse	305850	4.03
Medium	706500	2.18
Fine	1612529	0,52

difference between numerical and experimental values. The reason of this change is that numerical model was modeled as one phase and increasing Re number (velocity of the fluid) causes a decrease of effect of micro vortexes which was caused by velocity of the solid particles. Secondly, numerical results were verified by using y+ value.

This non-dimensional wall distance is defined (Minkowycz et al.[28] as;

$$y^{+} = \frac{u_T . z}{\gamma} \tag{16}$$

Where z is the distance to the nearest wall, u_T is the friction velocity at the nearest wall and γ is the local kinematic viscosity of the fluid. For verification of CFD model for heat transfer analysis, y^+ value was compared. In this investigation, when y^+ values were related to mesh elements for course, medium and fine mesh structure. The y^+ values used in the current work are shown in Table 3. Fine mesh, which is used in this study, was seen as the higher performance of heat transfer than other mesh structures.

RESULTS AND DISCUSSION

In this section, we will present the quantitative results for the effect of Re number, inlet velocity and type of nanofluid on Nu number.

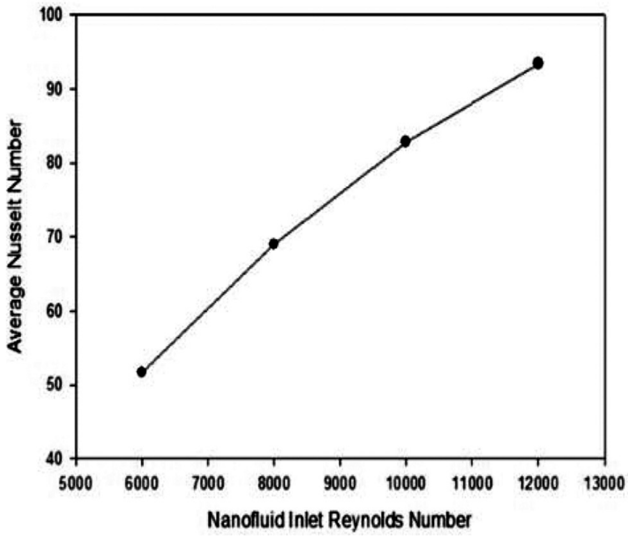

Figure 4. Average Nusselt number for different Reynolds numbers.

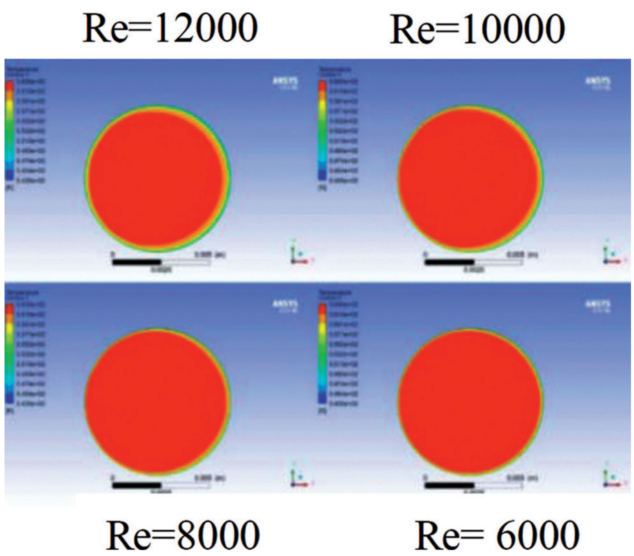

Figure 5. Temperature contours for different Reynolds numbers.

Effect of Re number of hot fluid on Nu number

Effect of inlet velocity of the hot fluid as Reynolds number for Cu-H_2O nanofluid on heat transfer is investigated. It is obtained that increasing Reynolds number for Re=6000-8000 causes an increase of 24.99%, for Re=6000-10000 causes an increase of 37.56% and for Re=6000-12000 causes an increase of 44.65% on average Nusselt number. So increasing Reynolds number causes an increase on heat transfer. The reason of this is increasing Re number causes an increase on fluid velocity. This causes an increasing on thickness of hydrodynamic boundary and decrease on thermal boundary layer. So this condition causes an increase on value of heat convection coefficient and decrease on thermal resistance. As a result heat transfer increases. Figure 4 and Figure 5 show variation of average Nusselt number and temperature contours for different Reynolds number. Increasing Reynolds number causes an increase on thermal boundary layer thickness. This causes a temperature variation (temperature decrease) on internal side of the inner tubes.

