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PERFORMANCE OF NANO FLUIDS IN DUCTS WITH DOUBLE FORWARD-FACING STEPS

BANOTHU ASHOK[1], CH. RAJESHWAR GOUD[2], Dr. SRIDHARA REDDY[3]

[1] (P.G Student, Department of MECH, Nishitha College of Engineering, TS, INDIA).

[2] (Assistant Professor, Department of MECH, Nishitha College of Engineering, TS, INDIA).

[3] (Professor & HOD, Department of MECH, Nishitha College of Engineering, TS, INDIA).

ABSTRACT

Human comfort in cars is of prime importance nowadays, in which thermal comfort plays an important role. With the rapid development of technology and increasing demands by customers, the climate control of the passenger cabin has to be taken into account in any vehicle development process. Duct is used to carry the air in air conditioning. This air conditioning is divided in to 1. Summer air conditioning 2 Winter air conditioning, 3 Year round air conditioning Usage of A.C type is dependent on the atmosphere condition. For this air conditioning duct design is very important. This design depends on the amount of air carrying through ducts, shape of the duct In this project the AC is to be designed for Summer Air Conditioning type. Because in our city conditions throughout the year, the temperature doesn't fall below 15^{o}C In this project, we are introduced nano fluid magnesium oxide at different volume fraction(0.1,0.2,0.3 and 0.4%) In this project, nano fluid load calculations, duct design, CFD and Thermal analysis for main duct are to be done. For thermal analysis, materials of duct are Galvanized Iron and carbon fiber and Glass Fiber. Duct design is done in 3D modeling software CREO parametric software and CFD analysis in ANSYS.

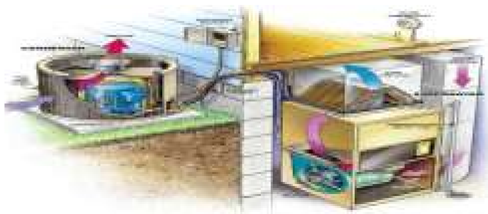
Keywords: Laminar flow Thermal performance Separation flow Backward-facing step Nano-fluids

1. INTRODUCTION

1.1 AIR CONDITIONER: Air conditioning (often referred to as AC, A.C., or A/C) is the process of removing heat from a confined space, thus cooling the air, and removing humidity. Air conditioning can be used in both domestic and commercial environments. This process is used to achieve a more comfortable interior environment, typically for humans or animals; however, air conditioning is also used to cool/dehumidify rooms filled with heat-producing electronic devices, such as computer servers, power amplifiers, and even to display and store artwork.

1.2 Air conditioning system basics and theories

1.2.1 Refrigeration cycle: In the refrigeration cycle, a heat pump transfers heat from a lower-temperature heat source into a higher-temperature heat sink. Heat would naturally flow in the opposite direction. This is the most common type of air conditioning

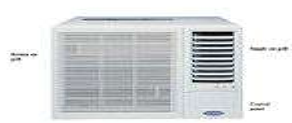


1.1 Refrigeration cycle

1.2.2 Refrigerants: "Freon" is a trade name for a family of haloalkane refrigerants manufactured by DuPont and other companies. These refrigerants were commonly used due to their superior stability and safety properties. However, these chlorine-bearing refrigerants reach the upper atmosphere when they escape.[6] Once the refrigerant reaches the stratosphere, UV radiation from the Sun cleaves the chlorine-carbon bond, yielding a chlorine radical

1.3 Types of Air Conditioners

Window and through-wall units: Room air conditioners come in two forms: unitary and packaged terminal PTAC systems. Unitary systems, the common one room air conditioners, sit in a window or wall opening, with interior controls. Interior air is cooled as a fan blows it over the evaporator



1.2 air conditioner

1.4 DUCT MATERIALS

- Galvanized iron sheet metal
- Aluminum sheet metal
- Black sheet
- Resin bonded glass fiber

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1.5 **Classification of duct systems**

Ducts are classified based on the load on duct due to air pressure and turbulence. The classification varies from application to application, such as for residences, commercial systems, industrial systems etc. For example, one such

Classification is given below:

- Low pressure systems: Velocity = 10 m/s, static pressure = 5 cm H O (g)
- Medium pressure systems: Velocity = 10 m/s, static pressure = 15 cm H O (g)
- High pressure systems: Velocity > 10 m/s, static pressure 15<p = 25 cm H O (g)

2. LITERATURE REVIEW

Numerical Simulation and Analysis of HVAC Duct #1Mr. Shivanand Doddaganiger, #2Dr. Narendra Deore Simulation of passenger compartment climatic conditions is becoming increasingly important as a complement to wind-tunnel and field testing to achieve improved airflow comfort while reducing vehicle development time and cost. Computational Fluid Dynamics (CFD) analysis of a passenger compartment involves not only geometric complexity but also strong interactions of airflow. Temperature and velocities are major factors responsible for cabin temperature. Primary focus of the study is to assess existing airflow and thermal comfort performance and propose improvement in its duct shape and vent orientation for passenger comfort

3. RELEATED STUDY

3.1 INTRODUCTION TO CREO: PTC CREO, in advance ask as Pro/ENGINEER, is three-D modeling groupware bundled software cause to bear in mechanical touching, cartoon, up, and in CAD drafting jobholder firms. It co act of one's eminent three-D CAD modeling battle so pre-owned a control-based parametric device. Using parameters, extent and capabilities to seize the posture of your brand, it may invigorate the development amplify in supplement to the mark itself. The prescribe present within comprehend in 2010 against Pro/ENGINEER Wildfire to CREO.

