Aerodynamic Characteristics of a Real 3D Flow around a Finite Wing

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Abstract

This paper presents a new method of solution for the aerodynamics of finite-span wings, which overcomes the difficulties of the previous methods. A lot of disturbance is created in the air when an aeroplane flies. It is through the study of these disturbances of the flow past the airfoil, lots of design considerations are done. In this paper, we design a 3D air wing and solve the flow equations in a CFD solver and study the characteristics features of the flow around a finite wing and the effect of the tip vortices that are caused by the difference of pressures between the lower and upper portion around the tips on an air airfoil.

Index terms— finite wing, real 3d flow, vortices, pressure differences, vortex flow.

1 Introduction

n airfoil is the shape of a wing or blade (of a propeller, rotor or turbine) as seen in crosssection. The design and analysis of the wings of aircraft is one of the principal applications of the science of aerodynamics, which is a branch of fluid mechanics.

Little modification in the airfoil has a direct impact on the performance of an aircraft. Here, we design a 3D air wing and solve the flow equations in a CFD solver and study the characteristics features of the flow around a finite wing and the effect of the tip vortices that are caused by the difference of pressures between the lower and upper portion around the tips on an air airfoil. Better visualization of this vortex flow past an aircraft helps in optimizing the design of a wing.

2 II.

3 Disturbance of Flow Past Airfoil

4 Design, Data Generation and Visualization

Some of the important works done on Airfoils have been studied before solving this problem. This paper serves as a basis for understanding, designing and solving the flow problem.

A detail of the literature survey done has been included in the references list.

The Ansys workbench has a comprehensive list of software for doing various Structural and Fluid analysis and is also equipped with superior visualization capabilities which are in par with any other dedicated visualization software's. This workbench has been used for designing, solving and visualizing the results. Execution of the Project:

The project is executed in three phases. A medium size mesh is used for meshing purpose. A refinement of the mesh is done near the wing region as it is the focus of our interest. From the data that is generated, the flow is visualized using various visualization tools like contours, vector visualizations, particle tracing etc.

IV. Although the Light Jet Executive has been successfully modeled and meshed, there has been certain constraints due to which it could not be solved. Some of the major limitation were the problem with integrating the mesh of the far field with the Light Jet Executive.

5 Results

Initial attempts to make the mesh very coarse were successful however solving the problem gave totally unrealistic results and was not stable.

V.

6 Conclusions and Future Work

? The air wing and domain is modeled, meshed and solved and various post processing visualization options has been used for better understanding & investigation of the flow.

? Visualization options such as slicing and volume rendering proved extremely useful for doing the investigation of flow pattern.

? A better refinement of the mesh and boundary mesh and implementing better solvers can give accurate results for the 3D wing which can be potentially be validated with experimental results.

? An adaptive mesh refinement near the high gradients especially close to the wing gives more accurate results.

? Refinement of mesh and better meshing options required for solving Light Jet Executive Model. [1]

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Figure 1: Figure 1 :

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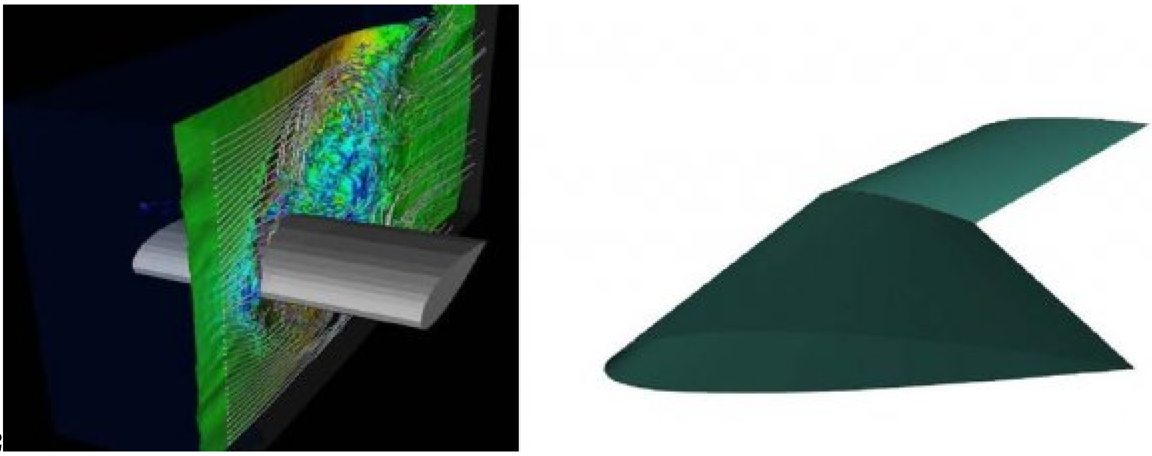