Effect of Inlet Velocity on Nu number

Effect of different inlet velocity ($V_{air,inlet}$ = 30, 45, 60, and 90 m/s) for cooling air on heat exchanger effectiveness: effect of inlet velocity of cooling air on average Nusselt number of the heat exchanger at Re = 12000 and $T_{hot,inlet}$ = 90°C was numerically investigated. It is obtained that increasing velocity of cooling air three times (from $V_{air,inlet}$ = 30 m/s to 90 m/s) causes only an increase of 6.96% on average Nusselt number of heat exchangers. The reason of this low increase is that heat capacity of air is too less than heat capacity of nanofluids. So fins should be used on air side surface of inner tube to increase surface area of outside of inner tube. Figure 6 and Figure 7 variation of Nusselt number of heat exchanger and temperature contours for different inlet velocity of air.

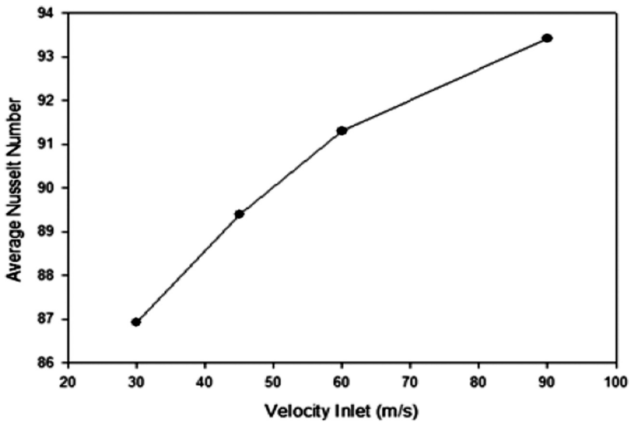

Figure 6. Average Nusselt number for different air inlet velocity.

