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CFD Analysis of Annular Curved Diffuser

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ABSTRACT

In this thesis the characteristics of flow within a circular cross sectioned annular curved diffuser is investigated at different mass flow rates and divergence angles. The divergence angles considered are 9^0, 15^0, 21^0, 27^0, 33^0, 39^0. CFD analysis is done all the diffuser models by changing mass flow rates 0.02259Kg/s, 0.04518Kg/s & 0.09036Kg/s to determine static pressure, velocity, pressure coefficient and turbulent kinetic energy. 3D modeling of the annular curved diffuser models are done in Creo 2.0. CFD analysis is be done in Ansys 14.5 to determine the flow characteristics.

I.INTRODUCTION

Diffusers are employed in several engineering application for decclerating the flow or for converting dynamic pressure into static pressure. Reckoning on application, they need been designed in many alternative shapes and sizes. The annular curved diffuser is one amongst such style and is an important element in several fluid handling systems. Annular diffusers are an integral element of the turbine engines of high-speed craft. It facilitates effective operation of the combustor by reducing the full pressure loss. The performance characteristics of those diffusers depend upon their geometry & inlet conditions. Half flip or curved diffusers are employed in wind tunnels, air-con & ventilation ducting systems, draft tubes, plumes, compressor crossover, etc.

II.LITERATURE SURVEY

P. K. Sinha[1], The distribution of velocity shows fluids of high velocity shifted & accumulated at the exit section concave wall because of the combined impact of centrifugal action & velocity diffusion. From the constant investigation it's determined that recovery of static pressure will increase up to area ratio of two and pressure recovery decreases steady up to angle of flip 75º. The total pressure loss coefficient nearly remains constant with the modification in area ratio & angle of flip for similar inlet conditions. **R. Keerthana[2],** the performance of a series of annular diffusers of divergence angles (9º, 15º, 21º and 27º) are determined. . A three-D annular diffuser model was done in PRO-E and therefore the analysis was allotted in ANSYS FLUENT. The results are indicated within the sort of velocity, pressure, static pressure distributaries diagrams and static pressure recovery coefficient on hub & casing wall. The results show some putting options because the divergence angle will increase the pressure recovery additionally will increase significantly.

III.3D MODELS OF ANNULAR CURVED DIFFUSER AT DIFFERENT DIVERGENCE ANGLES

3D modelling is done by changing the divergence angle 9^0, 15^0, 21^0, 27^0, 33^0,39^0

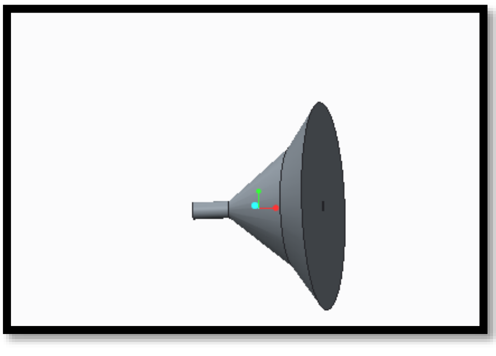

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Fig 1: - 3d Model of Curved Annular Diffuser with 39^0 divergence angle

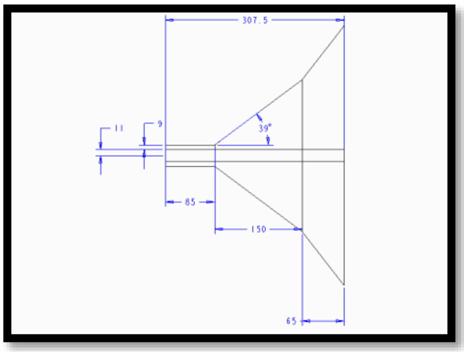

Fig 2: - Drafting of Curved Annular Diffuser with 39^0 divergence angle

Solver type: pressure based

Problem model: Standard k epsilon

MATERIAL:

Fluid: Water vapour

Casing material: Aluminium

BOUNDARY CONDITIONS:

INLET:

A. Mass flow rate:

1. 0.02259kg/s
2. 0.04518 kg/s
3. 0.09036 kg/s

B. Turbulence intensity:

1. Reynolds number 50000: 5%
2. Hydraulic diameter: 0.01788m

RESULTS:

The results that are taken for the present thesis work are as follows:

1. Static pressure
2. Pressure coefficient
3. Velocity magnitude

IV.CFD ANALYSIS OF CURVED ANNULAR DIFFUSER

CFD analysis is done on all the models by varying mass flow rate using water vapour.

