DESIGN OPTIMISATION AND PERFORMANCE ANALYSIS OF NACA 5 SERIES

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Abstract : This paper discusses about the Computational Analysis of NACA23012 and different parameters like Pressure contour, Velocity profile, Turbulence viscosity along with Streamline flow over NACA23012 2D Airfoil without any external surface like flaps slats and slots. NACA 23012 is a 5-digit NACA series having coefficient of lift 0.3. This Airfoil is analyzed by using Computational method with FLUENT in ANSYS software for Different Angle of attacks like -50, 00, 50, 70, 100,120, 16o. Analysis is carried out at a free stream velocity of 40m/s. The graphs between the performance parameters such as lift coefficient (cl) versus Alpha, lift coefficient Versus Drag Coefficient, Moment coefficient Versus Angle of attack and ci/cd versus Alpha which is the angle between chord line and free stream velocity vector has done using MATLAB and XFOIL software.

Keywords—- Pressure contour, Turbulence Viscosity, Velocity Profile, Streamline flow, Critical Reynolds Number (N Cri), Reynolds Number (Re), Angle of Attack (AOA**)**

I. INTRODUCTION

The difference between NACA 4 Digit and NACA 5 digit series is in Camber line and Numbering although they have same thickness envelope 5 digit series plays a major role in performance parameters. The Digits 23012 in NACA 23012 Signifies the airfoil as follows: -

I. DESIGN OF NACA23012 AIRFOIL: -

Coordinates of the airfoil has been taken from the available resources and from the literature review chord length and design prospective etc. are selected.

II. ANALYSIS OF NACA23012: -

A. Parameters Considered for Analysis: -

Inlet Velocity: - 40 m/s Temperature: - 273k
Fluid: - air (idea gas) Model: - Viscous- Laminar Density: - 1.225 kg/ m3

NACA23012 AT NEGATIVE AOA: -

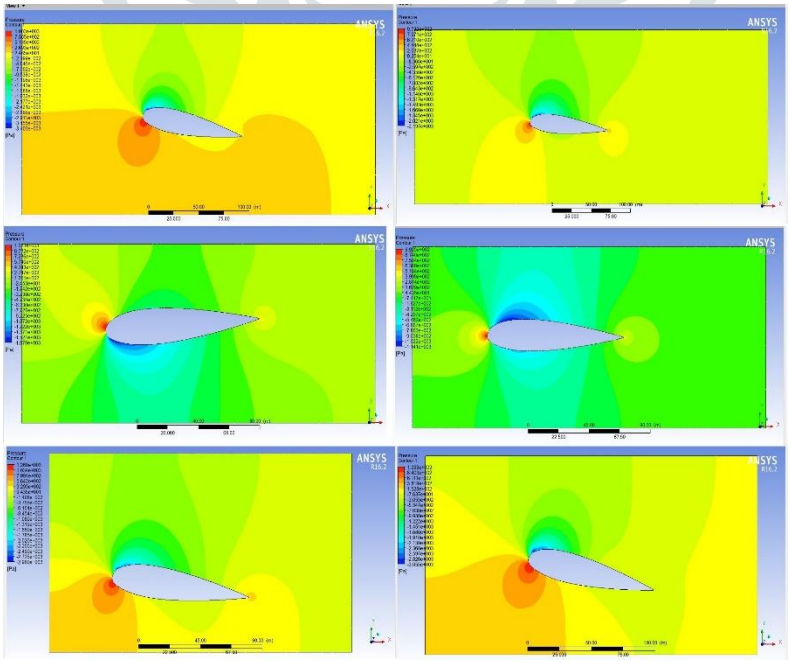


Figure I: Pressure Contour for different AOA (-5^o, 0^0, 5^0, 10^0, 12^0)

