International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 03 | Mar 2021 www.irjet.net p-ISSN: 2395-0072

NATURAL CONVECTIVE HEAT TRANSFER FROM TWO ADJACENT NARROW PLATES

BIJJE SADANAND[1], MRS. B.DEEPIKA[2], DR. K. VIJAY KUMAR[3], DR. M. SREEDHARREDDY[4]

[1]M. TECH Student, Dept. of Mechanical Engineering, Malla Reddy College of Engineering, Telangana, India
[2]Assistant Professor, Dept. of Mechanical, Malla Reddy College of Engineering, Telangana, India
[3]Professor, Dept. of Mechanical, Malla Reddy College of Engineering, Telangana, India
[4]Principal, Malla Reddy College of Engineering, Telangana, India

---***---

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.

Key words: *Narrow plates, Heat Transfer, Convection Pro E Software, CFD Analysis*

1. INTRODUCTION

1.1 Natural Convection:

In natural convection, the fluid motion occurs by natural means such as buoyancy. Since the fluid velocity associat ed with natural convection is relatively low, the heat tran sfer coefficient encountered in natural convection is also l ow.

1.2 Mechanisms of Natural Convection:

Consider a hot object exposed to cold air. The temperatu re of the outside of the object will drop (as a result of heat transfer with cold air), and the temperature of adjacent a ir to the object will rise. Consequently, the object is surro unded with a thin layer of warmer air and heat will be tra nsferred from this layer to the outer layers of air.

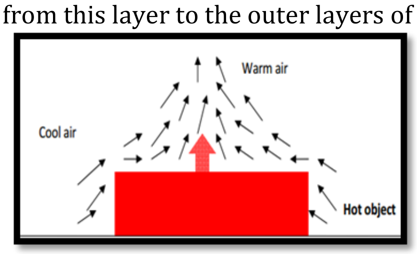

Fig-1.1: Natural convection heat transfer from hot body

The temperature of the air adjacent to the hot object is hi gher, thus its density is lower. As a resut, the heated air ri ses. This movement is called the natural convection curre nt. Note that in the absence of this movement, heat transf er would be by conduction only and its rate would be mu ch lower. In a gravitational field, there is a net force that p ushes a light fluid placed in a heavier fluid upwards. This force is called the buoyancy force.

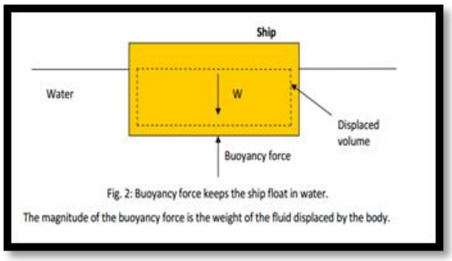

Fig-1.2: Natural Convection from a Vertical Plate

In this system heat is transferred from a vertical plate to a fluid moving parallel to it by natural convection. This will occur in any system wherein the density of the moving fluid varies with position. These phenomena will only be of significance when the moving fluid is minimally affected by forced convection.

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 Osterley' 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. MODELLING AND ANALYSIS

The vertical narrow plate is modeled using the given specifications and design formula from data book. The isometric view of vertical narrow plate is shown in below figure. The vertical narrow plate profile is sketched in sketcher and then it is extruded vertical narrow plate using extrude option.