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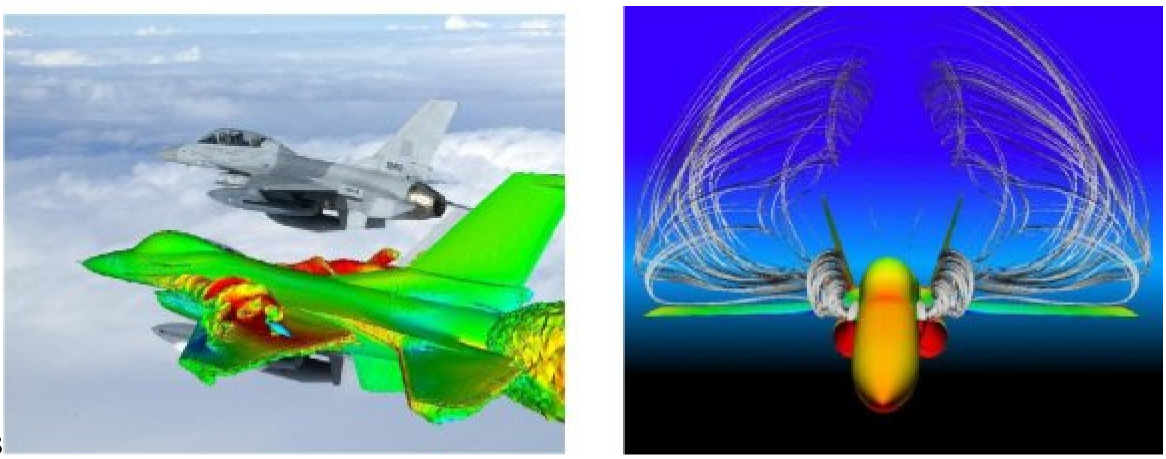

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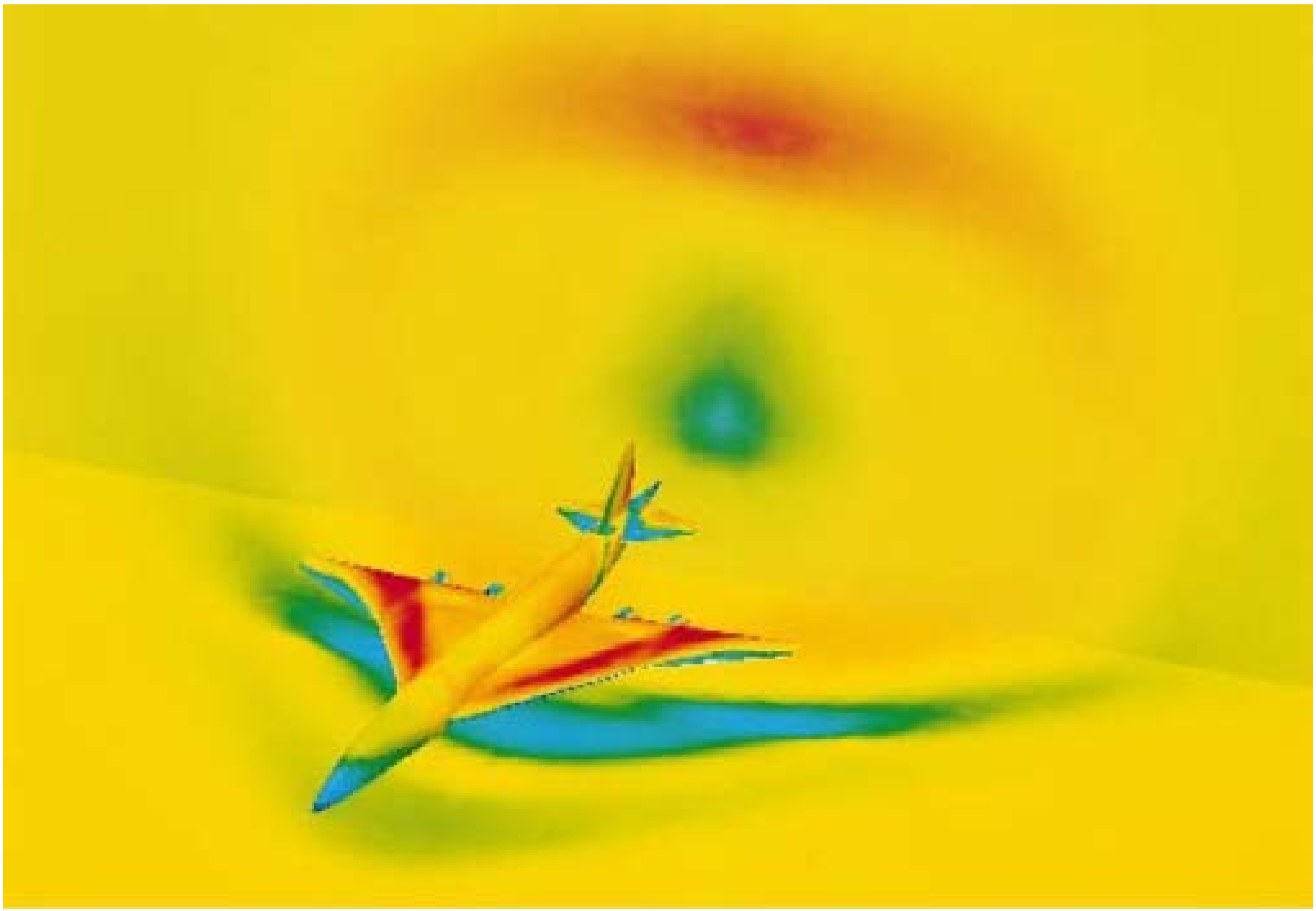

