CFD Analysis Of 2-Dimensional Incompressible Viscous Flow over Aerofoil section

Author:Jagadeesh.YJ Assistant Professor,

Dept.Of Mechanical Engineering, Visvesvaraya Technological University-BELGAUM

*BMS INSTITUTE OF TECHNOLOGY & Managament,*AVALAHALLI,

Post Box No:6443,Doddaballapura Main Road,BANGALORE-560064

Jagadeeshyj@yahoo.co.in

Abstract—In this paper the governing equations are discretised and the variation of flow is computed by using the commercial CFD software. CFD advantage of is used to determine the flow over aerofoil section. The present work shows the prediction of flow pattern and surface pressure distribution. The angle of attack taken is -8 deg. The stagnation point is observed when the flow hits the aerofoil section at leading edge and.On the surface of blade the flow remains attached and stalling condition is observed

Key Words— discretised, CFD,aerofoil blade, ,surface pressure.

1. Introduction

Due to the development in the CAD/CAE technology, now it is possible to analyse the fluid flow problem, in general any engineering problems. Now a days the CFD approach is becoming popular has come in this way. In the present work of flow analysis is obtained with commercial software. Flow over aerofoil section is analysed.Initially the geometry is created and then the fluid domain is discretized by mesh. In the solver and postprocessor its solutions and result are obtained. Basically a theory of CFDand new software tool are applied. This technique may be used for designing of any fluid equipment by using the advantage of CAE.

These phenomena are governed by set of partial differential equations which in most cases have no analytical solution. In addition to the governing equations, we also need the boundary and initial conditions, material properties, and geometrical details in order to completely describe the problem.

2. GOVERNING EQUATIONS AND NUMERICAL PROCEDURE

2.1Continuity equation

Physical principle:- Law of conservation of mass.

$$\frac{\partial}{\partial t}\iiint_{\upsilon}\rho \, \mathrm{d}\upsilon + \iint_{S}\rho \, \mathrm{V}\mathrm{dS} = 0$$

2. 2 Momentum equation

Physical principle: - Newton’s second law (F=ma)

$$\frac{\partial(\rho u)}{\partial t} + \nabla.(\rho u V) = -\frac{\partial p}{\partial x} + \frac{\partial \tau_{xx}}{\partial x} + \frac{\partial \tau_{yx}}{\partial y} + \frac{\partial \tau_{zx}}{\partial z} + \rho f_{x}$$

$$\frac{\partial(\rho v)}{\partial t} + \nabla.(\rho v V) = -\frac{\partial p}{\partial y} + \frac{\partial \tau_{xy}}{\partial x} + \frac{\partial \tau_{yy}}{\partial y} + \frac{\partial \tau_{zy}}{\partial z} + \rho f_{y}$$

$$\frac{\partial(\rho w)}{\partial t} + \nabla.(\rho w V) = -\frac{\partial p}{\partial z} + \frac{\partial \tau_{xz}}{\partial x} + \frac{\partial \tau_{yz}}{\partial y} + \frac{\partial \tau_{zz}}{\partial z} + \rho$$

Equations are the momentum equations in x, y and z direction respectively in conservation form.

$$\rho\frac{Du}{Dt} = -\frac{\partial p}{\partial x +}\frac{\partial \tau_{xx}}{\partial x} + \frac{\partial \tau_{yx}}{\partial y} + \frac{\partial \tau_{zx}}{\partial z} + \rho f_{x}$$

$$\rho\frac{Dv}{Dt} = -\frac{\partial p}{\partial y +}\frac{\partial \tau_{xy}}{\partial x} + \frac{\partial \tau_{yy}}{\partial y} + \frac{\partial \tau_{zy}}{\partial z} + \rho f_{y}$$

$$\rho\frac{Dw}{Dt} = -\frac{\partial p}{\partial z +}\frac{\partial \tau_{xz}}{\partial x} + \frac{\partial \tau_{yz}}{\partial y} + \frac{\partial \tau_{zz}}{\partial z} + \rho f_{z}$$

2.3 Discretisation methods

The discretisation methods i.e. the numerical methods for solving PDEs include the finite difference methods (FDM), and the finite volume method (FVM) is used.

