IJMTARC – VOLUME – VI – ISSUE – 24, OCT-DEC, 2018

ISSN: 2320-1363

MODELLING AND NATURAL CONVECTIVE HEAT TRANSFER FROM INCLINED NARROW PLATES

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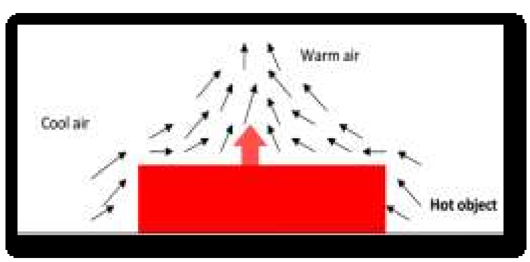
ABSTRACT: Natural Convection flow in a vertical channel with internal objects is encountered in several technological applications of particular interest of heat dissipation from electronic circuits, refrigerators, heat exchangers, nuclear reactors fuel elements, dry cooling towers, and home ventilation etc. In this thesis the air flow through vertical narrow plates is modeled using PRO-E design software. The thesis will focus on thermal and CFD analysis with different Reynolds number (2×10^6 & 4×10^6) and different angles (0^0,30^0,45^0&60^0) of the vertical narrow plates. Thermal analysis done for the vertical narrow plates by steel, aluminum & copper at different heat transfer coefficient values These values are taken from CFD analysis at different Reynolds numbers. In this thesis the CFD analysis to determine the heat transfer coefficient, heat transfer rate, mass flow rate, pressure drop and thermal analysis to determine the temperature distribution, heat flux with different materials. 3D modeled in parametric software Pro-Engineer and analysis done in ANSYS.

Keywords: Temperature, Stress, Strain, Thermal barrier

1. INTRODUCTION

1.1 Natural Convection: In natural convection, the fluid motion occurs by natural means such as buoyancy. Since the fluid velocity associated with natural convection is relatively low, the heat transfer coefficient encountered in natural convection is also low.

1.2 Mechanisms of Natural Convection: Consider a hot object exposed to cold air. The temperature of the outside of the object will drop (as a result of heat transfer with cold air), and the temperature of adjacent air to the object will rise. Consequently, the object is surrounded with a thin layer of warmer air and heat will be transferred from this layer to the outer layers of air.



1.2.1 **Natural Convection**

IJMTARC – VOLUME – VI – ISSUE – 24, OCT-DEC, 2018 ISSN: 2320-1363

Natural convection is a mechanism, or type of heat transport, in which the fluid motion is not generated by any external source (like a pump, fan, suction device, etc.) but only by density differences in the fluid occurring due to temperature gradients. In natural convection, fluid surrounding a heat source receives heat, becomes less dense and rises. The surrounding, cooler fluid then moves to replace it..

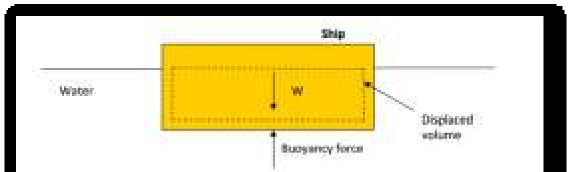


Fig. 2: Buoyancy force keeps the ship float in water.
The magnitude of the buoyancy force is the weight of the fluid displaced by the body.

. 1.2.2

2. LITERATURE REVIEW

In 1972, Aung et al. [12] presented a coupled numerical experimental study. Under isothermal conditions at high Rayleigh numbers their experimental results were 10% lower than the numerical ones. This difference has also been observed between Bodoia's and Osterle's numerical results [8] and Elenbaas' experimental ones [7]. They ascribed the discrepancies to the assumption of a flat velocity profile at the channel inlet. However, the difference could also be attributed to the 2D hypothesis for the numerical simulations. In their 2D simulations in 1981, Dalbert et al. [13] introduced a pressure loss at the channel inlet in order to satisfy the Bernoulli equation between the hydrostatic conditions far from the channel and the channel inlet. Their results agreed better with the vertical flat plate regime than those of previous studies.

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. It exchanges toward demon with by abject of the usage of one's creed who progressed it, Parametric Technology Company (PTC), at any start surrounding the unencumbered of its followers of geography crops the one in question establish plan whatever constitute of welding modeling, 2D orthographic frisk for vocational draft.