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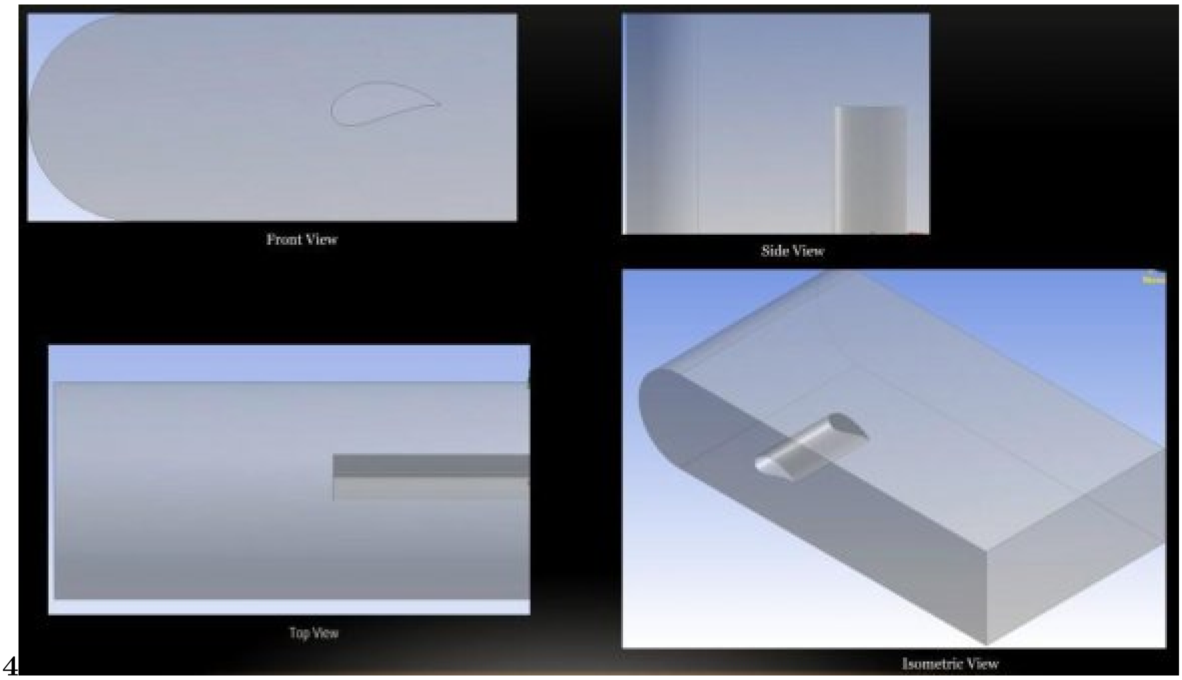

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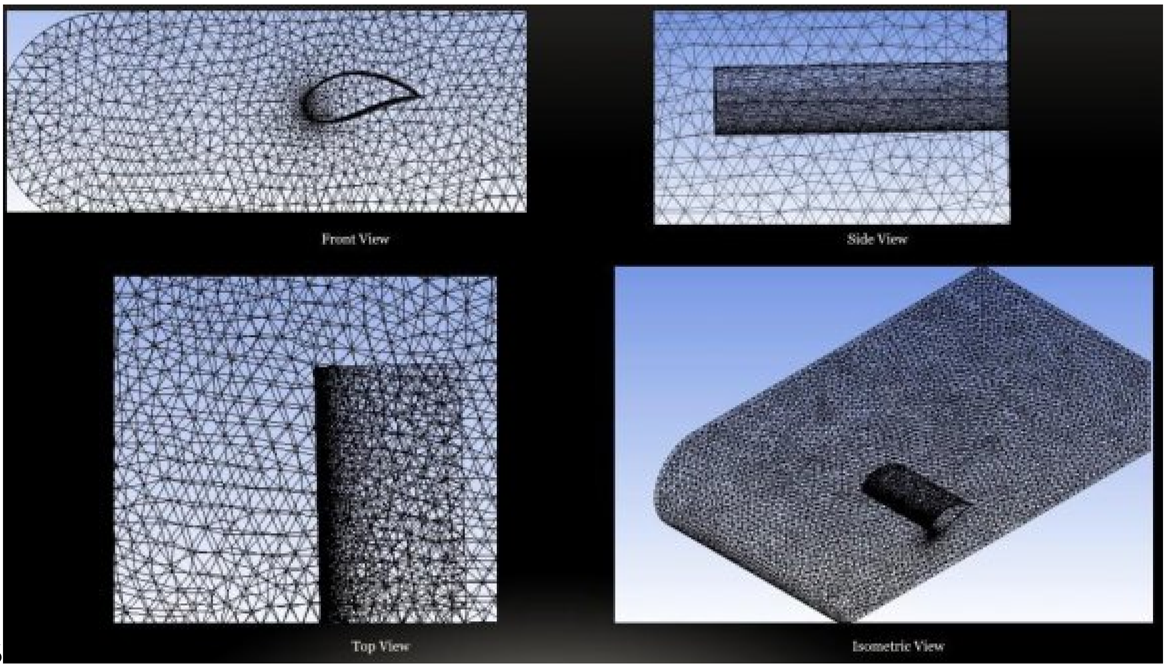