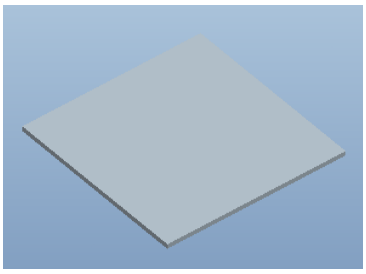

Fig-3.1: Vertical narrow plate at 0^0 3Dmodel

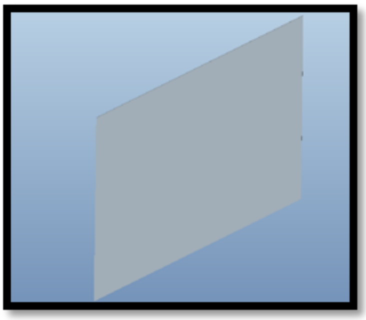

Fig-3.2: Vertical narrow plate at 30^0 3D model

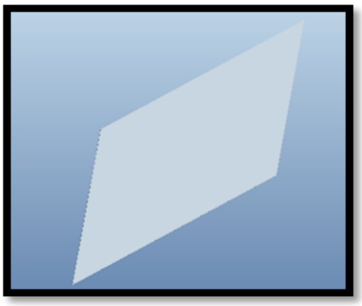

Fig-3.3: Vertical narrow plate at 45^0 3D model

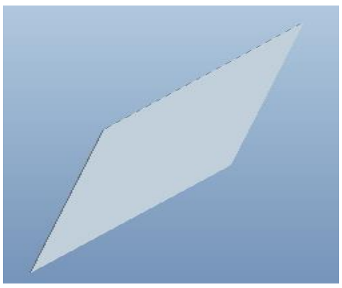

Fig-3.4: Vertical narrow plate at 60^0 3D model

3.1 VERTICAL NARROW PLATE SURFACEMODEL

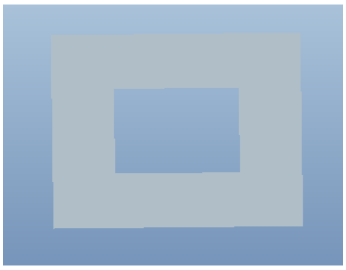

Fig-3.5: Vertical narrow plate at 0^0 3D models

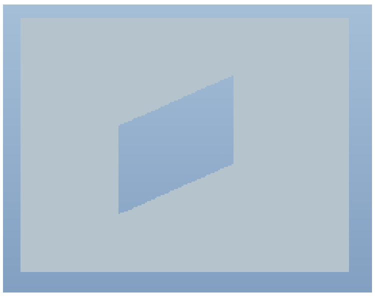

Fig-3.6: Vertical narrow plate at $30^0$3D models

Fig-3.7: Vertical narrow plate at $45^0$3D models

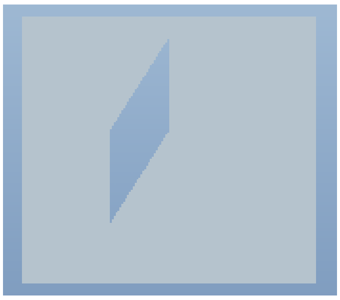

Fig-3.8: Vertical narrow plate at $60^0$3D models

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

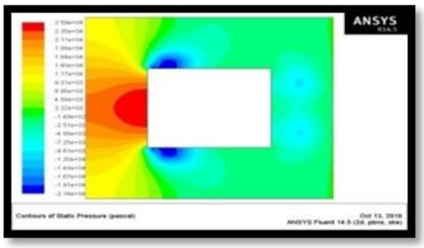

Fig-3.9: STATIC PRESSURE

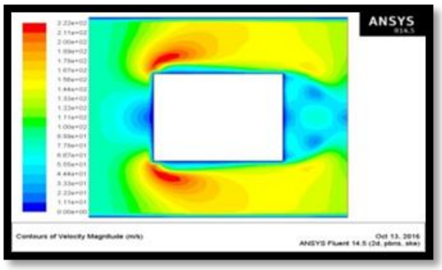

Fig-3.10: VELOCITY

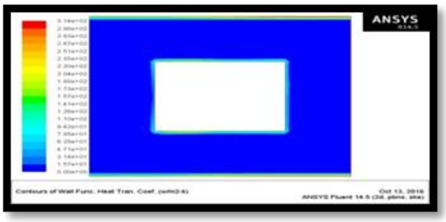

Fig-3.11: HEAT TRANSFER COEFFICIENT

Fig-3.12: STATIC PRESSURE

3.3 VERTICAL NARROW PLATE AT 60^0 REYNOLDS NUMBER - 2×10^6

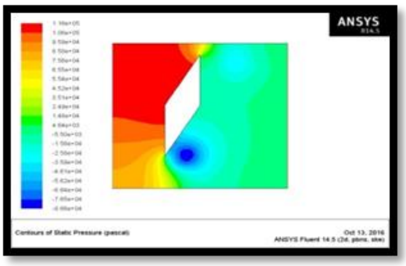

Fig-3.13: STATIC PRESSURE

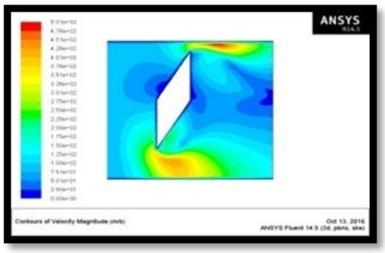

Fig-3.14: VELOCITY

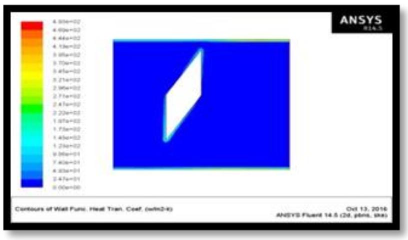

Fig-3.15: HEAT TRANSFER COEFFICIENT

