CFD Analysis of Mixer Ejector

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Abstract- *An ejector is a fluid dynamic pump with no moving parts. Traditional ejector designs use viscous forces to transfer energy from a high velocity primary stream to a lower energy secondary stream. The resulting exhaust jet has a higher flow rate and a lower velocity than the original primary flow. This paper deals with flow behavior of ejector at subsonic condition at one and two secondary inlets. The main objective of this paper is to analyses behavior of flow in an ejector by using ANSYS FLUENT. This process carried out at 1.1bar as pressure inlet The behavior of flow analyzed in both cases. This analysis gives pressure and velocity contours along the length of ejector .along with centerline pressure and velocity distributions.*

Keywords- An ejector, ANSYS FLUENT, contours, velocity, centerline pressure ,primary stream ,secondary stream

I. INTRODUCTION

Ejectors are gas dynamic devices, contain a nozzle in variable area duct Its primary use is to induce a secondary fluid by converting momentum and energy from high-velocity flow through primary nozzles. It essentially consists of nozzles, converging section, mixing chamber and diffuser. The simplicity in construction makes it suitable for many application. Conventionally ejectors have found use in thrust augmentation, refrigeration , fuel recirculation in fuel cells, to list a few useful applications in waste heat recovery, high altitude simulation facility Keenan and Neumann [1] have explained the basic concept of ejector based on 1-D analytical approach. BJ Huang et al [2] explained the effect of back pressure on the entrainment ratio. It is found that the ejector performs better at critical mode in order to obtain a better efficiency. A critical mode in ejector is obtained when the primary and entrained flow is choked and entrainment ratio becomes constant. At sub critical mode only primary flow is choked and entrainment ratio by changing back pressure. T Sriveerakul [3] in his paper has explained the ejector performance by varying the primary fluid properties flow using numerical modeling by using commercial codeFluent with various turbulence models and compared the results with the experiments. S Guru lingam [5] has also used numerical method to determine performance of ejector using irreversibility characteristics. He increased the efficiency of ejector by reducing the losses based on minimization of entropy method. This is achieved by forcing the propelled steam through a blower. Jocob Kenneth Cornman [6] has published the CFD optimization of small gas ejectors used in navy diving system. Optimization of small gas ejector is typically carried out by selecting single set of operating conditions and optimizing the geometry for the specified condition. Pierre van Eeden et al [7] have derived the correlation for ejector efficiency with an accuracy of ±2% using commercial CFD simulation software. The objectives of present study is to predict the behaviour of flow and mixing process in the ejector of the gas turbine engine ground test bed using with and without debris guard in the ejector. The CFD analysis has been carried outusing a commercial CFD package ANSYS FLUENT [8]. The entrainment ratio and pressure drop across the debris guardof the ejector with varying back pressure of ejector has been determined low.

II. EJECTORCONFIGURATION

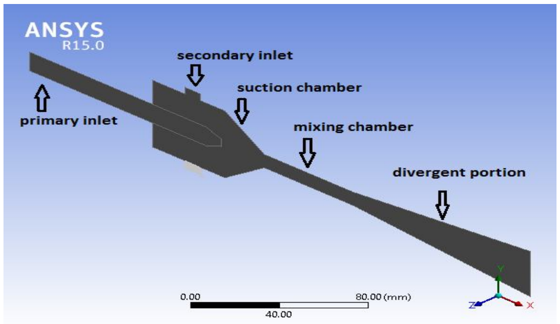

Fig :1 ejector with single secondary inlet in ansys design modler

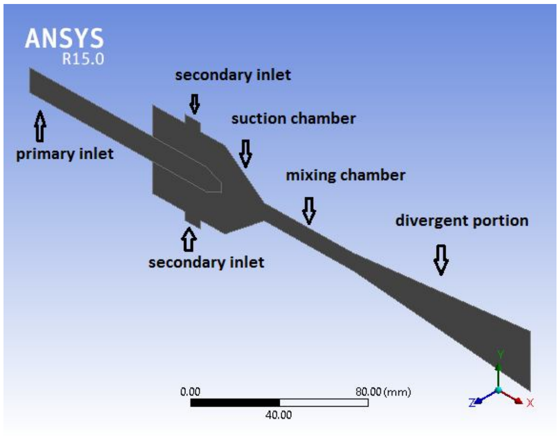

Fig : 2 ejector with double secondary inlet in ansys design modler

The ejector have suction chamber, mixing duct , divergent portion, primary flow inlet, for passage of secondary flow orifices made on suction chamber. Inside suction chamber, convergent nozzle adjusted in such way that primary fluid and secondary fluids have to mix each other .the mixing process takes place in mixing duct . the mixture comes out from divergent portion by building up pressure create a table or text box and place the “Author and Affiliation” information horizontally.