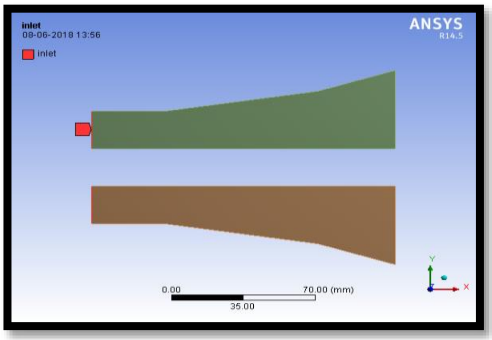

Fig 3: - inlet of fluid

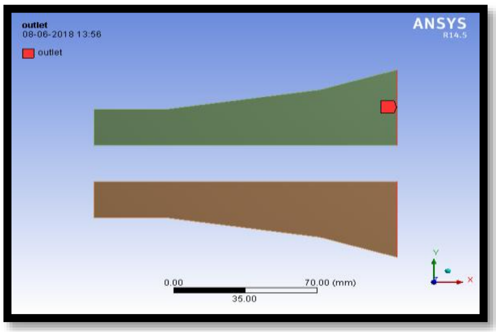

Fig 4: - outlet of fluid

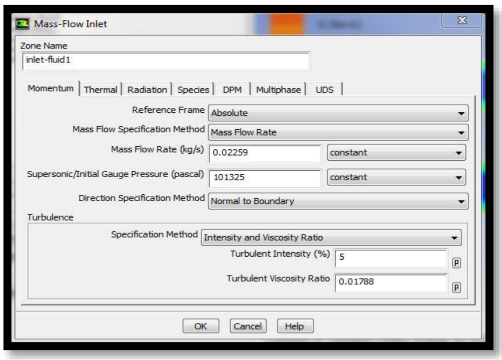

Fig 5: - Mass Flow Rate- 0.02259kg/s

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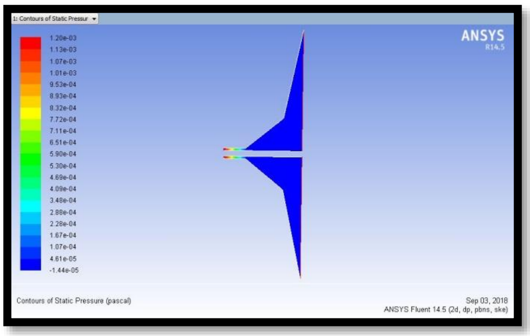

Fig 6:-static pressure in curved annular diffuser of Mass Flow Rate- 0.02259kg/s at Divergence angle 39^0

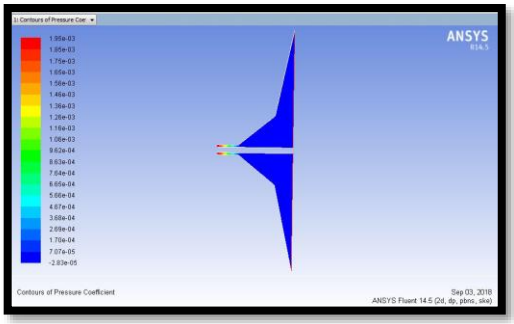

Fig 7:-pressure coefficient in curved annular diffuser of Mass Flow Rate- 0.02259kg/s At Divergence angle 39^0

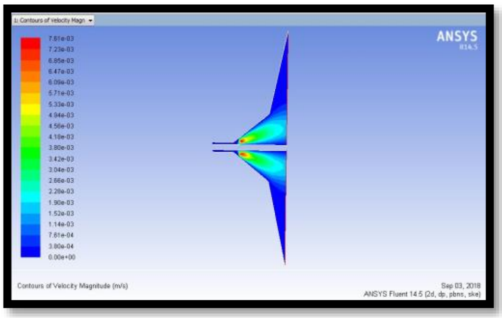

Fig 8:-velocity in curved annular diffuser of Mass Flow Rate- 0.02259kg/s At Divergence angle 39^0

