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DESIGNING AND ANALYSIS OF HOMER NOZZLE USING ANSYS

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Abstract - *During the last decades the nozzle design has played a vital role in science and technological development. Nowadays, nozzle design have drawn enormous amount of attention from the designing engineers all over the world. They offer several advantages in the aerospace industries. In our project we designed and analysed HOMER (High speed orienting momentum with enhanced reversibility) nozzle. Homer nozzle consists of two inlets with different velocities. The reason for developing and analysing homer nozzle are we can attain the dynamic control of the deflection angle, it helps in thrust vectoring, short take-off and landing. Due to elimination of movable components in this design the need for lubrication and maintenance is reduced. We have carried out the designing using the CATIAV5 software. Then the geometry is analysed using ANSYS18.1. The nozzle outlet flow has been studied for various inlet velocities. This paper will summarize the importance of coanda surface in thrust vectoring.*

***Key Words*: HOMER, CATIA V5, ANSYS 18.1, Coanda and Thrust vectoring.**

1. INTRODUCTION

The eventual fate of the aviation field is predicated on the need to fulfil open and administrative need as far as expanded security and limit, diminished discharges and commotion, higher mobility and expanded adaptability of utilization, decreased time for movement and take off, and decreased landing space prerequisites. The ACHEON (Aerial Coanda High Efficiency Orienting plane Nozzle) is another propulsive engineering that means to satisfy the majority of these objectives. It characterizes a novel class of aviation vehicles, which are green, all electric, with improved manoeuvring capability, short takeoff, and landing. This framework has the capability of expanding the manoeuvrability of a high stream jet with a improved increment in performance. This project explains about a progressively efficient propulsion system. It plans to check how ACHEON can be executed inside the engineering of a conventional airplane and breaks down the advantages and the practicality of the framework.

1.1 Overview of HOMER nozzle

Commonly discussing there are two normal ways to deal with attaining thrust vectoring (TV), to be specific mechanical or fluidic frameworks. Right now HOMER nozzle presents a new age idea dependent on Coanda effect involving two mass co-stream streams. Though giving likenesses the fluidic approach, by not utilizing moving components, it is an alternate methodology as in two-mass centre streams are utilized, rather than an enormous primary and a little secondary fluid control flow. We will currently depict the structure wherein HOMER can be utilized for V/STOL applications. A recorded outline identified with airplane V/STOL innovation was introduced in the propulsion field. In the primary portion of the earlier century aircrafts have considered a to be accomplishment as flying vehicles. In this manner, it isn't weird to distinguish the first usage of thrust vector is to control.

The propellers which can tilt, utilized at first in aircrafts, it is proposed for aircraft, it brought about thrust due to the turboprop motor nacelles rotation. But, the mechanical multifaceted designs related with this arrangement have demonstrated to be very problematic. The cautious plan should consider movements due to adaptable, twisting shafts, also the impacts of gyroscope. The fighter airplanes in Europe have been utilizing this innovation. An alternate methodology, ready for short take-off and landing, depends on nozzle design. The utilization of the mechanically arranged nozzle is to redirect all the fluid flow. It was progress full, and ready to achieve changes in angle above or below the normal axis till 90 degrees, to use an engine to achieve take off vertically rather than least ordinary propulsion as it were.

2. Methodology

The design of the 2D HOMER nozzle is carried out in CATIA V5 software. The design consists of two inlets which are separated by a central septum with a single outlet through the coanda surface. The HOMER nozzle inlets are of 56cm in length. The radius R of the coanda surface is 58cm. The curved part in the HOMER nozzle is called as coanda surface. The septum is of 40cm in length. The septum is drawn by using the arc length of R144 mm. The origin of the septum is placed 56 mm above the inlet and from there a horizontal and vertical lines are drawn with the measurements of 94mm and 20mm respectively. The nozzle is symmetrical with the axis line. The one side of the nozzle is drawn using the line tool, circle tool and the other side is mirrored to the centre axis line using the mirror tool in CATIAV5.