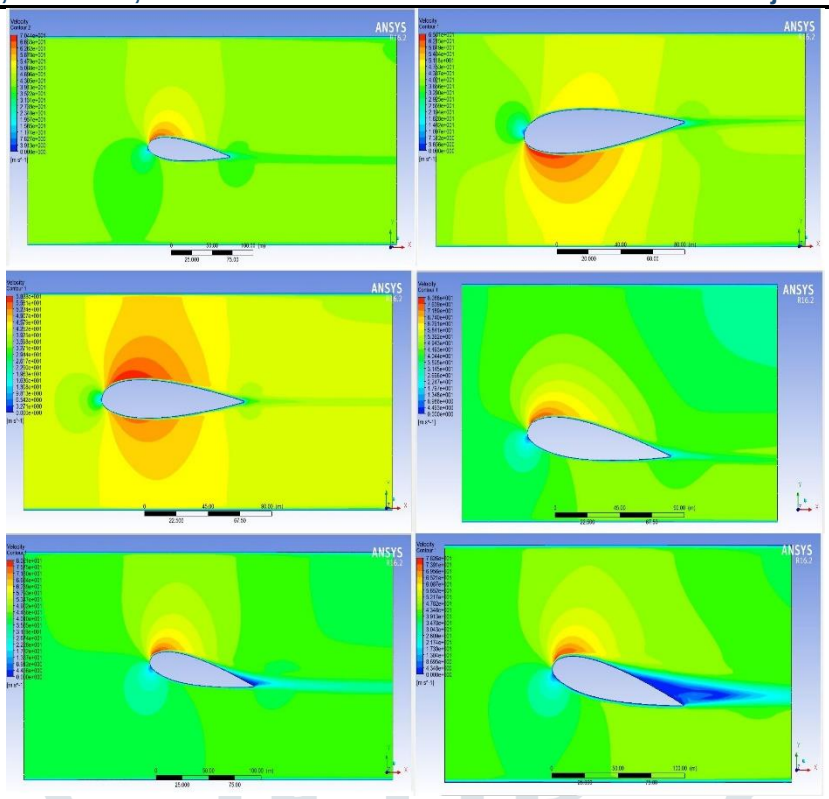


Figure II: Velocity Contour for different AOA (-5^{o}, 0^{0}, 5^{0}, 10^{0}, 12^{0})