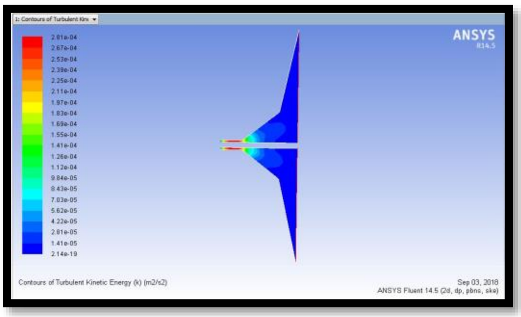

Fig 9:-turbulent kinetic energy in curved annular diffuser of Mass Flow Rate- 0.02259kg/s at Divergence angle 39^0

V.RESULTS TABLE

Mass flow rate -0.02259kg/s

Divergence Angles	**Static pressure (Pa)**	**Pressure coefficient**	**Velocity magnitude (m/s)**	**Turbulent kinetic energy (k) (m^2/s^2)**
9^0	-7.14e-03	-1.49e-03	9.84e-01	4.70e-02
15^0	9.06e-05	5.73e-04	1.19e+00	4.65e-02
21^0	3.51e-04	6.20e-04	1.49e+00	6.50e-02
27^0	8.85e-04	1.45e-03	1.16e+00	4.58e-02
33^0	5.75e-05	9.37e-05	2.27e+00	1.75e-01
39^0	1.20e-03	1.95e-03	7.61e-03	2.81e-04

Mass flow rate -0.04518kg/s

Divergence Angles	**Static pressure (Pa)**	**Pressure coefficient**	**Velocity magnitude (m/s)**	**Turbulent kinetic energy (k) (m^2/s^2)**
9^0	-3.23e-02	-6.40e-03	1.93e+00	`9.80e-02
15^0	1.07e-03	4.45e-03	2.33e+00	1.05e-01
21^0	7.81e-03	1.27e-02	2.95e+00	1.82e-01

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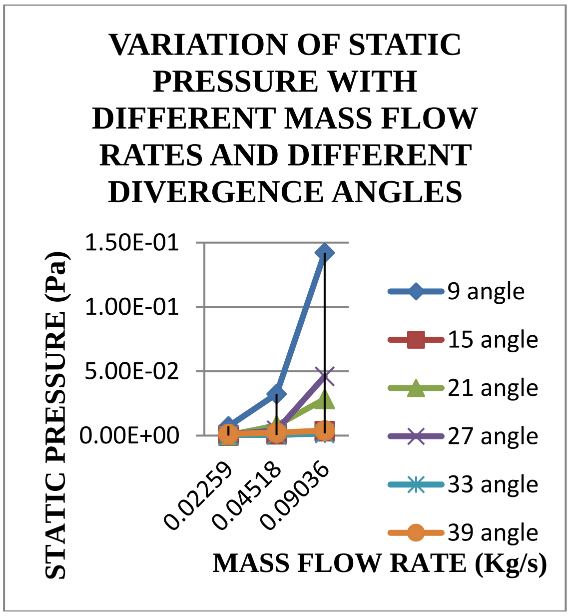
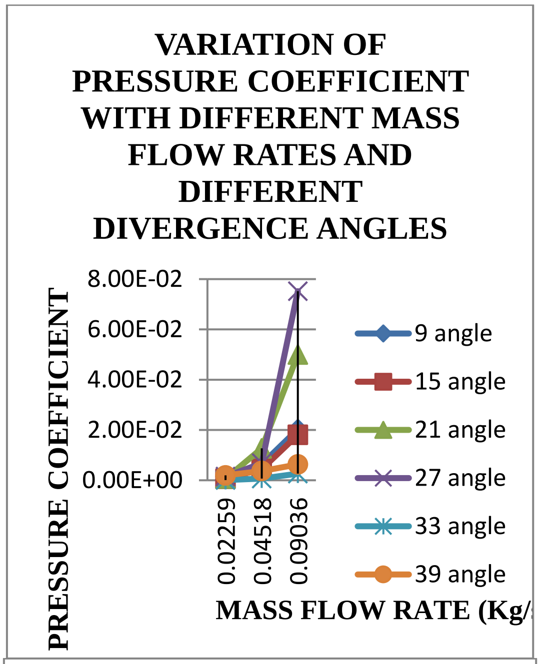
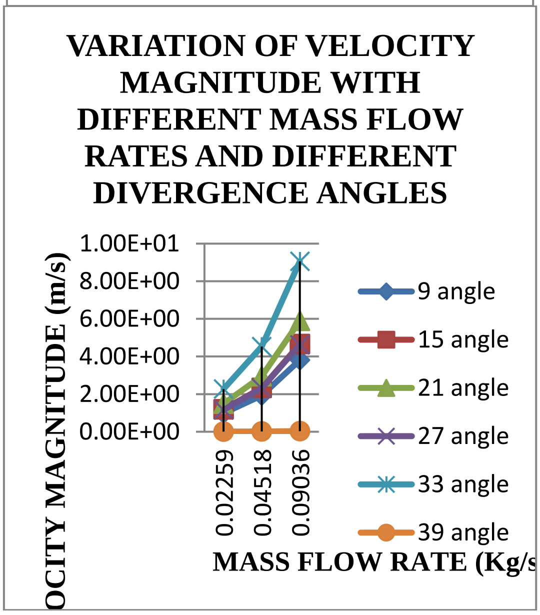
27⁰	4.10e-03	6.79e-03	2.31e+00	1.35e-01
33⁰	4.29e-04	6.62e-04	4.53e+00	4.95e-01
39⁰	2.27e-03	3.70e-03	1.61e-02	5.67e-04