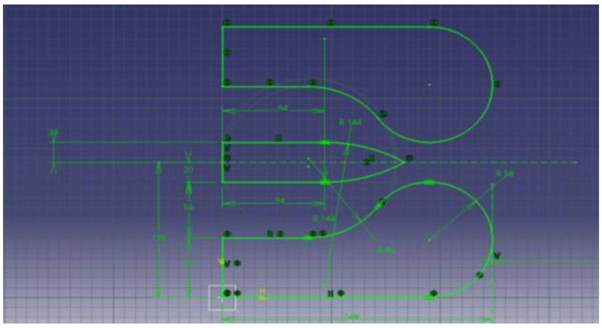

Fig -1: Design of HOMER nozzle with dimensions

The HOMER nozzle is designed with a domain which is in the shape of a semi circle with radius R 800cm. The flow with the specified parameters flows only inside the domain. The semi circle is drawn using a circle tool and it is connected with the nozzle by the lines. The inlets are closed so that the flow passes through the inlets. The dimension of the domain is much greater than the size of the nozzle so that the boundary of the domain does not affect the nozzle. The design is then converted to a surface by using the shape tool. The surface is created in case of a closed surface.

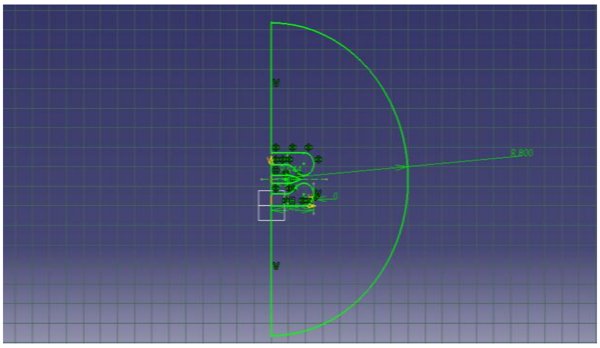

Fig -2: HOMER nozzle with domain

After completing the 2D design in the CATIA V5 and forming into a surface. ANSYS18.1 is opened with the fluent flow. The geometry is opened with the design modeller. The 2D design is then imported to the ANSYS18.1 software in the XY axis. Once the geometry is imported it is updated. The tick mark in the fluent flow box allows us to mesh the imported geometry.

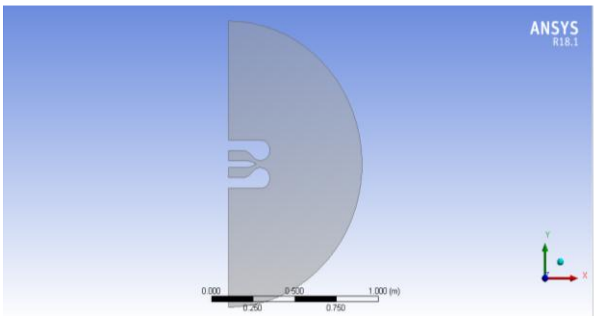

Fig -3: Imported geometry in ANSYS

The meshing tool automatically meshes the given geometry. The mesh method is changed to all triangles method by clicking on mesh icon and choosing insert option. Under insert various options are displayed from the various method displayed all triangles has been choosen. The geometry is then named by right clicking on the mesh icon on the left side. Then the sections were named accordingly such as inlet1, inlet2, wall, Pressure far field. The fine meshing is done and the below image represents the detailed view of the mesh.