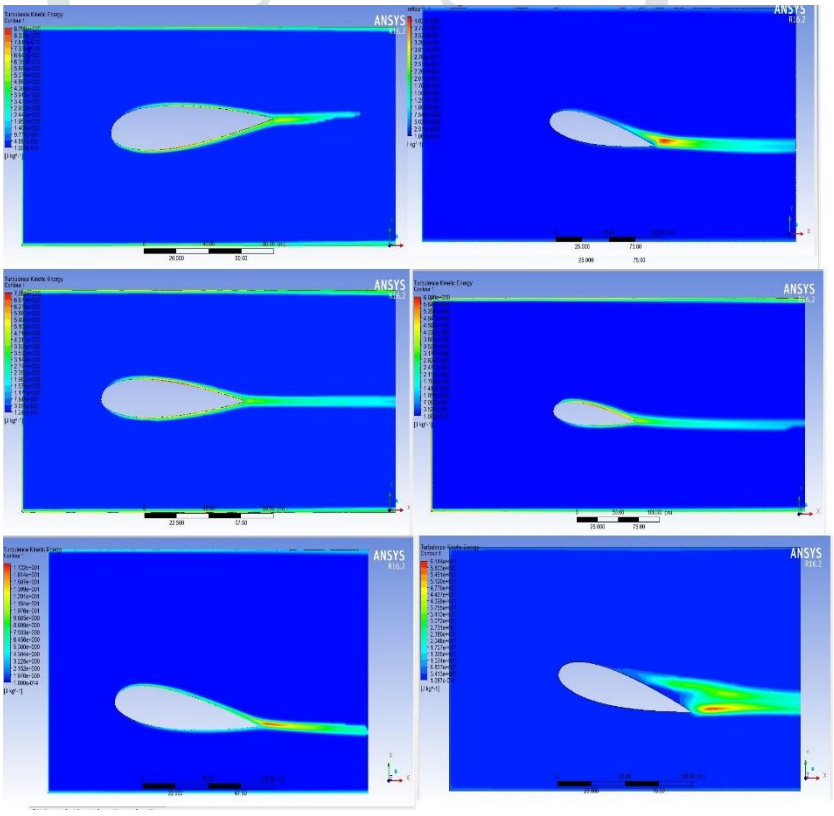


Figure III: Turbulence for different AOA (-5^{o}, 0^{0}, 5^{0}, 10^{0}, 12^{0})

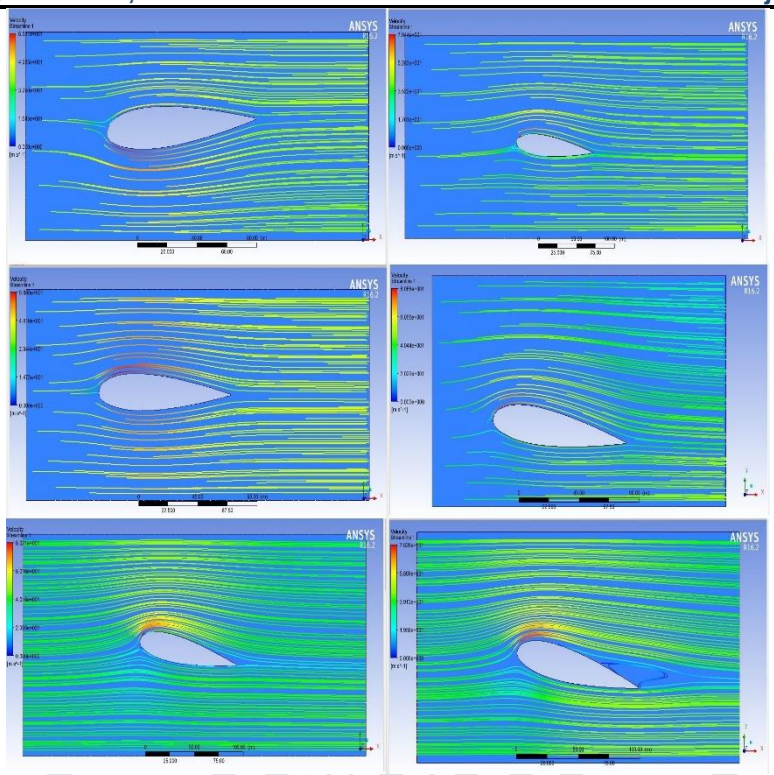
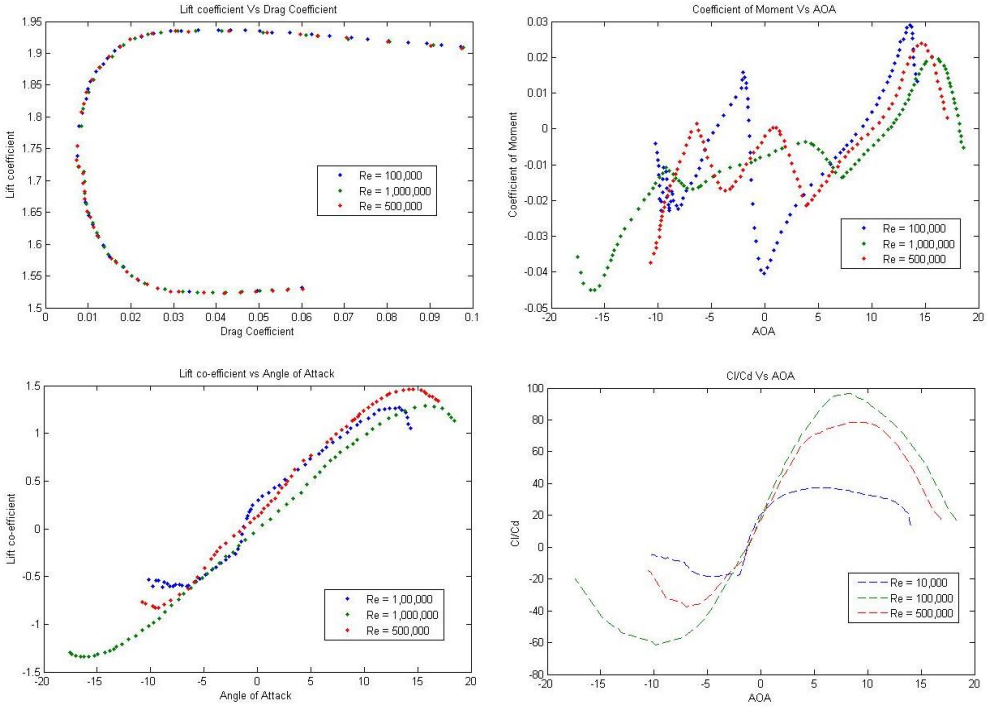


