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DESIGN AND ANALYSIS OF DIESEL FLOW IN PIPE BENDS

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Abstract : Pipe flow, a branch of Hydraulics and Fluid Mechanics, was a type of liquid flow within a closed conduit (conduit in the sense of a means of containment). The other type of flow within a conduit is open channel flow. These two types of flow were similar in many ways, but differ in one important respect. Pipe flow does not have a free surface which is found in open-channel flow. Pipe flow, being confined within closed conduit, does not exert direct atmospheric pressure, but does exert hydraulic pressure on the conduit.

1. Introduction

Generally any application involving pipe flow will not only consist of flow through straight pipes.It will also comprise of fluid flow through pipes of varying cross sections, [1-3]predominantly classified as expansion and contraction. These in turn can be subdivided into sudden and gradual change. The pipeline may also consist of pipe bends of various angles and types like mitred bends, sharp bends, filleted bends etc.[1-5]

2. Literature Review

The phenomenon of flow through pipes has been studied and subjected to research throughout the years. Amongst the various literatures on flow through pipes, the recent work focuses on pressure and velocity variations in pipe bends and variable flow areas.[6-9]

A. S. Nejad and S. A. Ahmed (1992) [10-11] studied the Flow field characteristics of an axis symmetric sudden-expansion pipe flow with different initial swirl distribution. The results of an experimental investigation depicting the effects of swirl profile on confined flows in a sudden-expansion coaxial dump combustor are presented. Three swirlers (freevort ex, forced vortex, and constant angle) with the same nominal swirl number were designed and fabricated to study the effects of swirl type on the isothermal dump combustor flow field. [12-13]They found, upon imparting swirl to the inlet flow resulted in a considerable reduction of the corner recirculation length, a marked increase in turbulent mixing activity, and in one case creation of a central recirculation zone. Their work highlights the importance of the combustor inlet swirl profile and shows that swirl type as well as swirl strength can affect the flow field significantly. The present database is well suited for numerical codes development and validation[14-15]

3. Conditions For Analysis

- Diesel has been chosen as the fluid for analysis.
  Properties of diesel:
  Density = 730 kg/m^3
  Viscosity = 0.0024 kg/m-s
  Reynolds Number has been chosen for laminar is2000. For this Reynolds's number the velocity of Diesel was found to be 0.13 m/s[15-21].
  Reynolds Number has chosen for Turbulent is 5000. For this Reynolds number the velocity of diesel was found to be 0.3287 m/s.