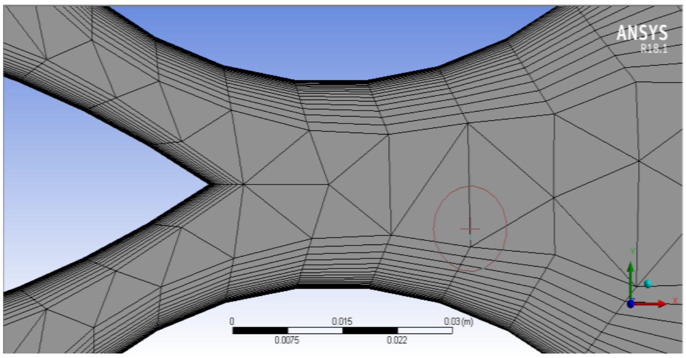

Fig - 4: Detailed image of the mesh

An inflation of 20 layers is inserted by right clicking on the mesh icon the insert option has been choosen and under the insert icon inflation has been choosed. Further,the mesh has been updated and then the maximum layers has been altered to 20 layers. The grid independence study has been done to analyse the cells. The cells near the surface has been analysed .The other cells which are located farer from the nozzles wall is not considered. This is because those cells which are away from the wall surface of the nozzle are not greatly influenced by the analysis.

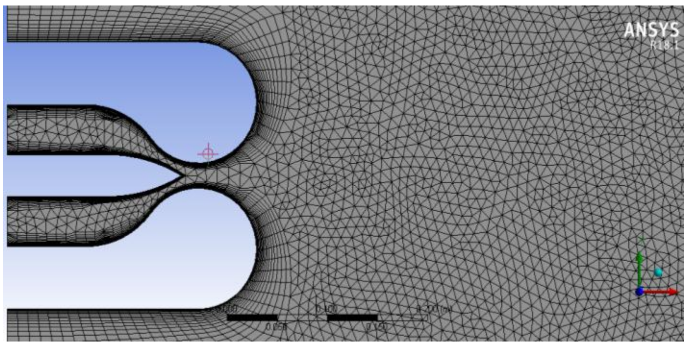

Fig -5: Computational mesh overview

Once the meshing is completed, the geometry has been updated to the setup stage. The pressure based solver has been chosen. Planar is selected for 2D space. Under the models in the viscous has been chosen. In the viscous dialogue box Realizable k-epsilon(2 eqn) model is chosen . In the near- wall treatment, standard wall function is chosen. In materials air is selected. The boundary condition is specified as mass flow rate for both the inlets. In the solution methods scheme has been opted to SIMPLEC. Pressure, momentum, turbulent kinetic energy and turbulent dissipation rate are in second order. Least square cell based gradient is chosen. Then the initialization process is done. The 1000 iterations have been applied for the computation process. Once the solution is converged the results are obtained.

3. RESULT AND DISSCUSSION

The pressure contours and the velocity contours are analyzed at the outlet of the nozzle section. The images of the pressure contour and velocity contour is listed below.

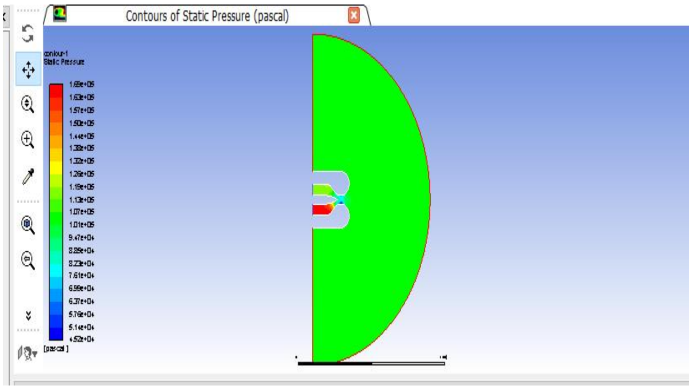

Fig -6: Pressure contour

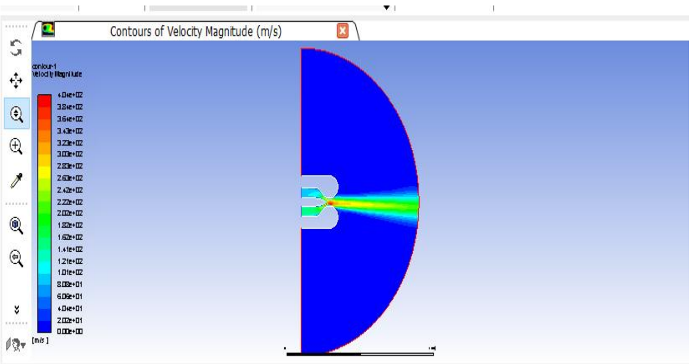

Fig -7: velocity contour

By referring the results of the simulation and the contour results, there is an increase in the deflection angle with the increase in the velocity. This happens because the pressure at the top of the nozzles wall is increased.

