HEAT TRANSFER ENHANCEMENT IN VERTICAL NARROW PLATES BY NATURAL CONVECTION

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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 (2×106 & 4×10 6) and different angles (00,300,450&600) 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:-Pro E,Ansys, CFD Analysis

INTRODUCTION

1.1Natural Convection:In natural conve ction, the fluid motion occurs by natural means such as buoyancy. Since the fluid velocity associated with natural convecti on is relatively low, the heat transfer coe fficient encountered in natural convectio n is also low.

Mechanisms of Natural Convection Conside r a hot object exposed to cold air. The tempe rature of the outside of the object will drop as a result of heat transfer with cold air and t he temperature of adjacent air to the object will rise. Consequently, the object is surroun ded with a thin layer of warmer air and heat will be transferred from this layer to the oute r layers of air.

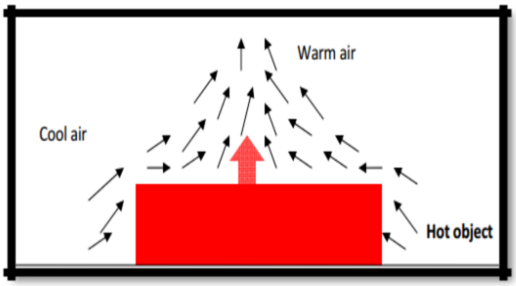


Fig:1Natural convection heat transfer fro m a hot body

The temperature of the air adjacent to th e hot object is higher, thus its density is l ower. As a resut, the heated air rises. Thi s movement is called the natural convect ion current. Note that in the absence of t his movement, heat transfer would be by conduction only and its rate would be m uch lower. In a gravitational field, there i s a net force that pushes a light fluid plac ed in a heavier fluid upwards. This force is called the buoyancy force.

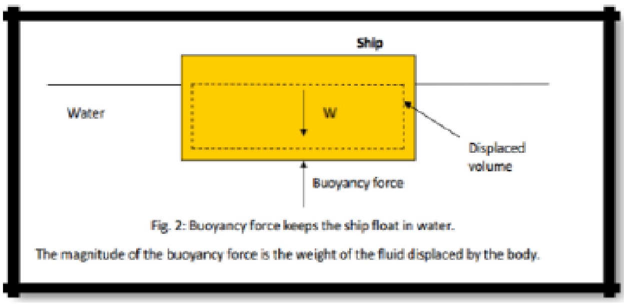


Fig:2 Natural Convection from a Vertical Plate

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 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. INTRODUCTION TO CAD

Throughout the history of our industrial society, many inventions have been patented and whole new technologies have evolved. Perhaps the single development that has impacted manufacturingmore quickly and significantly than any previous technology is the digital computer. Computers are being used increasingly for both design and detailing of engineering components in the drawing office. Computer-aided design (CAD) is defined as the application of computers and graphics software to aid or enhance the product design from conceptualization to documentation. CAD is most commonly associated with the use of an interactive computer graphics system, referred to as a CAD system. Computer-aided design systems are powerful tools and in the mechanical design and geometric modeling of products and components.

There are several good reasons for using a CAD system tosupport the engineering design Function:

- ☐ To increase the productivity
- ☐ To improve the quality of the design
- ☐ To uniform design standards
- ☐ To create a manufacturing data base
- ☐ To eliminate inaccuracies caused by hand-copying of drawings and inconsistency between
- ☐ Drawings

3.1 INTRODUCTION TO PRO/ENGINEER

Pro/ENGINEER, PTC's parametric, integrated 3D CAD/CAM/CAE solution, is used by discrete manufacturers for mechanical engineering, design and manufacturing.Created by Dr. Samuel P. Geisberg in the mid-1980s, Pro/ENGINEER was the industry's first successful parametric, 3D CAD modeling system. The parametric modeling approach uses parameters, dimensions, features, and relationships to capture intended product behavior and create a recipe which enables design automation and the optimization of design and product development processes.

This powerful and rich design approach is used by companies whose product strategy is family-based or platform-driven, where a prescriptive design strategy is critical to the success of the

design process by embedding engineering constraints and relationships to quickly optimize the design, or where the resulting geometry may be complex

or based upon equations. Pro/ENGINEER provides a complete set of design, analysis and manufacturing capabilities on one, integral, scalable platform. Thesecapabilities, include Solid Modeling,Surfacing, Rendering, Data Interoperability, Routed Systems Design, Simulation, Tolerance Analysis, and NC and Tooling Design.

Companies use Pro/ENGINEER to create a complete 3D digital model of their products. The models consist of 2D and 3D solid model data which can also be used downstream in finite element analysis, rapid prototyping, tooling design, and CNC manufacturing. All data is associative and interchangeable between the CAD, CAE and CAM modules without conversion. A product and its entire bill of materials(BOM) can be modeled accurately with fully associative engineering drawings, and revision control information. The associativity in Pro/ENGINEER enables users to make changes in the design at any time during the product development process and automatically update downstream deliverables. This capability enables concurrent engineering — design, analysis and manufacturing engineers working in parallel — and streamlines product development processes.