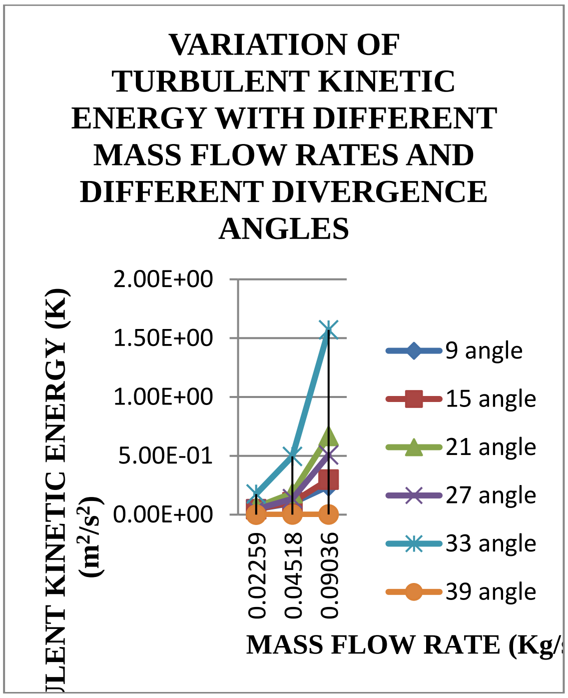
Mass flow rate -0.09036 kg/s

Divergence Angles	Static pressure (Pa)	Pressure coefficient	Velocity magnitude (m/s)	Turbulent kinetic energy (k) (m^2/s^2)
9⁰	-1.42e-01	-2.03e-02	3.81e+00	2.42e-01
15⁰	3.34e-03	1.81e-02	4.66e+00	2.98e-01
21⁰	2.84e-02	5.00e-02	5.90e+00	6.69e-01
27⁰	4.60e-02	7.52e-02	4.62e+00	5.07e-01
33⁰	1.69e-03	2.64e-03	9.06e+00	1.57e+00
39⁰	3.86e-03	6.31e-03	3.38e-02	1.13e-03









VI.CONCLUSION

Turbulent flow inside the annular curved diffusers with change in divergence angles is analyzed using the Ansys Fluent .The static pressure & pressure coefficient follow the same strategy as the flow proceeds. Both the static pressure and the pressure coefficient are increased as the flow proceeds.
The impact of the divergence angle is clearly noticed on the pressure coefficient. As the divergence angles increases the pressure coefficient also increases leading to high pressure recovery.

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