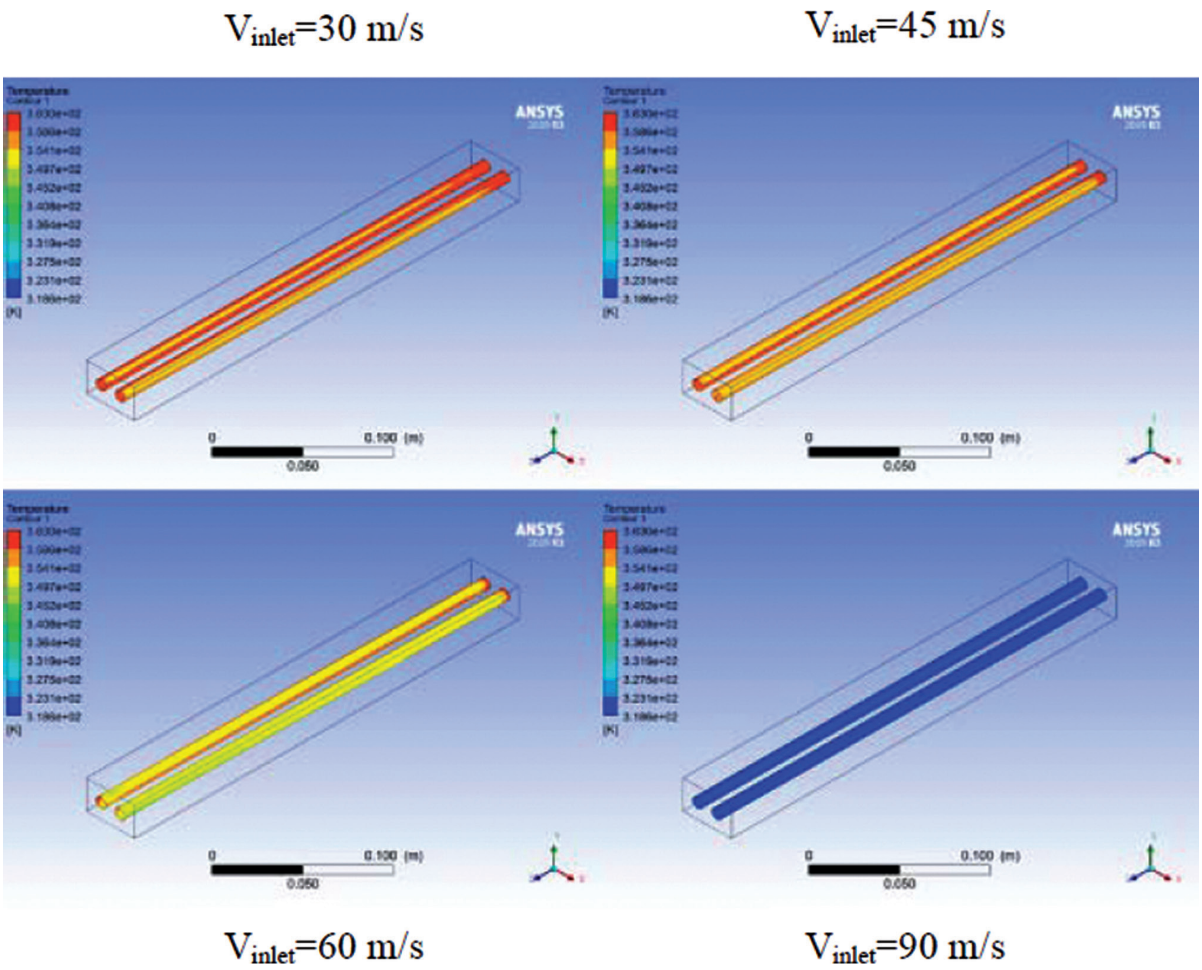

Figure 7. Variation of temperature contours for different air inlet velocity.

Effect of Altitude on Nu number

In this section, effect of cooling air temperature at different on heat transfer is investigated for Re=12000 and $V_{air,inlet}$ = 90m/s. It is obtained that increasing or decreasing air inlet temperature at different attitude does not cause any significant change on average Nusselt number.

The reason of this, decreasing inlet temperature of air causes a decrease on temperature difference in thermal boundary layer. It also causes a decrease on local and average Nusselt number. So not only cooling performance of crossflow heat exchanger but also performance of UAV do not change for different attitude. Figure 8 shows variation of average Nusselt number for different air inlet temperature.

Effect of type of Nanofluid on Nu number

Effect of nanofluid on heat transfer is investigated for different nanofluids at Re=12000 and $T_{hot,inlet}$= 90°C. Particle diameter and volume ratio of nanofluids were assumed as Dp=20 nm and φ=1%. It was obtained that

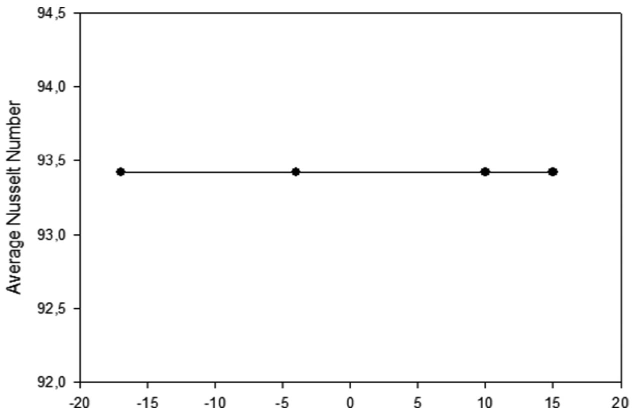

Figure 8. Average Nusselt number for different air inlet temperature.

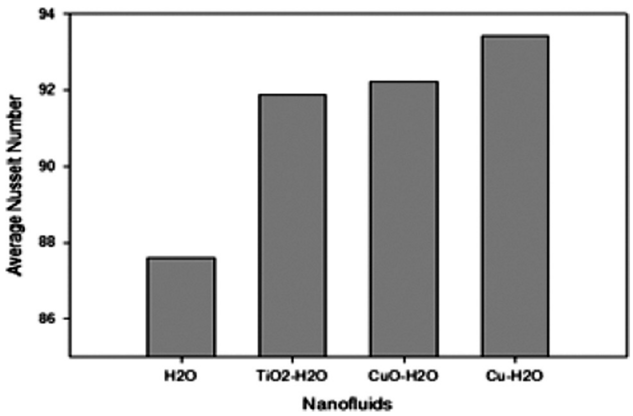

Figure 9. Average Nusselt number for different nanofluids.