There is an increase in the pressure because of the flow separation and due to the formation of vortices. Further the direction of deflection has been measured for various velocities. The two inlets have been fed with two different velocities. It is found that the inlet with the greater velocity is prone to be deflected. If the inlet 1 has higher velocity than inlet 2 then the direction of deflection is towards inlet 1. By varying the inlet velocities the thrust vectoring is attained on the desired direction.

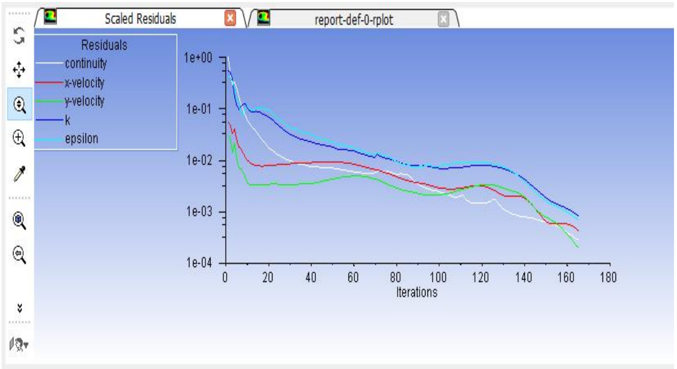

Fig - 8: Graphical Representation of Velocities

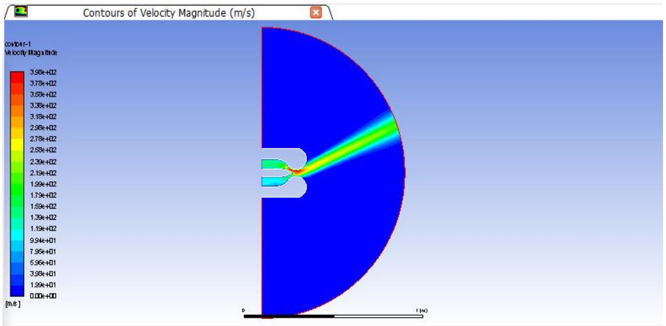

Fig - 9: Velocities (150 m/s and 100 m/s)
Direction of deflection: Upwards

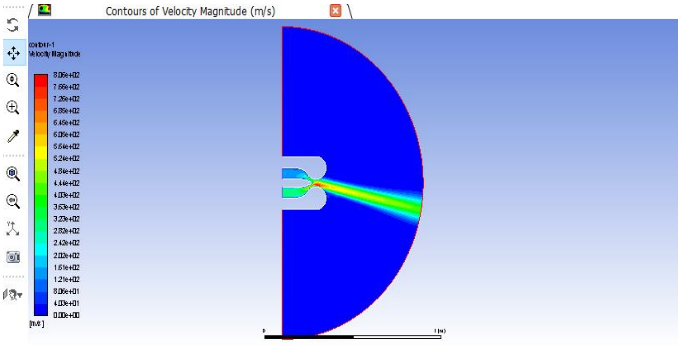

Fig - 10: Velocities (100 m/s and 150 m/s)
Direction of deflection: downwards

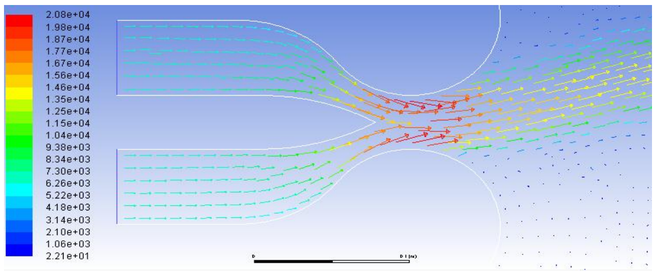

Fig -11: Velocity vector image

Further various inlet velocities have been analysed and the direction of the deflection is found and the results are tabulated below.