4. ANSYS Software:

ANSYS is an Engineering Simulation Software (computer aided Engineering). Its tools cover Thermal, Static, Dynamic, and Fatigue finite element analysis along with other tools all designed to help with the development of the product. The company was founded in 1970 by Dr. John A. Swanson as Swanson Analysis Systems, Inc. SASI. Its primary purpose was to develop and market finite element analysis software for structural physics that could simulate static (stationary), dynamic (moving) and heat transfer (thermal) problems. SASI developed its business in parallel with the growth in computer technology and engineering needs. The company grew by 10 percent to 20 percent each year, and in 1994 it was sold. The new owners took SASI's leading software, called ANSYS®, as their flagship product and designated ANSYS, Inc. as the new company name.

4.1 Benefits of ANSYS:

• The ANSYS advantage and benefits of using a modular simulation system in the design process are well documented. According to studies performed by the Aberdeen Group, best-in-class companies perform more simulations earlier. As a leader in virtual prototyping, ANSYS is unmatchedintermsof functionality and power necessary to optimize components and systems.

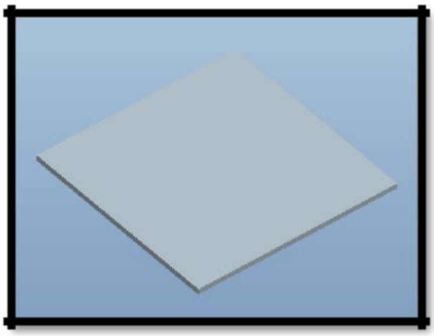
• The ANSYS advantage is well-documented.

• ANSYS is a virtual prototyping and modular simulation system that is easy to use and extends to meet customer needs; making it a low-risk investment that can expand as value is demonstrated within a company. It is scalable to all levels of the organization, degrees of analysis complexity, and stages of product development.

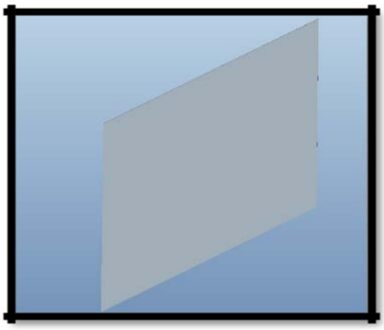
4.2 MODELLING AND ANALYSIS

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.

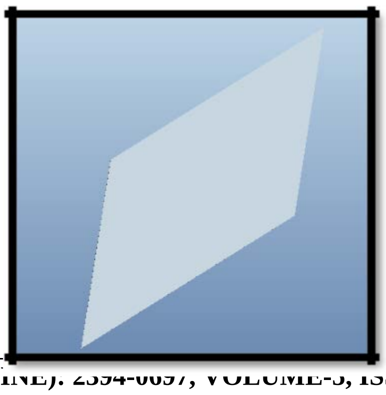
Vertical narrow plate at 00 3D model vertical narrow plates at 00 2D models



Vertical narrow plate at 300 3D model vertical narrow plates at 300 2D models



Vertical narrow plate at 450 3D model vertical narrow plates at 450 2D models



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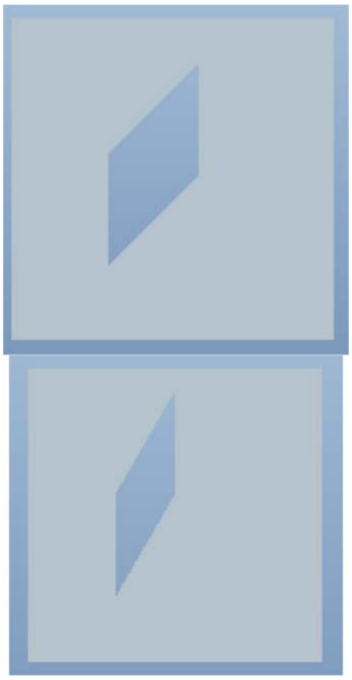
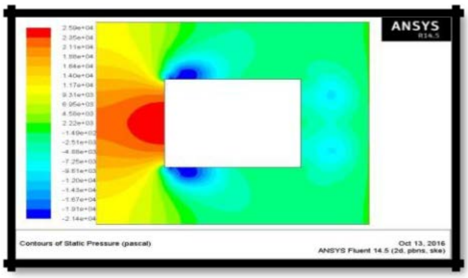
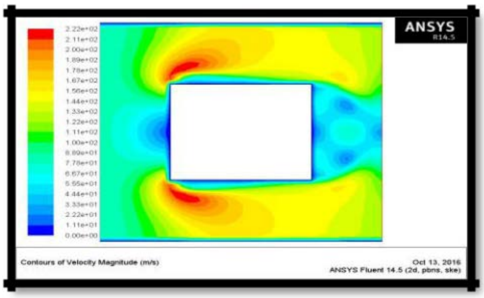
Vertical narrow plate at 600 3D model vertical narrow plates at 600 2D models Vertical narrow plate at 450 3D models Vertical narrow plate at 600 3D models