III. BOUNDARY CONDITIONS

The boundary conditions used for the ejector configuration are as follow:-

Primary inlet: Total pressure and supersonic gauge pressure is specified at the primary inlet ,along with total temperature and hydraulic diameter

Secondary inlet: Total pressure and supersonic gauge pressure is specified at the secondary inlet along with total temperature and hydraulic diameter

Outlet: Static pressure and temperature are specified at the outlet of ejector.

Wall: All faces enclosing the flow are defined as walls. Adiabatic no-slip boundary condition has been appliedThe computations for the fluid flow in the ejector were performed using the commercial solver ANSYS FLUENT 15. A 2-Dimensional compressible N-S equation mode of computer code has been used. Realizable k-turbulence model combined with standard wall function has been chosen. The grid has been chosen based on the grid independence studies performed The fluid is considered to be compressible. To reduce the numerical errors, a second order volume discretization scheme was used. The SIMPLE algorithm was used for pressure-velocity coupling in the computations. All predicted quantities were steady state. The minimum convergence criteria for the continuity equation, velocity and turbulence quantities are 10–6. The outlet pressures as well as the mass flow rate at the outlet of the ejector section were given carefully.

IV. SOLUTION INTIALIZATION AND RUN CALCULATION

Do A rake of 200 points formed in order to plot center- line pressure distribution and velocity distribution along ejector curves

In cell zone conditions set as default and then solution is initialized .while entering run calculations 500 iteration were given .after executing iteration solution is completed

V. RESULTS AND DISCUSSIONS

Case1:

The ejector analyses have been carried out for a fixed primary and secondary inlet pressure at 1.1 bar when single secondary inlet open the contours of pressure and velocity displayed

From pressure contours pressure is uniform at primary inlet in suction chamber pressure decreases simultaneously velocity increases so due to low pressure atmospheric air drawn and mixed with primary flow and then pressure rises

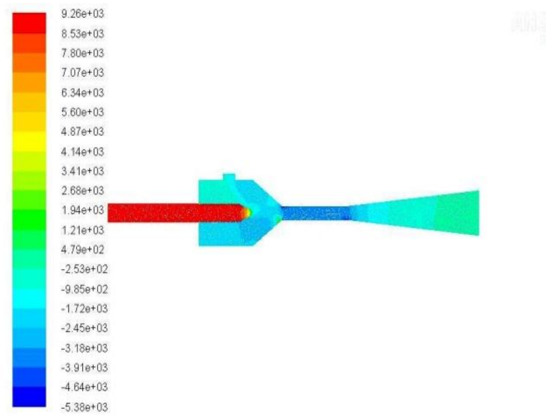

Fig 3: Pressure contours of ejector with single secondary inlet

Velocity contours revels that primary flow is not effectively mixed with secondary flow, just primary flow takes away the secondary flow