3.1 Straightpipe

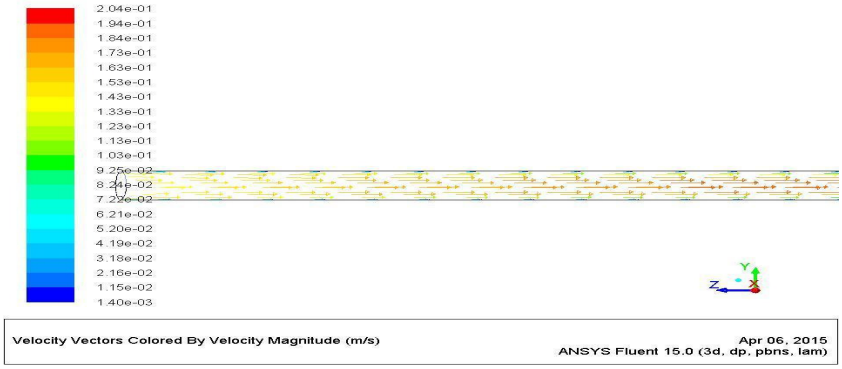


Figure 1. Shows the velocity vectors of straight pipe

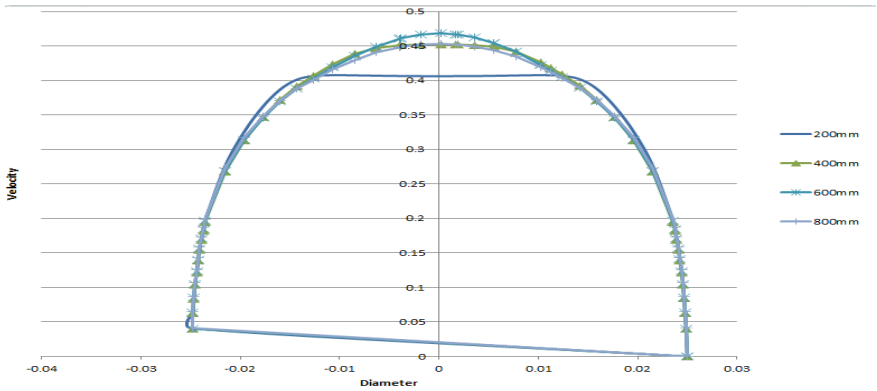


Figure 2. Graph shows the velocity profile of straight pipe

3.2 Pipe With 30 Degree Fillet Bend

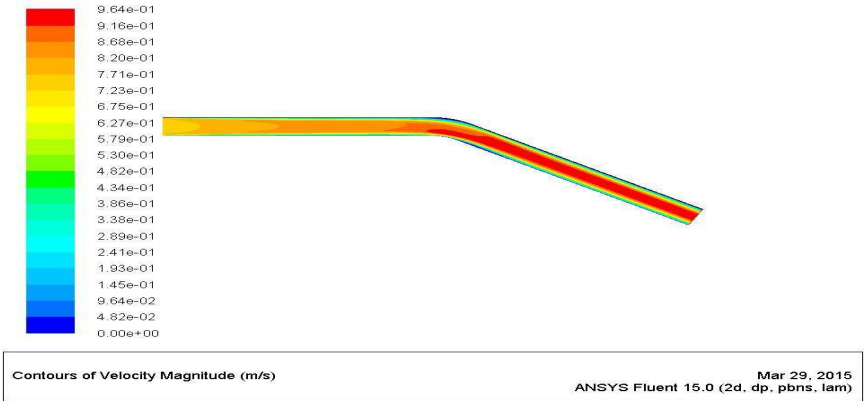


Figure 3. How is the velocity contour of fluid for the pipe with 30 Degree Fillet Bend

This figure clearly shows the advantages of fillet bends and the turbulence created is a lot less when compared to previous cases.[16-17]

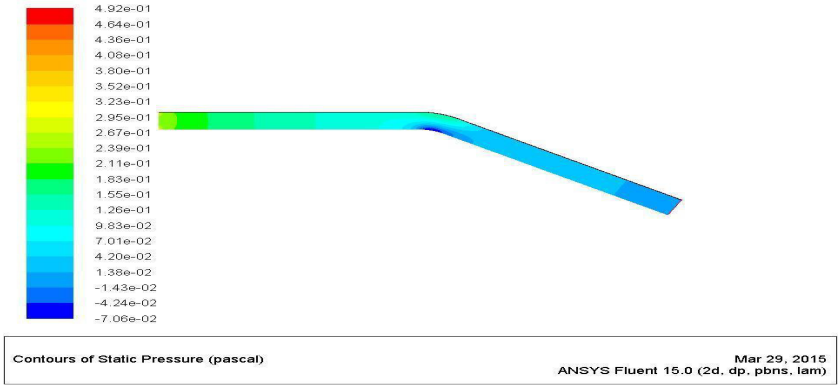


Figure 4. Depicts the velocity contour of straight pipe

4. Conclusion

The analysis of a pipe flow with various pipe configurations was done using ANSYS Fluent 15.0 and the results were obtained. The results clearly show the following

- In case of sudden contraction in pipes, there is abrupt rise in fluid velocity at the region of contraction which is termed Vena Contracta. It is formed due to the convergence of flow as shown by the vector plot.
- In case of sudden expansion in pipes, there is a drop in velocity after a certain distance from the region of expansion which is basically determined by the velocity of fluid flow which in our case is 0.73 m/s. The fluid slowly starts to stabilize, but it can be properly visualized only if the length of the pipe is longer than the configuration that has been used. Negative pressure is formed at the region of recirculation, and the phenomena can more clearly be explained by using a finer mesh.
- In case of 30 degree bends, the pressure losses were more at the region of sharp bends than the filleted bends. The Turbulent flow was found to be more stable than the flow with constant velocity at inlet.
- The results found in 60 degree and 90 degree bends with configurations
  (Fillet and constant velocity at inlet & Turbulent flow at inlet), were found to be similar as in the case of 30 degree configuration. The only significant difference found was that the rise in velocity was proportional to the angle of bend (i.e. the larger the angle of bend, the greater the rise in velocity at the point of bend)

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