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Extended Abstract

CFD Analysis of NACA 2421 Aerofoil at Several Angles of Attack

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ABSTRACT

In this paper NACA 2421 Aerofoil is analyzed at several angles of attack ranging from -200 to 200 and with the Reynolds number at 1.8×10^5 and the velocity are 20 m/s. The co-efficient of lift and drag are compared with the standard values in the literature. Variation of pressure co-efficient is plotted in the form of contour. The aerofoil is designed in ANSYS and it is imported to Computational Fluid Dynamics and the variations of CL and CD with respect to various angles of attack is analyzed.

Keywords:

Computational fluid dynamics; Aerofoil; Angle of attack; Stalling

INTRODUCTION

The NACA 2421 Aerofoil is designed for subsonic aircraft wings because of the better performance. Significance of improving a UAV performance can be done at very low Reynolds number 1.8 $\times 10^5$. Flow separation occurs normally due to very low inertia and very high viscosity. In general NACA 2421 Aerofoil generates more lift in subsonic speed

OBJECTIVE

As per the Bernoulli's principle if the pressure increases the velocity will decrease and vice versa. Due to this pressure difference the lift is generated. In this work the flow separation over NACA 2421 unsymmetrical airfoil is observed and steps are taken to increase the lift to drag ratio.

MATERIALS AND METHODS

SST turbulence model

Shear Stress Transport (k-ω) is used as a low turbulence model. It wills often the good behavior in adverse pressure gradients and separating the flow. It is used to predict the effect of turbulence.

CFD MODELLING AND MESHING

By using the geometry Modeler of Andy's Fluid Flow CFX, the imported co-ordinates are processed to prepare the model. Mesh generation is done by the polygonal mesh

PROBLEM DEFINITION

In this work the stalling region is analyzed and the various angles of attack are also analyzed. For all type of NACA series the lift to drag ratio is very important criteria for the Aircraft design. Here the lift to drag ratio, critical angles of attack and stall regions are analyzed over the NACA 2421 Aero foil with the various angles of attack.

BOUNDARY CONDITIONS AND INPUTS

The most fundamental part of CFD problem is to mention the boundary conditions. To conduct the simulation, the boundary condition of the problem some important conditions are needs to be considered as given below. Various Inputs and Values

- Analysis Type - Steady State,
- Fluid Velocity – 20 m/s,
- Fluid Density – 1 Bar,
- Mach Number – 1.8,
- Turbulence Model – SST,
- Fluid Viscosity – 1.8×10^5,
- Operating Temperature – 28°C

RESULT AND DISCUSSION

Basically if the angle of attack increases the lift is also increasing up to the certain limit. After the angle of attack reaches 15° the stalling and the critical angle of attack is starting. If the lift is increasing, simultaneously the drag is also increasing

CONCLUSIONS

- In all the cases up to the stalling angle if the lift is increases, simultaneously the drag is also increasing.
- The effective angle of attack is 70 to 140. Below 70

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- there is very low lift and after 140 stalling and the critical angle of attack is reached.
- At the angle of attack is at 50 the pressure is 2.452 × 10002 at the top and -4.735 × 10002 Pascal at the bottom.
- At the angle of attack of 150 the pressure is 2.46 × 10002 Pascal at the top and -6.159 × 10002 Pascal at the bottom.
- The flow separation will affect the generation of lift in the Aerofoil section.

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