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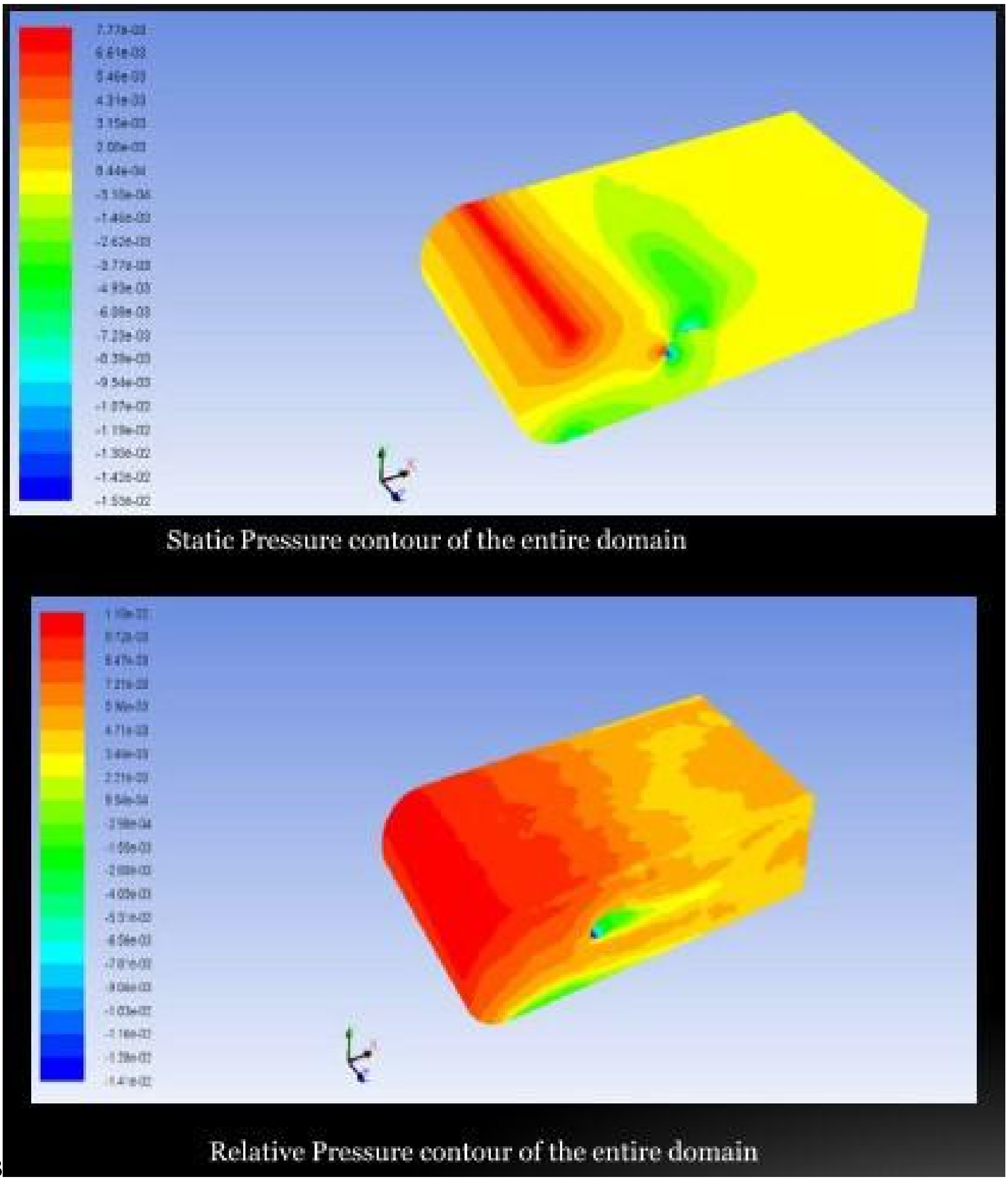

Static Pressure contour of the entire domain

Relative Pressure contour of the entire domain

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Figure 7: Figure 6 :Figure 8 :