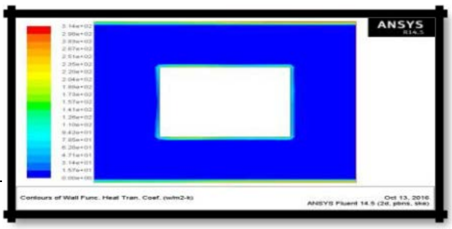
4.4 VERTICAL NARROW PLATE AT 00 REYNOLDS NUMBER - 2×106 STATIC PRESSURE



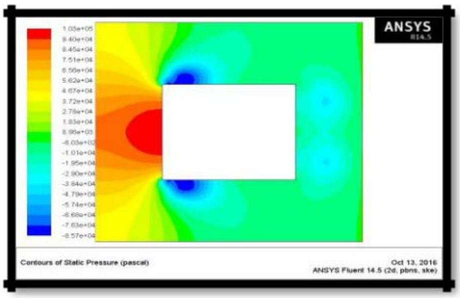
VELOCITY



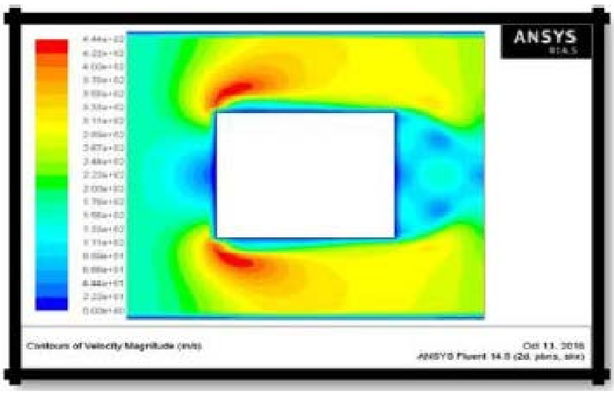
HEAT TRANSFER COEFFICIENT



STATIC PRESSURE

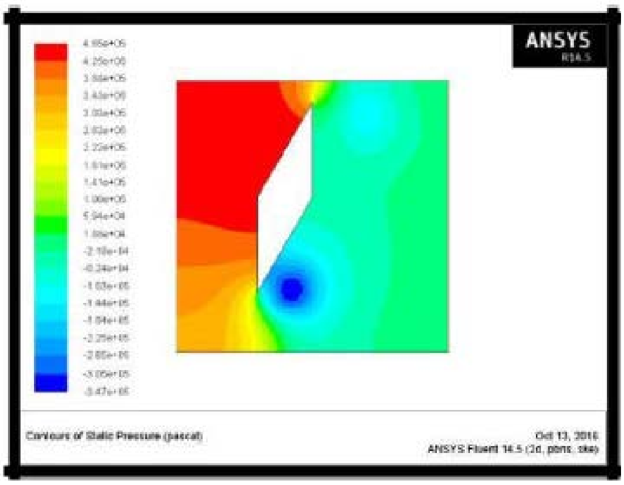


VELOCITY

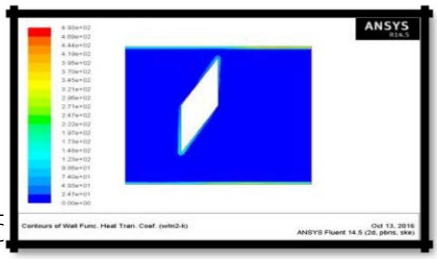


4.5 VERTICAL NARROW PLATE AT 600

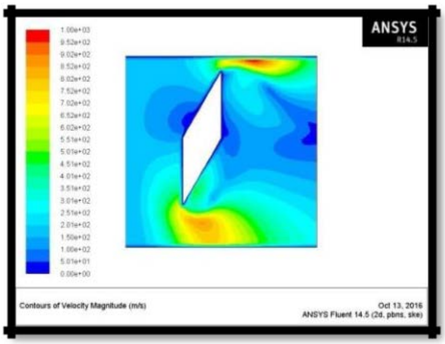
REYNOLDS NUMBER - 2×106 STATIC PRESSURE



VELOCITY



STATIC PRESSURE



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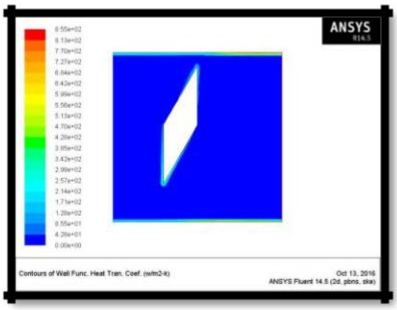

CONCLUSION:

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 (2×106 & 4×106) and different angles (00,300,450&600) 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 00 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.

6. REFERENCES

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