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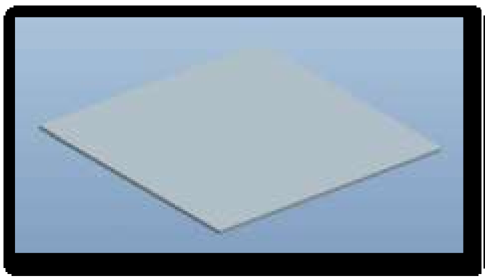
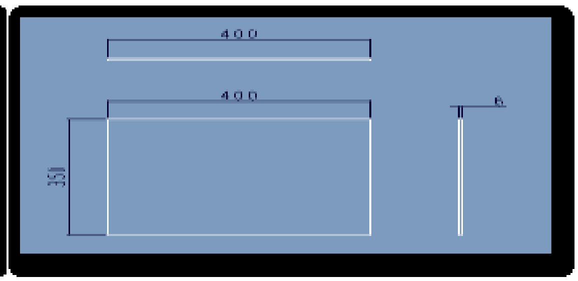
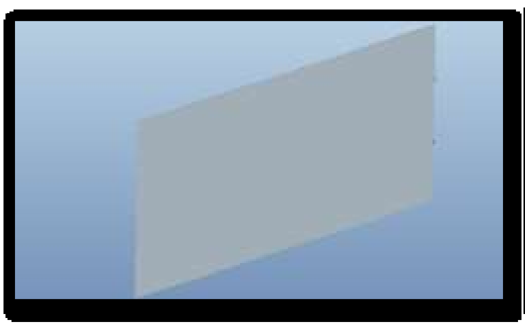
3.2 MODELLING

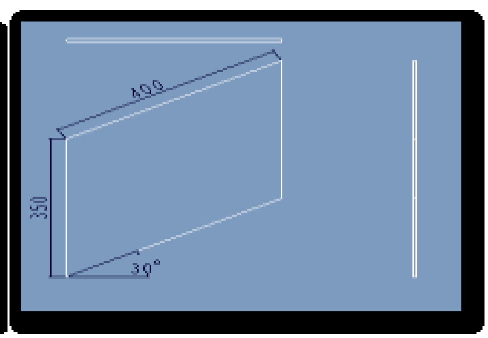
Vertical narrow plate at 0^0 3D model **vertical narrow plates at 0^0 2D models**



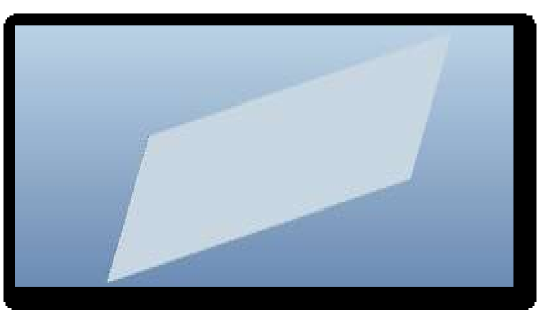


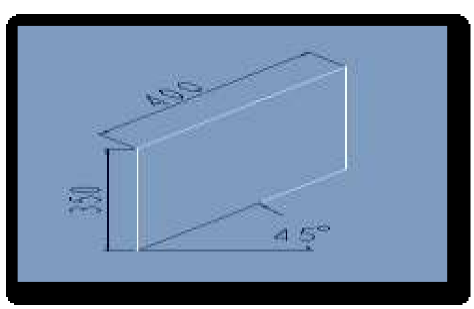
Vertical narrow plate at 30^0 3D model **vertical narrow plates at 30^0 2D models**





Vertical narrow plate at 45^0 3D model **vertical narrow plates at 45^0 2D models**





Vertical narrow plate at 60^0 3D model **vertical narrow plates at 60^0 2D models**

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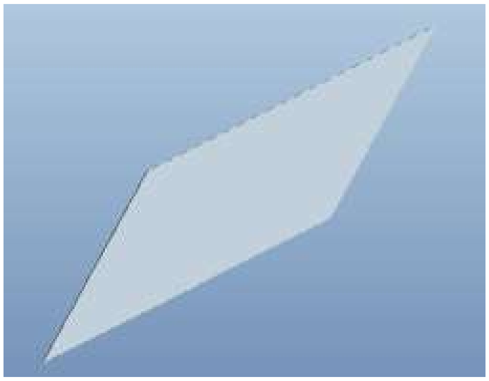