Figure II: Stream line flow for different AOA (-5º, 0^0, 5^0, 10^0, 12^0)

AOA	Minimum pressure (pa)	Maximum pressure (pa)	Minimum Velocity (m/s)	Maximum Velocity (m/s)
-5º	-1676.42	1023.532	2.008206	66.19709
0º	-1142.521	993.8486	2.880149	59.46346
5º	-2215.183	974.4504	2.409249	: 71.2171
7º	-2978.851	1270.298	3.442923	81.45344
10º	-3415.306	1003.428	0.5610691	84.271824
12º	-3069.742	1079.767	: 0.4757	81.740

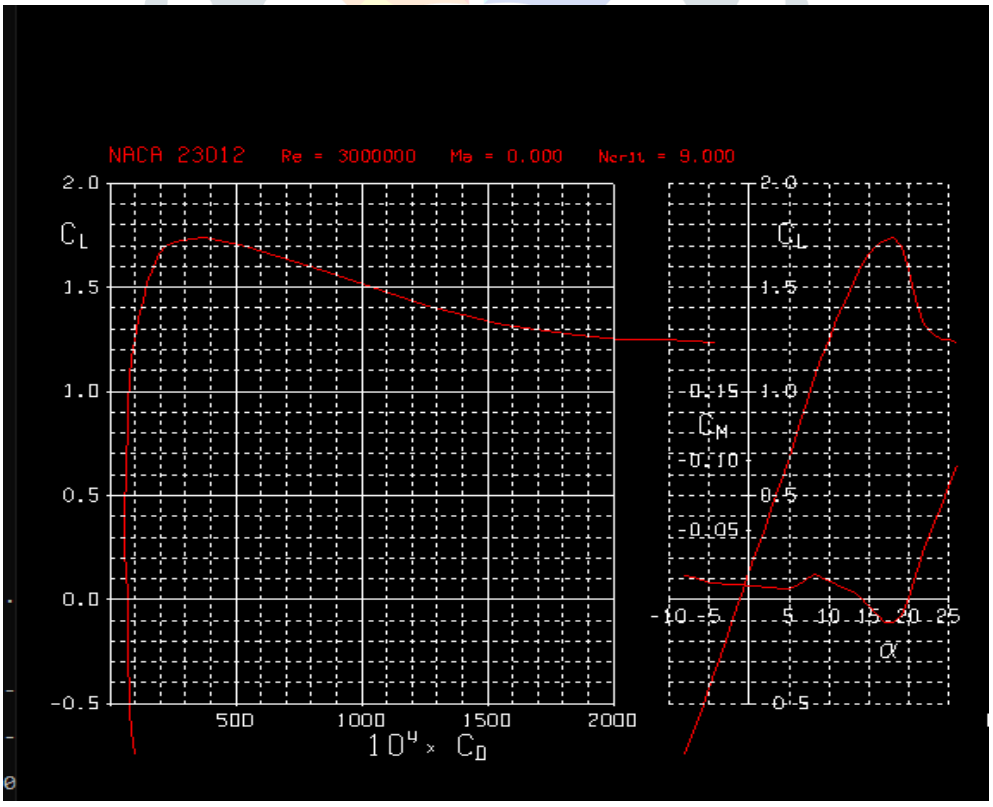
Table I: Different angle of attack pressure and velocity values