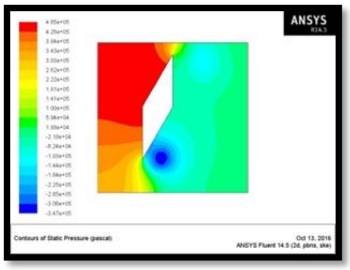

Fig-3.16: STATIC PRESSURE

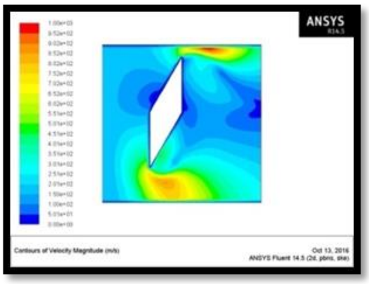

Fig-3.17: VELOCITY

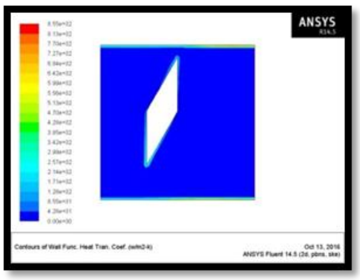

Fig-3.18: HEAT TRANSFER COEFFICIENT

4. RESULT TABLE

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

5. 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

REFERENCES

1.Arpaci, V. S., 1995, "Buoyant Turbulent Flow Driven by Internal Energy Generation," Int. J. Heat Mass Transfer, Vol. 38, pp. 2761-2770.Asfia, F. J., and Dhir, V. K., 1994, "An 2.Experimental Study of Natural convection in a Volumetrically Heated Spherical Pool With Rigid Wall," ASME Paper94-WA/H7--26.

3.Cheung, F. B., i980a, "Heat Source-Driven Thermal Convection at Arbirrary Prandtl Numbers," J. Fluid Mech., YoL 97, pp. 743-758.

4. Cheung, F. B., 1980b, "The Boundary Layer Behaviour in Transient Turbulent Thermal Convection Flow," ASME Journal of Heat Transfer, Vol. 102, pp.373-375.

5.Cheung, F. B., 1978, "Turbulent Thermal Convection in a Horizontal Fluid Layer With Time Dependent Volumetric Energy Sources." AIAA/ASME Thermo physics and Heat Transfer Conf.,78-HT-6, Palo Alto.

BIOGRAPHIES

Name : Bijje Sadanand
M.Tech (Thermal Engineering) Scholar, Department of Mechanical Engineering, MRCE, MYSAMMAGUDA, HYDERABAD, TELANGANA, INDIA