RESEARCH RESULTS

Numerical Analysis of Erosion in Bends Pipes with Various Bend Angle and Different Bend Ratio

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ABSTRACT

In the present study, erosion wear of a 95° degree with 3.0 bend ratio pipe, 95° degree with 2.5 bend ratio, 0° degree with 2.5 bend ratio, 50° degree with 2.5 bend ratio, 65° degree with 2.5 bend ratio, 35° degree with 2.5 bend ratio pipe bend has been investigated using the Computational fluid dynamics code FLUENT. Strong particles were followed to assess the disintegration rate alongside k-ε tempestuous model for persistent/liquid stage stream field. Debris - strong are infused from the bay surface at speed going from 8 ms-1 at two distinct fixations. By considering the cooperation between strong fluid, impact of speed, molecule size and fixation were examined. Disintegration wear was expanded remarkable with speed, particles size and focuses. Anticipated outcomes with CFD have uncovered well in concurrence with test results. it is cleared that results on 95° degree with 3.0 bend ratio pipe has low erosion DPM rate compared to all different bend angle and its results is better than all bend angle pipe with all parameters .so we can suggest this modified geometry of bend pipe with 3.0 bend ratio 95 degree because it has less DPM erosion rate and reduce the leak problem bend pipe surface. Abrasive solid erosion is a common issue faced in many industrial applications and can incur significant loss to production efficiency. In a piping system, the bends are generally the most vulnerable to the abrasive erosion due to the abrupt change of flow. Reducing the erosion at the bend is key to industries for safety purpose and ensure equipment longevity. This research focusses on the effectiveness of utilizing the swirling flow in reducing the erosion rate at the elbow bends. Numerical approaches are adopted to systematically evaluate the impact of the degree of swirling in the flow on the erosion reduction at the elbow. The results demonstrate the promising prospect of the swirling flows as a mechanism to control the erosion at the pipe elbow.

1. INTRODUCTION

Abrasive erosion are common issues encountered in numerous manufacturing and processing industries that employs pneumatic system to transport granular material. Abrasive erosion has detrimental effect to the industries as it causes more frequent production downtime for maintaining equipment. Abrasive erosion left unchecked can result in severe consequence, such as leakages of processing materials from the system that damages the equipment and contaminates the surrounding environment. Minimizing erosion is important to industries due to the impact it has on the maintenance cost, and the risk management. In Many engineering industries and other different plants like thermal power plant, Natural gas power plant, gas fired power plant is having a erosion wear due to the kinetic energy transferred to target surface by impinging solid particles. Ash is usually captured by electrostatic precipitator or extra particle filtration apparatus before the flue gases spreads the chimney. Ashes as the finish produce in incomplete combustion are typically mineral but frequently still comprise an amount of combustible organic or extra oxidizable residues. The collected ash in a hopper directly under the furnace, when it is uninvolved by high pressure and water jets and cleared, via sluiceways, into ash grinders. and it is used for the reprocessing or reuse of coal ash in removal. For example, coal ash is insignificant ingredient in the production of concrete and wallboard, and similarly in pipe-bend, tees, plumbing, valves, elbows and centrifugal pump etc. the pipe-line structure suffers from erosion wear and Erosive wear outcomes from the effect of particles against surfaces. Erosion in the piping can be well-defined as the process by which the interior surface of a pipe weakens due to the coarse action of touching solid particles and gas bubbles existing on the sewage flow.

An example is that the one of the components of pipe- bend or elbow which is connected in the pipe line system and its main function is to give the direction like horizontal, vertical and inclined for the fluid mixture inside it. Many researchers have done the experiment on it and find out the theoretical erosion models to evaluate the magnitude and location of solid-liquid erosion wear on the system. In present study erosion wear is investigated in the pipe-bend using the CFD. of solid-liquid erosion wear of the system. In the present study erosion wear is investigated in the pipe-bend using the CFD.

1.2 Erosion Wear

Erosion wear is a process of removal of material from a target surface due on continuous impact on solid particles at very high velocity. The particle suspended in the solid liquid combination floe that erodes the wetted passage and then reducing equipment's service life in the slurry transportation system. Pump and impeller and nozzle insides of abrupt bend in both tube and pipe also is to suffer from erosive wear.