GRAPHICAL REPRESENTATION OF NACA 23012 PARAMETERS: -



Parameters:-

Viscosity = 3e6; re= 3000000**;** α= -8 to 26 ; Alpha min, max, delta = -10 25 5
CL min, max, delta= -0.5 2 0.5
CD min, max, delta = 0 0.2 0.05
-CM min, max, delta = -0.15 0 0.05
Stimulation has been carried in XFOIL software



Cl Vs Cd and Cl, Cm VS α

CONCLUSION: -

From the above stimulation of 2D NACA 23012 Airfoil it is concluded that the flow over Airfoil will gets separated around an Angle of attack between 12^{o} to 14^{0} And the level of turbulence increases with increasing the Angle of attack for larger angle of attack above 10 flow is getting separated and it can observed in the above CFD stimulation. In order to increase the

performance of the airfoil we can add external surfaces or high lifting devices such as flaps to increase the surface area of wind due to increase if surface area pressure difference will gets generated and results in high lifting force. For the Attachment of flow use slats and slots which help to keep the flow attached to the surface. If we add high lifting devices to the NACA23012 we can fly around an angle of attack 22^0 without getting effected by stall and the performance characteristics will be obtained with less fuel consumption which gives better efficiency as well as cost reliable.

V. REFERENCES: -

1. Anubhav Dasgupta, Vikash Kumar Nayak, Nityananda Nandi , "Numerical analysis of lift and drag characteristics of NACA 23012 airfoil with NACA 23012 external-airfoil flap", in

2. Douvi C. Eleni*, Tsavalos I. Athanasios and Margaris P. Dionissios, "Evaluation of the turbulence models for the simulation of the flow over a National Advisory Committee for Aeronautics (NACA) 0012 airfoil", in Journal of mechanical engineering.

3. Krishna Ganesan,Sai Gowtham J, "Study of effect of Gurney Flap on an inverted NACA 23012 Rear Wing", in International Journal of Engineering Research & Technology

4. Carl J. We zinger, "Pressure Distribution over an NACA 23012 airfoil with an NACA 23012 external airfoil flap NACA", in Annual Report of the National Advisory Committee for Aeronautics

5. Michael A. Cavanaugh, Paul Robertson, William H. Mason (2007), 'Wind Tunnel Test of Gurney Flaps and T-Strips on an NACA 23012 Wing' - AIAA Journal 4175

6. Muhammad Ferdous Raiyan, Mohammed Nasir, Uddin Akanda, "A COMPARATIVE FLOW ANALYSIS OF NACA 6409 AND NACA 4412 AEROFOIL" in " International Journal of Research in Engineering and Technology

7. Carr, L. W., "Progressin the Analysis and Prediction of Dynamic Stall," Journal of Aircraft, Vol. 25, No. 1, 1988, pp. 6–

8. McCroskey,W.J.,"UnsteadyAirfoils,"AnnualReview of FluidMechanics, Vol. 14, 1982, pp. 285–311.

9. Alrefai, M., and Acharya, M., "Controlled Leading-Edge Suction for Management of Unsteady Separation over Pitching Airfoils," AIAA Journal, Vol. 34, No. 11, 1996, pp. 2327–2336.

10. Karim, M. A., and Acharya, M., "Suppressionof Dynamic-Stall Vortices over Pitching Airfoils by Leading-Edge Suction," AIAA Journal, Vol. 32, No. 8, 1994, pp. 1647–1655.