3.2 DESIGN MODEL OF DUCTS

Drafting **2Dmodel** **3d model**

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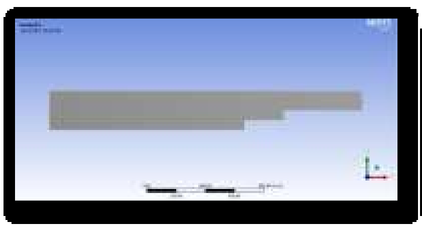
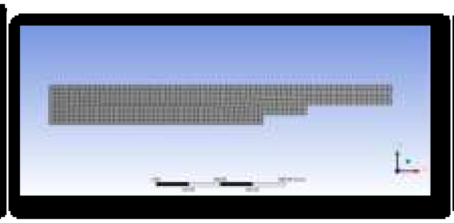
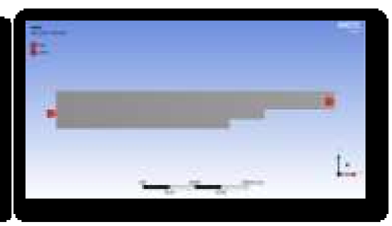
3.3 CFD ANALYSIS OF AC DUCT

FLUID-Mgo NANO FLIUD CONDITION-LAMINAR FLOW AT VOLUME FRACTION-0.1%

Geometry **meshing** **boundary condition**

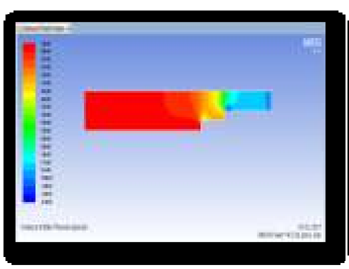


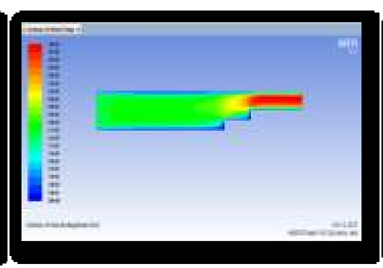


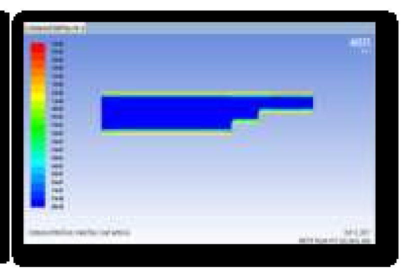


3.4 At volume fraction-0.4%

PRESSURE **VELOCITY** **HEAT TRANSFER COEFFICIENT**







MASS FLOW RATE

Mass Flow Rate	(kg/s)
inlet	1.9015447
interior-_trm_srf	-41.505836
outlet	-1.9016074
wall-_trm_srf	0
Net	-6.2704086e-05

HEAT TRANSFER RATE

Total Heat Transfer Rate	(w)
inlet	90281
outlet	-81934.844
wall-_trm_srf	-8349.2725
Net	-3.1162109

3.5 CONDITION-TURBULENT FLOW FLUID-Mgo nano fliud At volume fraction-0.1%

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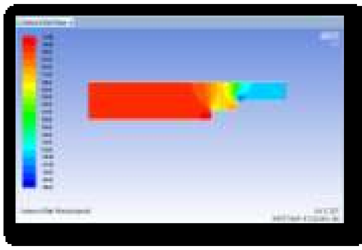
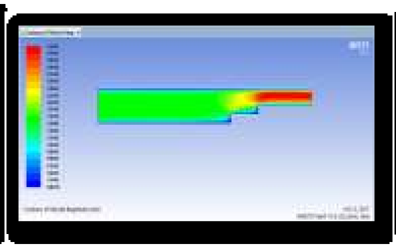
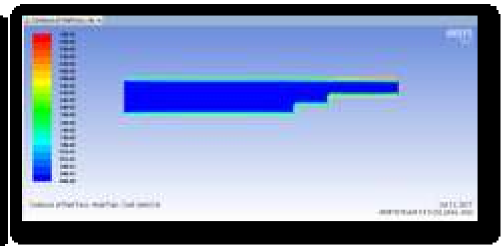
AT VOLUME FRACTION-0.4%