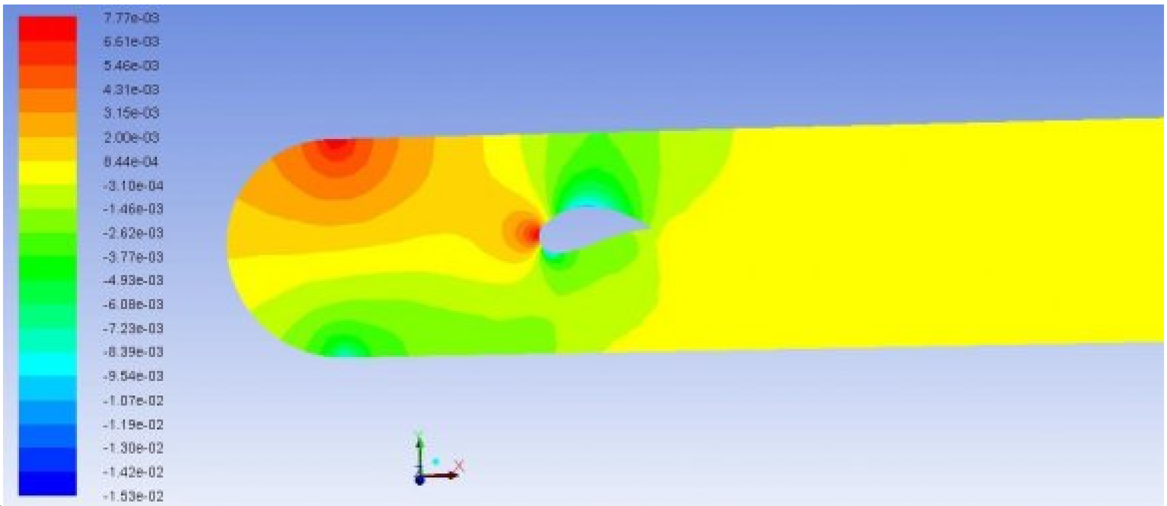

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Figure 8: Figure 11 :

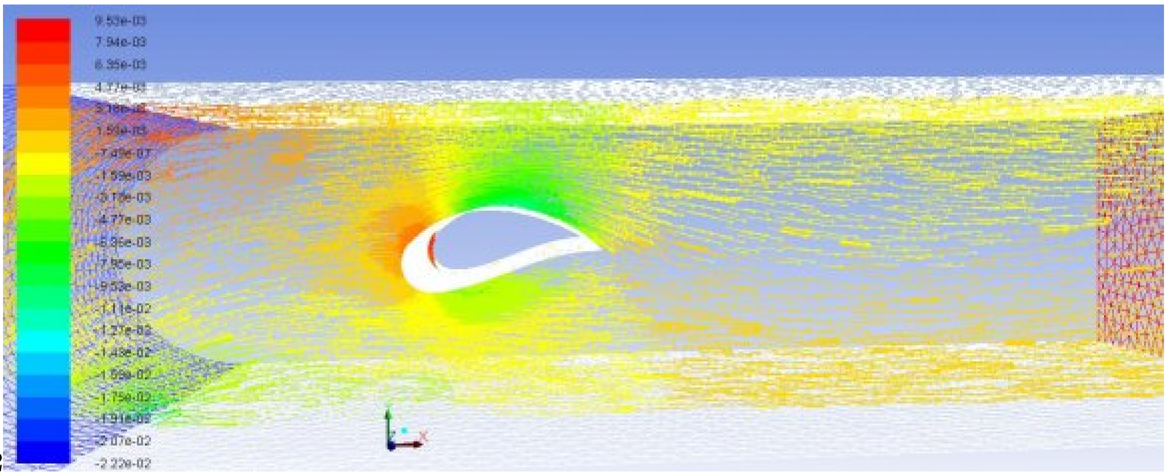

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Figure 9: Figure 12 :