Erosion wear can be classified mainly in three categories:

1. Solid particle erosion. solid particle erosion leads to the reduction of material volume from a targeted material as the outcome of solid particle impinges on it from a flowing fluid.

2.Liquid impact erosion. The continues striking of liquid jet on material surface cause liquid impact erosion.

3.Cavitation erosion When the vapor or gas in a liquid forms cavity of bubbles that cause wear.

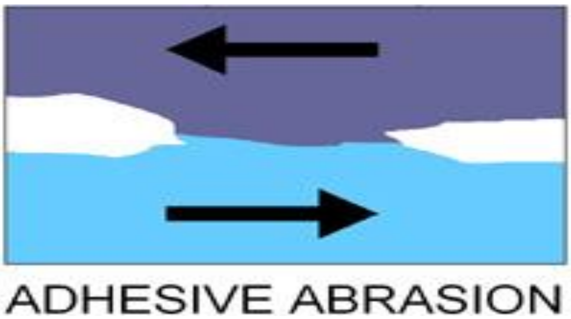
1.3 Types of Slurries

A) Abrasive Wear

Abrasive wear is described as the removal or eroding away of deciduous from a surface by means of interaction with passing cloud gas or rubbing a solid abrasive wear occur when a rigid and even sake surface escape with less hard surface in solid American Society for Testing and Materials i.e ASTM explicates abrasive wear as the loss function of material because of rigid materials or rough prominences are published.

B) Adhesive Wear

where is happened by localized material passes between contacting hard surface or loss from surface it is also created when like material grind Each Other without lubrication on the surface.



2. LITERATURE SURVEY

To evaluate the erosion wear. The high disintegration wear was found with base debris slurry because of quality of the carbon, un-consumed coal and particles in the base debris. They observed that the coal particles breakdown into small particles due to collision with wall and may not have enough energy to deform the target wall surface, hence fewer erosion rate was originated with coal slurry. Also the results revealed that the high weight loss in the initial stage and became stable in the final stage along the travel distance of both the slurries.[1]

Zhang et al. et al. (2000) performed simulation for the solid-liquid two phase flow to evaluate the erosion-corrosion in the pipe in CFD. The k- turbulent model and Lagrangian-model were used with the boundary conditions velocity inlet and outlet over the domain. The glass material of particles size 8 m was used as erodent material. The results obtained for the erosion rate, corrosion were found good agreement with experimental results of Nesic & Postlehwaite.[2]

Edward et al. (2001) numerically studied the solid particle erosion in Typical elbows, extended radius elbows and worked tees. They observed more force move in long span elbow rather than standard elbow. Because of the energy the particles doesn't strike to the divider. The large amount of particles followed the fluid streamline or remain suspended in the fluid through the long curvature (don't strikes early to the wall). The gradual rerouting of the flow leads to fewer erosion than instantly flow redirection. They detected the particles drop the velocity near the stagnant region due to fluid cushion effect owing this particles don't strikes the barrier and low erosion wear was observed in plugged tees. Also they found low erosion complexity in long radius elbow in its place of standard elbow or plugged tees.[3]

Bozzini et al. (2003) studied erosion phenomenon of pipe bend in CFD code Fluent by using four phases (oil, sea water, hydrocarbon mixture and sand particles). The Discrete Phase Model was used to track solid particles of diameter 300 µm. They observed the solid particles have less transporting capacity at low velocity and settle-down pipe-bend where the erosion wear was examined at the same time they increased the gas volume flow rate in the mixture to improve the erosion rate. The total mass flow rate of particles was affecting the fluid flow behaviour not the erosion rate. The high speed of combination had produced high drag power and latency power on strong particles which push the strong particles toward external sweep of twist where the high disintegration rate was examined.[4]

Wood et al. (2003) performed CFD recreation to gauge the disintegration initiated by sand water in steel pipe-curve of preliminary and research center scaled. The particle tracking and turbulence copies were employed in the simulation process. The almost constant velocity as fine as small impact angle was detected in straight pipe but fluctuated velocity outline and high impact angle were got in the bend cross- section. Due to this high velocity and bearing angle the high erosion rate was found in the bend zone than the straight pipe. The experimental and numerical results had found good agreement.[5]