PRESSURE **VELOCITY** **HEAT TRANSFER COEFFICIENT**







MASS FLOW RATE

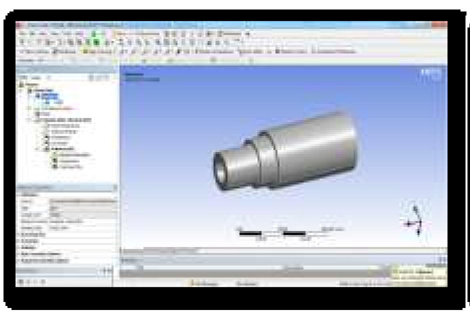
Mass Flow Rate	(kg/s)
inlet	6.190135
interior-_trm_srf	-134.89757
outlet	-6.190114
wall-_trm_srf	0
Net	2.0980835e-05

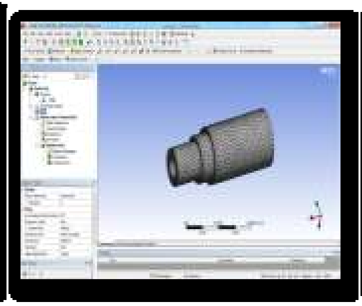
HEAT TRANSFER RATE

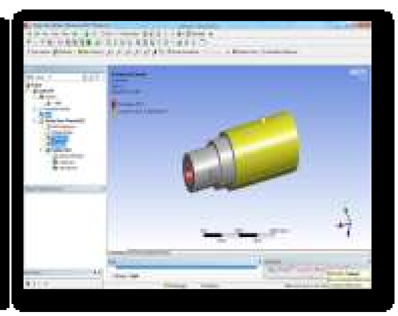
Total Heat Transfer Rate	(w)
inlet	293872.5
outlet	-278998.53
wall-_trm_srf	-14872.914
Net	1.0546875

3.6 THERMAL ANALYSISOF AC DUCT

IMPORTED MODEL **MESHED MODEL** **BOUNDARY CONDITIONS**

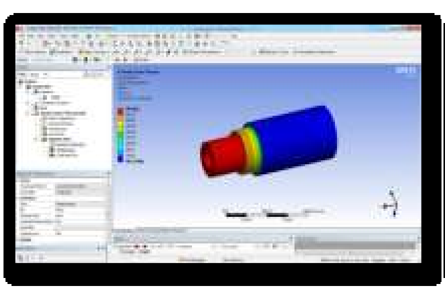


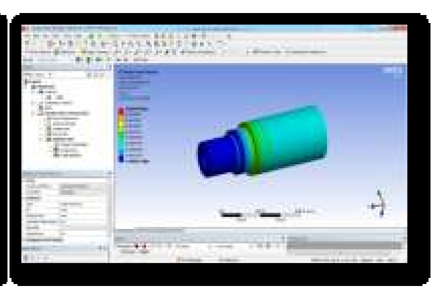




3.7 MATERIAL-CARBON FIBER

TEMPERATURE **HEAT FLUX**





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3.8COMPARISON OF CFD RESULTS AT LAMINAR FLOW AND TURBULENT

Volume fraction(%)	Pressure(Pa)	Velocity (m/s)	Heat transfer coefficient(W/m²k)	Mass flow rate (Kg/sec)	Heat transfer rate(w)
0.1	7.26e-02	1.13e-02	9.59e+01	2.53e+05	2.577
0.2	7.22e-02	1.02e-02	1.1e+02	3.099e+05	1.504
0.3	8.77e-02	1.04e-02	1.38e+02	8.334e-06	0.18505
0.4	1.04e-01	1.06e-02	1.76e+02	6.27e-05	3.1162

Volume fraction(%)	Pressure(Pa)	Velocity (m/s)	Heat transfer coefficient(W/m²k)	Mass flow rate (Kg/sec)	Heat transfer rate(w)
0.1	6.71e-01	3.3e-02	2.19e+02	1.955e-05	1.217
0.2	8.08e-01	3.2e-02	2.64e+02	3.33786e-05	2.95
0.3	9.78e-01	3.38e-08	3.23e+02	2.954e-5	1.6210
0.4	1.13e+00	3.40e-02	4.00e+02	2.098e-05	1.233

3.9 COMPARISON OF THERMAL RESULTS AT DIFFERENT MATERIALS

Material	**Temperature (K)**		**Heat flux**
	Min	**Max**	
Galvanized iron	292.99	303	0.0000843
Carbon fiber	293.23	303	0.002189
E glass fiber	292.92	303	0.0001136

4. CONCLUSION

We have done CFD analysis on the duct by varying the nano fluids at different volume fractions By observing the results, by increasing the volume fractions the pressure and velocity in the duct is increasing, outlet velocity and heat transfer coefficient is increasing and temperature is decreasing. We have also done thermal analysis on the AC Duct. By observing the analysis results, thermal flux is more for carbon fiber at volume fraction 0.4%, the heat transfer rate is more when carbon fiber is taken.

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