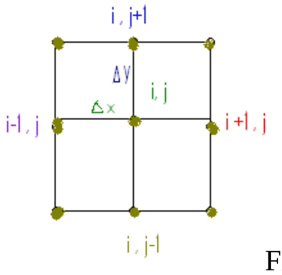

Fig-2.3.1. Mesh Grid

2.4Geometry mesh

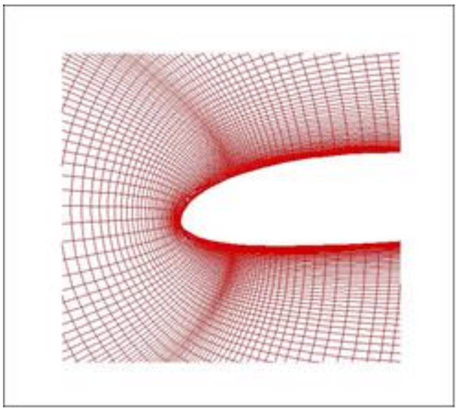

Fig.2.4.1Numerical Grid used for simulation of flow past aerofoil. [O-topology with 320x100 control volumes divided in two blocks]

3.RESULT

he particle traces are shown. We got the negative loops for the negative angle of attack for the aero foil section in the Cp variation.

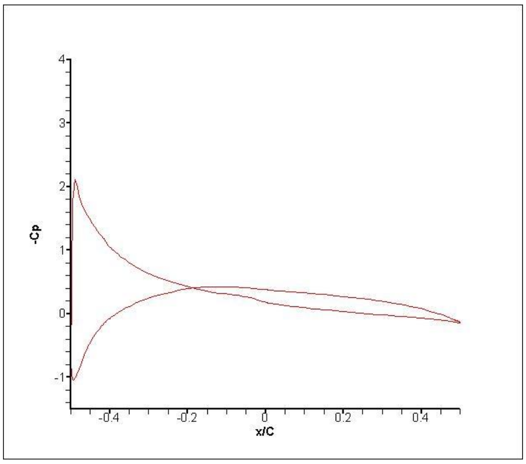

Fig.3.1Surface Pressureα= -8^0

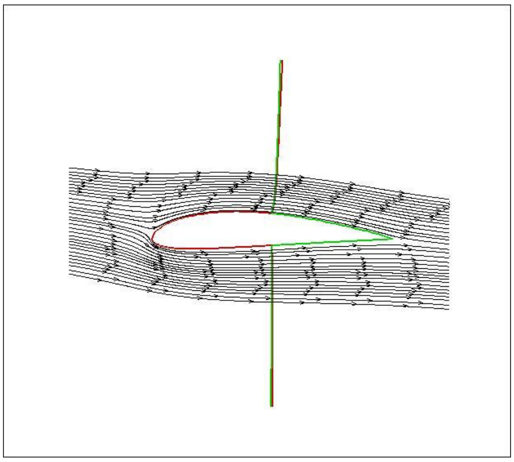

Fig.3.2.Particle traces

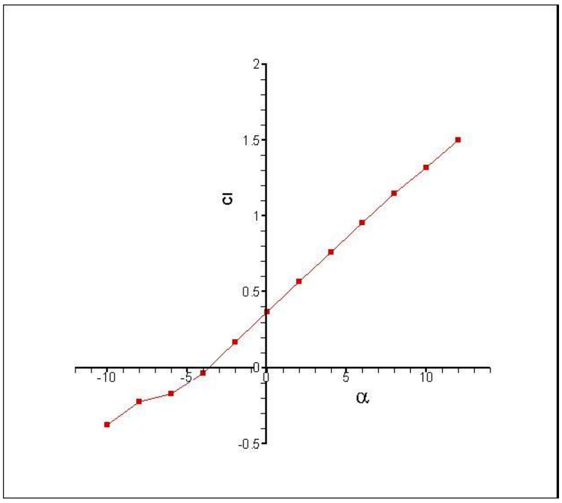

Fig.3.3.Lift Coefficient Cl with α -variation

4.CONCLUSION

From the literature we know that there will be no such loop formation for the positive angle of attack. There is negative loop formation has been observed for the negative angle of attack.Further for some more angles of attack with different flow boundary conditionsinvestigations to be analysed to know more flow distribution**.**

Notations:
P-pressure
μ - viscosity
τ - viscous stress
U,V,W-free stream mean velocity
u’,v’,w’- instantaneous velocity
ρ – density
f- body forces

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