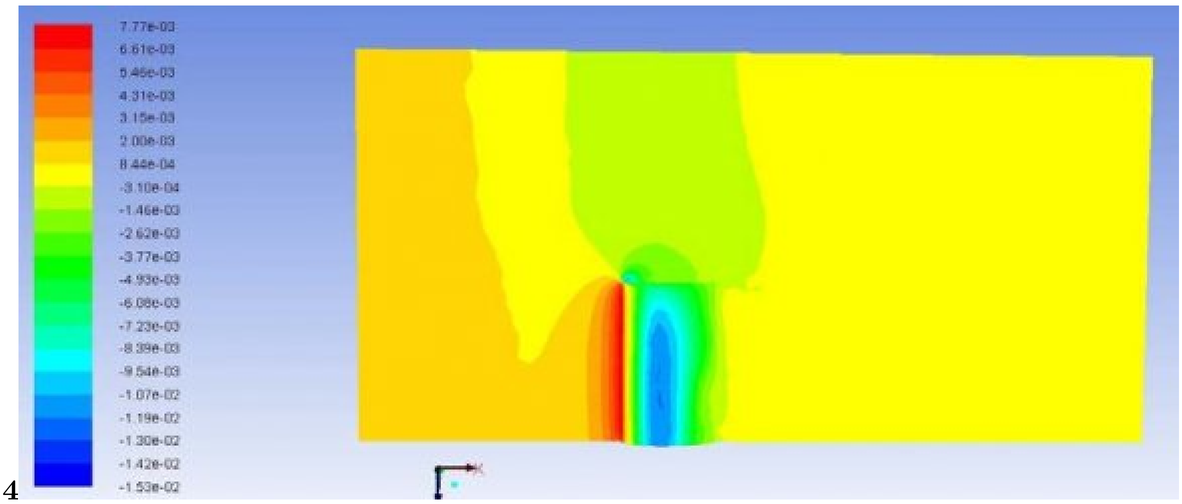

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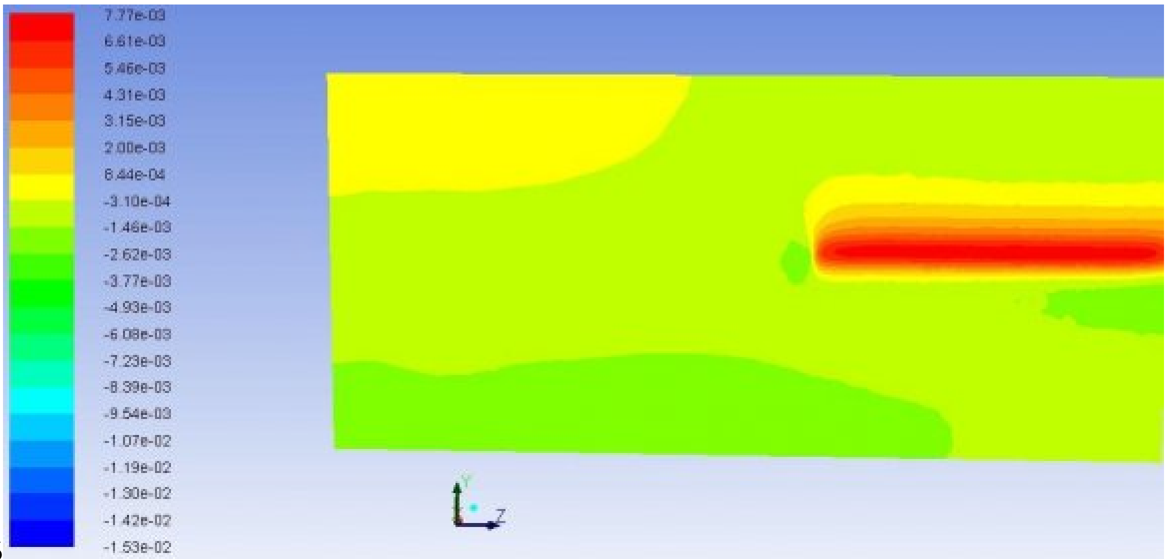
Figure 10: Figure 14 :

15 

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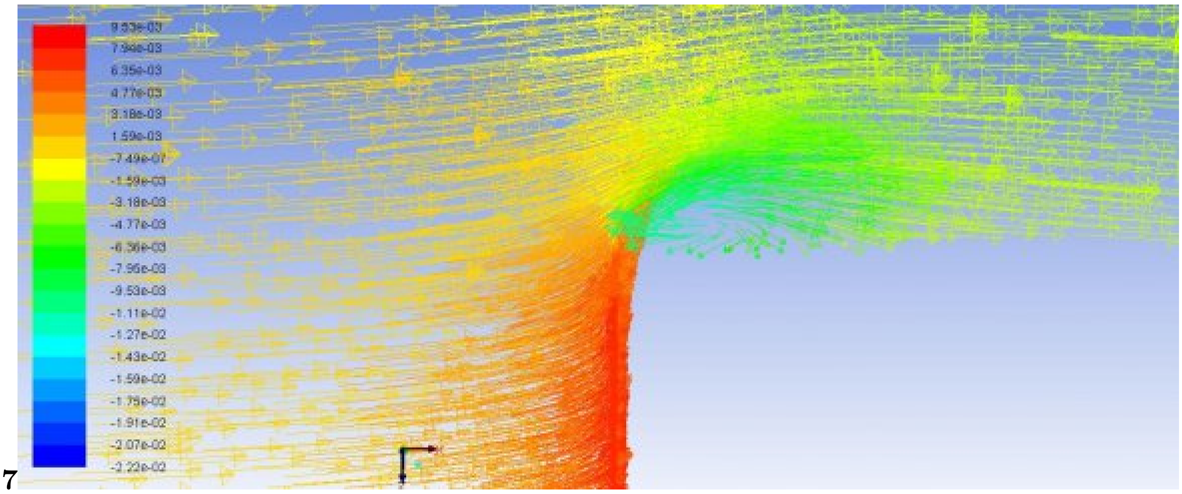
17 