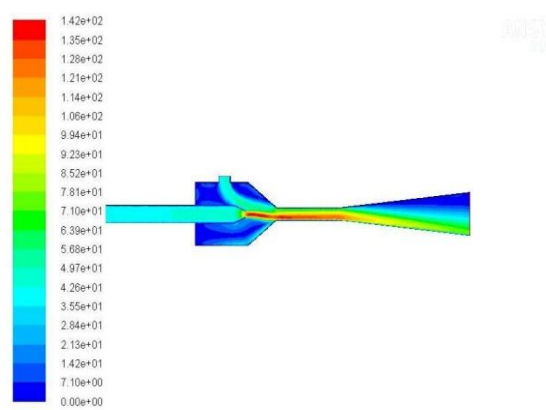

Fig 4: Velocity contours of ejector with single secondary inlet

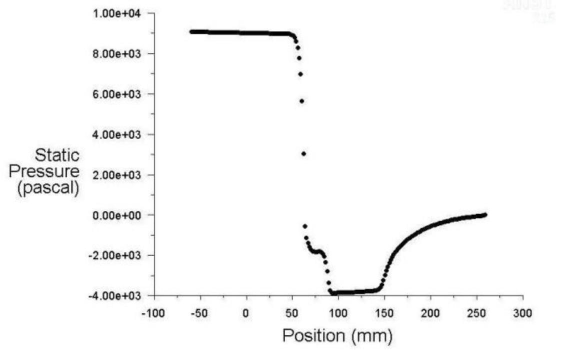

Fig5: Centre line Pressure distribution of single secondary inlet ejector

Center line pressure distribution curve shows that pressure drops after nozzle and remains constant in mixing chamber and then gradually increases

Case2:

The same ejector with two secondary inlets opened primary and secondary flows shows profiles of contour as shown below

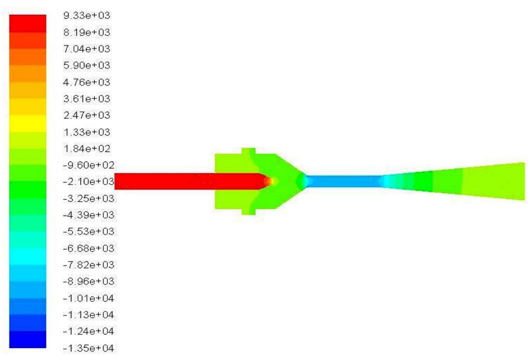

Fig 6: Pressure contours of ejector with double secondary inlet

Pressure of contours indicates that low pressure created at suction chamber and pressure built ups in divergent effectively

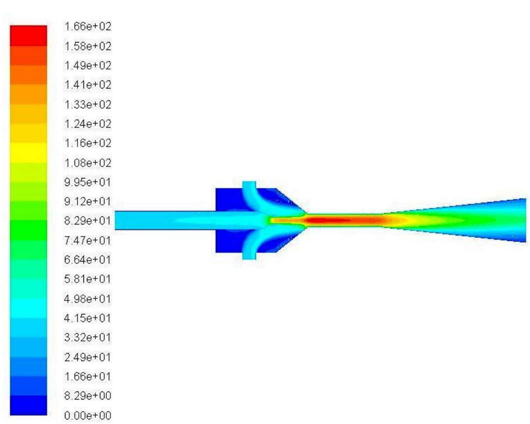

Fig 7: Velocity contours of ejector with double secondary inlet

Velocity contours reveals that primary and secondary streams mixing takes place effectively .velocity high at nozzle exit and then decreases

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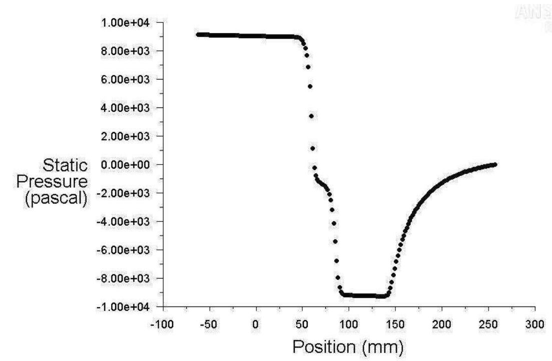

Fig8: Centre line Pressure distribution of single secondary inlet ejector

Above Centre line Pressure distribution curve shows that in primary inlet pressure constant and then pressure drop lower than first case in mixing chamber . Naturally pressure rises to atmospheric pressure at ejector exit.

VI. CONCLUSION

From above results comparing pressure contours in both cases pressure drops more in ejector with two secondary inlets, results better mixing. From velocity contours it can be noted that in single secondary inlet ejector primary flow takes away secondary flow like a layers without mixing to better extent where as in ejector with double secondary inlet since from two sides secondary fluid coming that mix with primary stream better than first one. This is also indicating by centerline pressure distribution. From fig and fig low pressure obtained in double secondary inlet ejector where better mixing takes place in order to increase performance of ejector. Hence it can be conclude that ejector with double secondary passage is efficient than ejector with single secondary inlet.

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