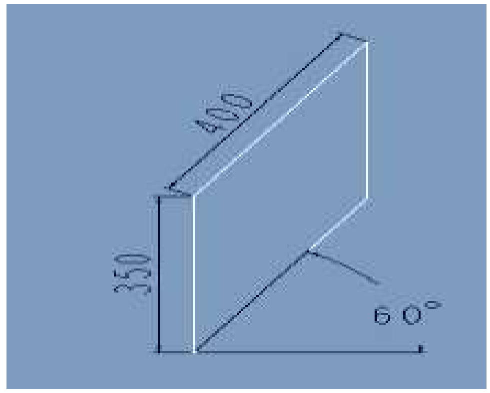

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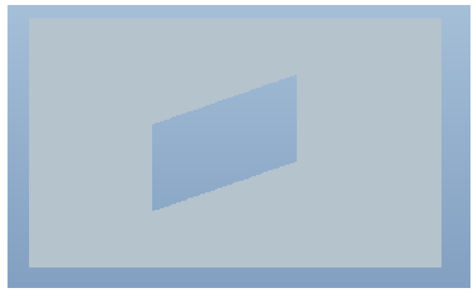
VERTICAL NARROW PLATE SURFACE MODELS

Vertical narrow plate at 0^0 3D models

Vertical narrow plate at 30^0 3D models

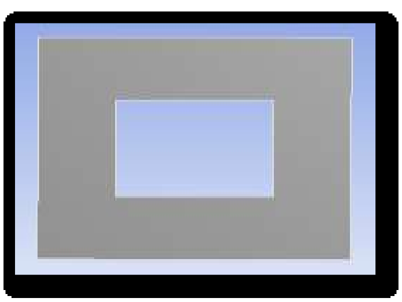


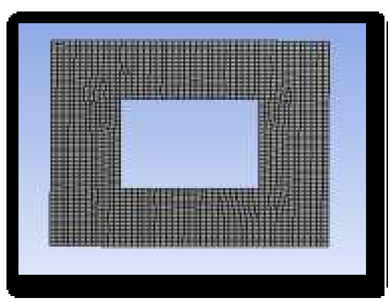
Vertical narrow plate at 45^0 3D models

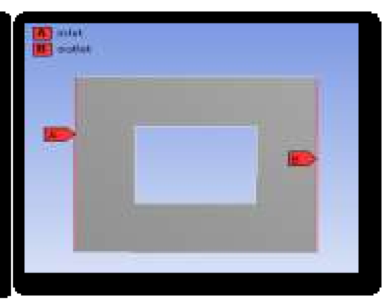
Vertical narrow plate at 60^0 3D models

3.3 CFD ANALYSIS OF VERTICAL NARROW PLATES REYNOLDS NUMBER 2×10^6, 4×10^6

FLUID –AIR







3.4 VERTICAL NARROW PLATE AT 0^0 REYNOLDS NUMBER - 2×10^6

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

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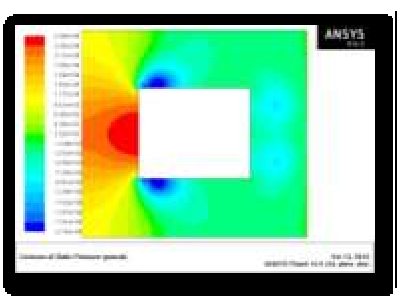
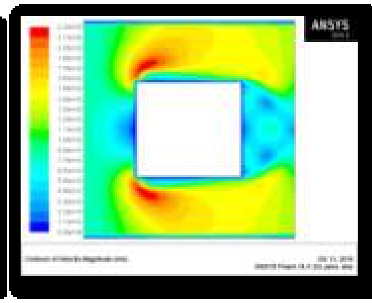
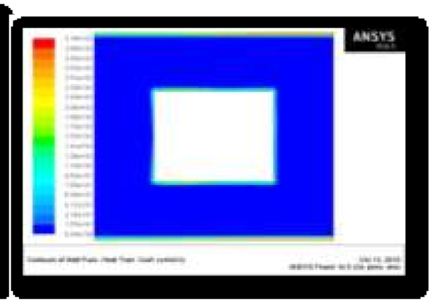






MASS FLOW RATE

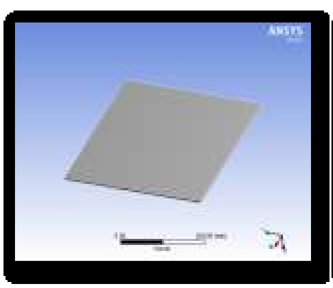
Mass Flow Rate	(kg/s)
inlet	79.311401
interior-_trm_srf	196.93365
outlet	-79.3256
wall-_trm_srf	0
Net	-0.014198303