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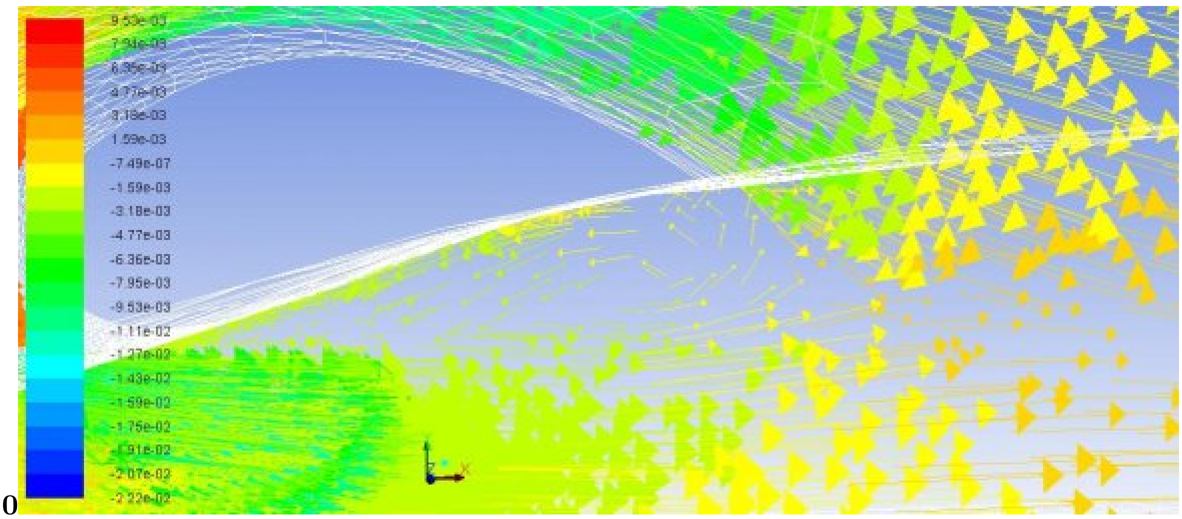
20 

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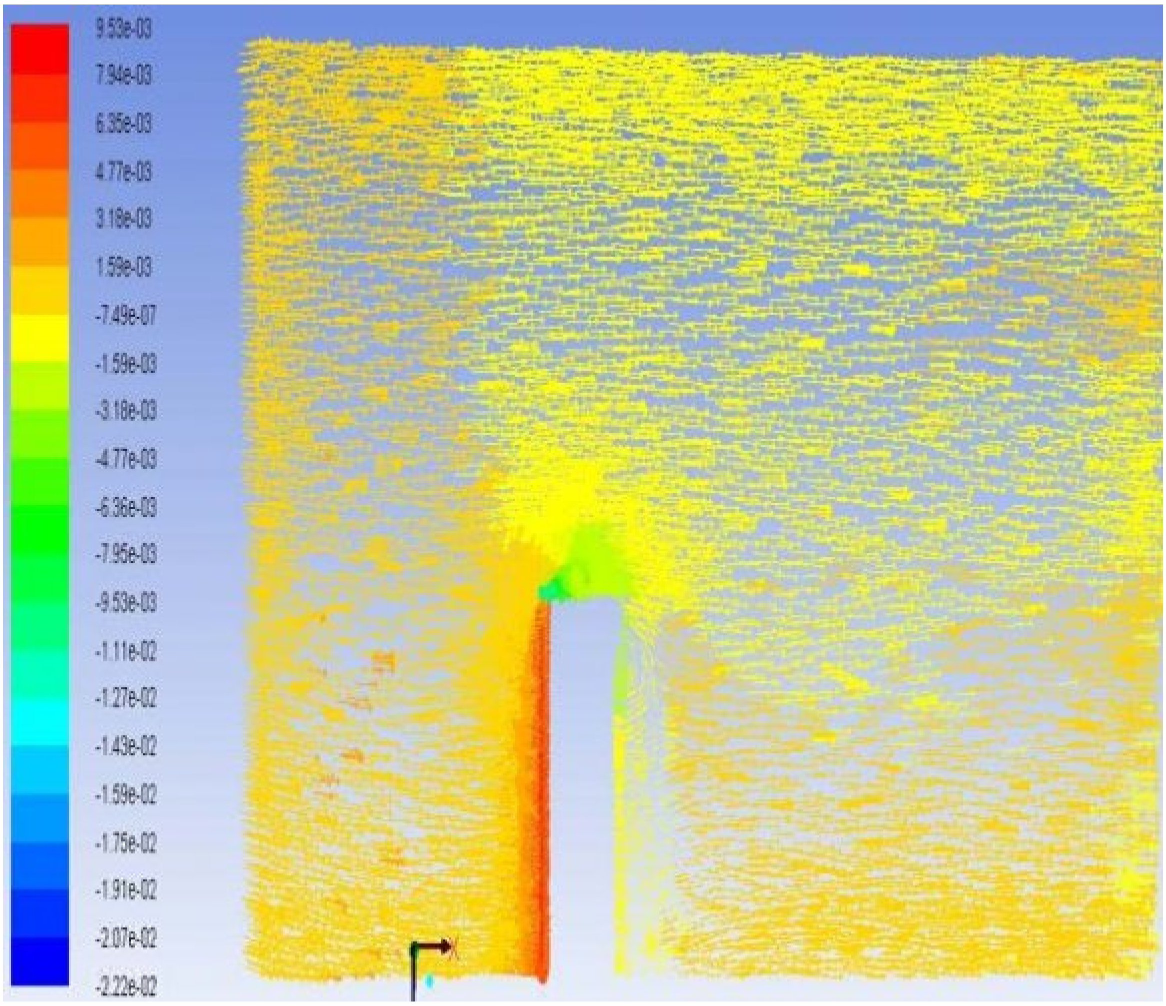
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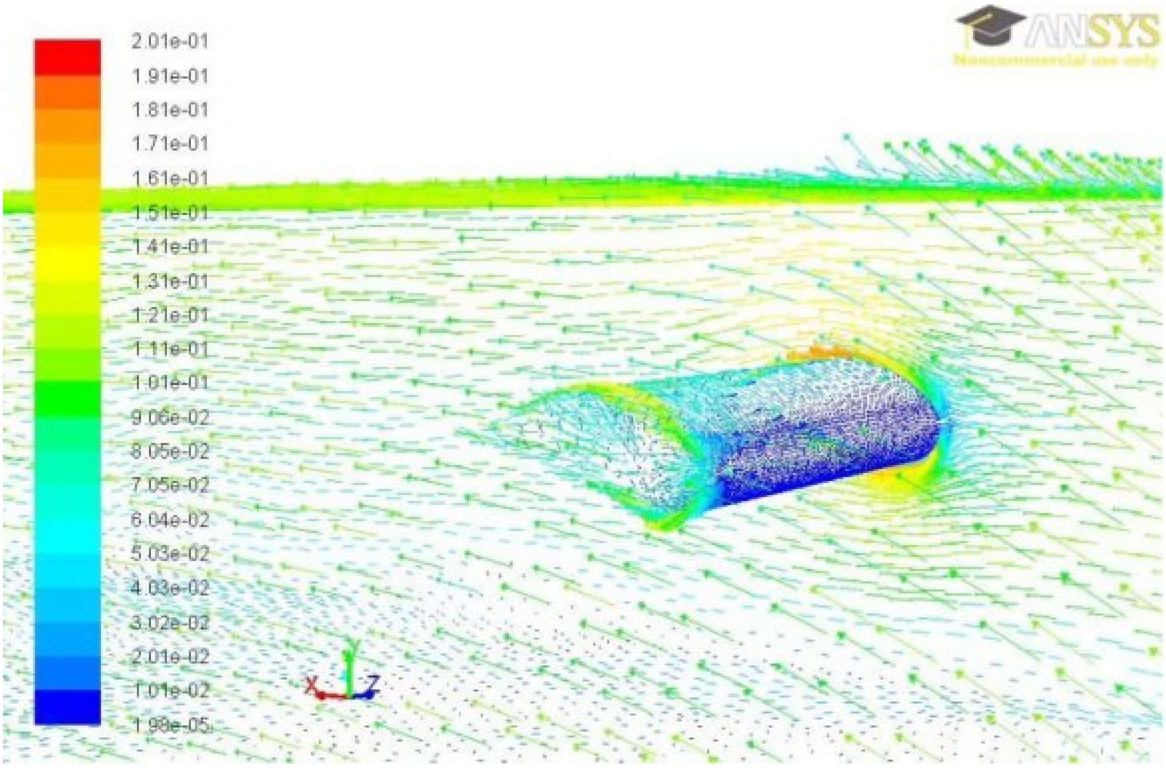