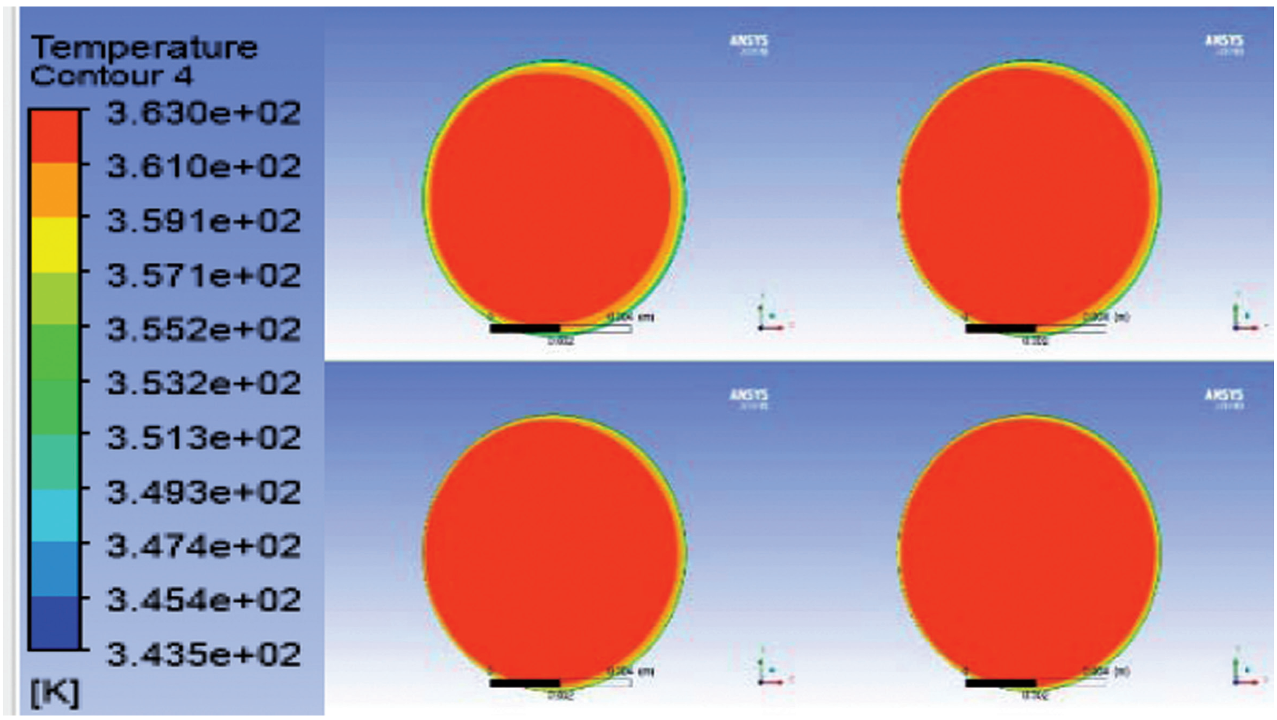

Figure 10. Variation of temperature for different nanofluids.

Cu-H_2O nanofluid shows the best heat transfer performance. Using Cu-H_2O nanofluid causes an increase of 5.28%, 4.89% and 6.63% on average Nusselt number according to CuO-H_2O and TiO_2-H_2O nanofluids and H_2O. So higher thermal conductivity of nanofluid causes higher heat transfer. This result shows that the thermal conductivity of nanofluid is a significant parameter on enhancing heat transfer. Figure 9 and Figure 10 show variation of average Nusselt number and temperature contours for different type of nanofluids.

CONCLUSION

In this study, effect of nanofluids on cooling performance of a crossflow heat exchanger on an unmanned air vehicle is investigated numerically. From the results obtained, it can be concluded that:

a. Increasing Re of hot fluid (nanofluid) causes an increase on heat transfer. Increasing Re from 6000 to 12000 can result in an increase of around 45% in average Nu.

b. Increasing inlet velocity for cooling air causes an increase in Nusselt number of the heat exchanger. It is obtained that increasing air inlet velocity from $V_{air,inlet}$ = 30 m/s to 90 m/s, causes an increase of 6.96% on average Nusselt number of the heat exchanger

c. Increasing or decreasing air inlet temperature at different attitude does not result in any significant changes in average Nu.

d. Using Cu-H_2O nanofluid results in an increase of 5.28%, 4.89% and 6.63% in average Nu as compared to CuO-H_2O and TiO_2-H_2O nanofluid and H_2O. Cu-H_2O nanofluid shows the best cooling performance. This result also shows that the thermal conductivity of nanofluids is a significant parameter on enhancing heat transfer.

e. Numerical results were also compared with experimental results from literature. It was found that the maximum difference between numerical and experimental results is less than 10%. Therefore, the model developed is a good representative of the real-life system.

f. It is recommended that for improving performance of UAV and designing more efficient heat exchangers, different sized and types of particles with different application geometries be investigated.

AUTHORSHIP CONTRIBUTIONS

Authors equally contributed to this work.

DATA AVAILABILITY STATEMENT

The authors confirm that the data that supports the findings of this study are available within the article. Raw data that support the finding of this study are available from the corresponding author, upon reasonable request.

CONFLICT OF INTEREST

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

ETHICS

There are no ethical issues with the publication of this manuscript.

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