Table -1: Direction of deflection

INLET -1 Velocity m/s	INLET -2 Velocity m/s	Direction of deflection
150	100	Upwards
100	150	Downwards
250	200	Upwards
200	250	Downwards
550	500	Upwards
500	550	Downwards

3. CONCLUSION

This analysis has proved to be useful in relation to the application of the HOMER nozzle in thrust vectoring. This work is purely based on the principle of Coanda effect. By employing this principle for the design of the propulsion system is technically feasible. With reference to the results it is clear that there are several parameters which affect the thrust vectoring of the aircraft. The deflection angle is not only affected by the inlet velocities but also by the mass-flow rate. The height of the central septum from the nozzle wall also influences the flow deflection. The reason for choosing HOMER nozzle for thrust vectoring is because it eliminates the usage of movable elements. Since the usage of the movable elements were rejected in this propulsion system the maintenance and need for lubrication is reduced.

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REFERENCES

[1] ACHEON, "Acheon project," 2013. [Online]. Available: http://acheon.eu/project/.

[2] L. N. Cattafesta III, M. Sheplak: Actuators for Active Flow Control. Annual Review of Fluid Mechanics, 43(2011), 247-272.

[3] M. Gad-El-Hak, Flow Control: Passive, Active, and Reactive Flow Management. New York: CambridgeUniversity Press, 2000.

[4] Thomas C. Corke, C. Lon Enloe, Stephen P. Wilkinson: Dielectric Barrier Discharge Plasma Actuators for Flow Control. Annu. Rev. Fluid Mech., 42(2010), 505–29.

[5] D Caruana : Plasmas for aerodynamic control. Plasma Phys. Control. Fusion, 52(2010), 124045.

[6] G. Touchard: Plasma actuators for aeronautics applications - State of art review-. International Journal of Plasma Environmental Science and Technology, 2(2008).

[7] R. Hanson, P. Lavoie, A. Naguib, J. Morrison: Transient growth instability cancellation by a plasma actuator array. Experiments in Fluids, 49(2010)1339–1348.

[8] T. Corke, M. Post, D. Orlov : SDBD plasma enhanced aerodynamics: concepts, optimization and applications. Progress in Aerospace Sciences,43(2007)212–217.

[9] D. M. Orlov, T. Apker, C. He, H. Othman, T.C. Corke : Modeling and Experiment of Leading Edge Separation Control Using SDBD Plasma Actuators. in AIAA 45th Aerospace Sciences Meeting AIAA paper No. 2007–0877, Reno, Nevada, 8–11 January 2007.

[10] D. M. Orlov: Modeling and simulation of single dielectric barrier discharge plasma actuators. University of Notre Dame, Ph.D. thesis 2006.

[11] S. Lemire, H.D. Vo: Reduction of fan and compressor wake defect using plasma actuation for tonal noise reduction. Journal of Turbomachinery, 133(2011)

[12] S. Grundmann, M. Frey, C. Tropea: Unmanned aerial vehicle (UAV) with plasma actuators for separation control. In 47th AIAA Aerospace Sciences Meeting Including the New Horizons Forum and Aerospace Exposition in Orlando Florida, 2009, p. 698.

[13] F. Thomas, A. Kozlov, T. Corke : Plasma actuators for cylinder flow control and noise reduction. AIAA Journal, 46(2008), 1921–1931.

[14] Monique M. Hollick, Maziar Arjomandi, Benjamin S. Cazzolato:An investigation into the sensory application of DBD plasma actuators for pressure measurement. Sensors and Actuators A, 171(2011), 102–108.

[15] Huang, T.C. Corke, and F.O. Thomas: Unsteady Plasma Actuators for Separation Control of Low-PressureTurbine Blades. AIAA Journal, 44(2006), 1477–1487.

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