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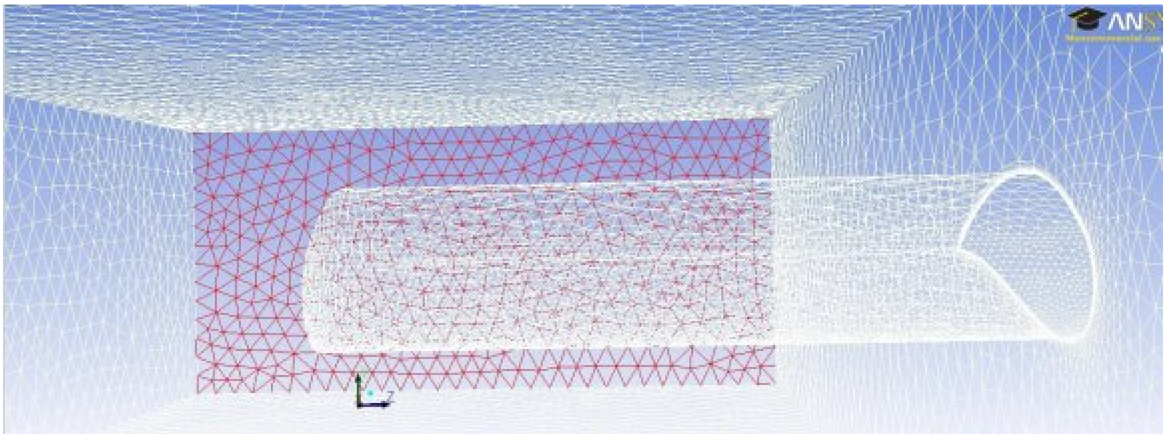

Figure 16:

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