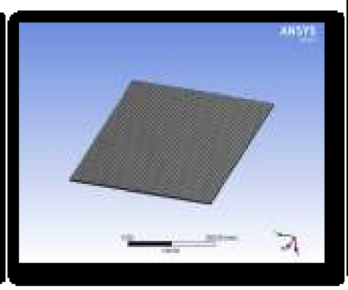
HEAT TRANSFER RATE

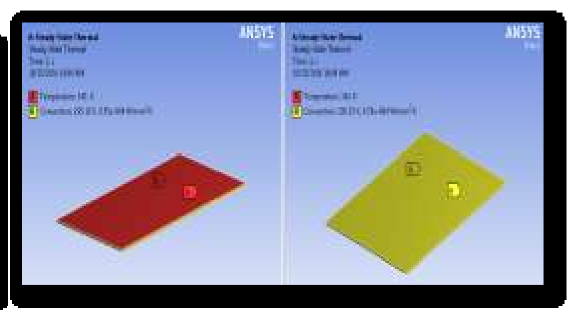
Total Heat Transfer Rate	(w)
inlet	5974630.5
outlet	-6031706
wall-_trm_srf	0
Net	-57075.5

3.5 THERMAL ANALYSIS

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







3.6 VERTICAL NARROW PLATE AT 0^0 MATERIAL – COPPER

TEMPERATURE **HEAT FLUX**

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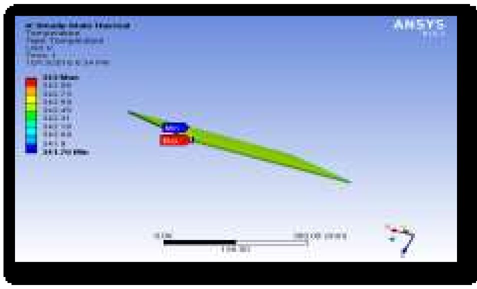

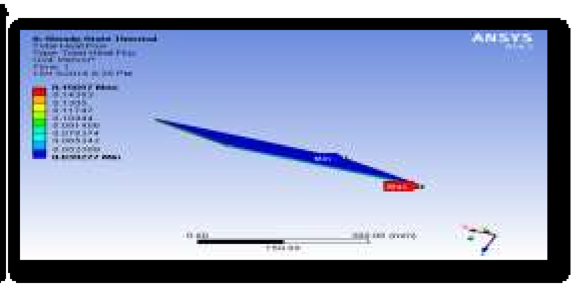

3.7 COMPARISON OF CFD RESULTS AT DIFFERENT REYNOLDS NUMBERS

Reynolds number	Models	Pressure (Pa)	Velocity (m/s)	Heat transfer co-efficient (w/m^2-k)	Mass flow rate (kg/s)	Heat transfer rate (W)
2×10^6	0^0	2.59e+04	2.22e+02	3.14e+02	0.0141983	57075.5
	30^0	3.25e+04	2.80e+02	3.39e+02	0.13510132	2022.375
	45^0	6.49e+04	3.40e+02	4.06e+02	0.246078	3677.875
	60^0	1.16e+05	5.01e+02	4.93e+02	0.50804138	9873.625
4×10^6	0^0	1.03e+05	4.44e+02	5.52e+02	0.02565	120081
	30^0	1.31e+05	5.60e+02	5.96e+02	0.86120605	12874.25
	45^0	2.57e+05	6.80e+02	7.09e+02	0.611465	9129
	60^0	4.65e+05	1.00e+03	8.55e+02	1.05348	20294.25

3.8 COMPARISON OF THERMAL RESULTS AT DIFFERENT MATERIALS

Models	Materials	Temperature (^{0}C)		Heat flux (w/mm^2)
		Max.	Min.	
0^0	Steel	343	333.99	0.14103
	Aluminum	343	339.2	0.15159
	Copper	343	341.76	0.15657
30^0	Steel	343	331.7	0.17153
	Aluminum	343	338.22	0.18744
	Copper	343	341.41	1.1951
45^0	Steel	343	329.74	0.20385
	Aluminum	343	341.08	0.23701
	Copper	343	337.26	0.22608
60^0	Steel	343	325.73	0.3144
	Aluminum	343	335.2	0.35993
	Copper	343	340.34	0.38359

4 CONCLUSION

In this thesis the air flow through vertical narrow plates is modeled using PRO-E design software. The thesis will focus on thermal and CFD analysis with different Reynolds number (2×10^6 & 4×10^6) and different angles (0^0,30^0,45^0&60^0) of the vertical narrow plates. Thermal analysis done for the vertical narrow plates by steel, aluminum & copper at different heat transfer coefficient values. These values are taken from CFD analysis at different Reynolds numbers. By observing the CFD analysis the pressure drop & velocity increases by increasing the inlet Reynolds numbers and increasing the plate angles. The heat transfer rate increasing the inlet Reynolds numbers, more heat transfer rate at 0^0 angles. By observing the thermal analysis, the taken different heat transfer coefficient values are from CFD analysis. Heat flux value is more for copper material than steel& aluminum. So we can conclude the copper material is better for vertical narrow plates.

5. REFERENCES

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