Chen et al. (2004) studied erosion wear on 1 inch nudge and plugged tee of aluminum in CFD code CFX code by seeing air and sand particles (150µm in diameter). Grid independent test and unit independent test had been approved out for both the geometries. In lagrangian model, two partition collision approaches (Stochastic rebound and Forder rebound) were used to estimate the erosion rate at different velocities (15.24m/s, 30.38m/s, 45.72m/s). The results obtained with Forder rebound model needed 15% more erosion rate in elbow or large number of re-circulations leads to local corrosion rate in tee domain. But stochastic rebound model's results have made a decent agreement with experimental results. Finally, the average erosion wear place was found by graphical approach for the elbow and tee.[6]

Habbib et al. (2004) studied erosion wear on 1 inch nudge and plugged tee of aluminum in CFD code CFX code by seeing air and sand particles (150µm in diameter). Grid independent test and unit independent test had been approved out for both the geometries. In lagrangian model, two partition collision methods (Stochastic rebound and Forder rebound) were used to estimate the erosion rate at different velocities (15.24m/s, 30.38m/s, 45.72m/s). The results obtained with Forder rebound perfect needed 15% more erosion rate in shove or large number of re-circulations leads to local erosion rate in vest domain. But stochastic rebound model's results have made a decent agreement with experimental results. At last, the normal disintegration wear place was found by graphical methodology for the elbow and tee.[7]

Wood et al. (2004) studied slurry erosion rates in horizontal pipe-bend by means of CFD code-Fluent V5.4. The results remained predicted at midway of the conventional pipe and 45o along the bend. The particle velocity and source of particles were varying sideways with the peripheral angles. The erosion rates, sand volume, impact angle, influence velocity, were predicted for the straight pipe and bend. Negative impact angle or opposite flow were found at 90o and 270o plane angles of pipe-bend. Due to the particles lading and impact velocity of the particles, somewhat erosion wear was studied at these angles and ensuing the damaging of material at the particular zone.[8]]

3. PROBLEM FORMULATION

3.1 Erosion Rate Prediction in Single and Multiphase Flow Using CFD

Predicting erosion in a multiphase flow is a hard task erosion is the erosion of material surface caused by the collision of certain particle the influence of sand particle motion across carrier fluid such as methane methane oil mixed gases studying using a CFD technique through the use of CFD package the erosion process in single and multiphase flow is examined in the ANSYS fluent 6.0 is a simulation software apart from that the corrosion rate is calculated by API recommended standard and the value from the cfd and compared numerically along with the pressure for the forces acting on the parent section are computed.

3.2 Parameters of The Fluid Flow

Erosion is a complicated phenomenon mainly happening in the oil and gas transport lines and slow process that is affected due to the several factors in operational conditions and well conditions. and well conditions. It can significantly affect the damage the pipeline and also reduces the life of the pipeline Measuring the erosion while it's far progresses could be very tough and plant operators must have an amazing best calculation of the inner situation of the pipework in their whole system. This will make erosion control and controlling hard Depending at the manufacturing situations and geography of the well, strong particles, that are especially sand and quite erosive, that is gift useful in flow. But in corrosive flow, liquid droplets which might be a primary thing specifically in excessive speed gas streams. The sand debris that trapped or entrained withinside the produced gases from the reservoir may also include very, small debris which are infrequently separable via way to means of physical way. In this paper a method is supplying to estimate the erosional price in manufacturing and transportation centers and their additives because of the impingement and impact of sand particles of various sizes (microns).

3.3 Force Exerted on A Pipe Bend Figure 1:

The average velocity, pressure and the area of flow at the inlet section (one) and the outlet section (2) are V1, A1, P1 and V2, A2, P2 respectively. Let the forces Fx and Fy are the component forces acting on the fluid by the pipe bend in the x and y directions respectively. the other l forces acting over the fluid in the control volume area P1A1 over the section (1) and P2A2 over the section (2). Now the momentum equation is written as:

P1a1-p2a2-cos@+fx= pa(v2cos@-v1)

From this equation we may find Fx Similarly Fy can be determined from the momentum equation in the y direction. If we know about the Fx and Fy, the total resultant force F

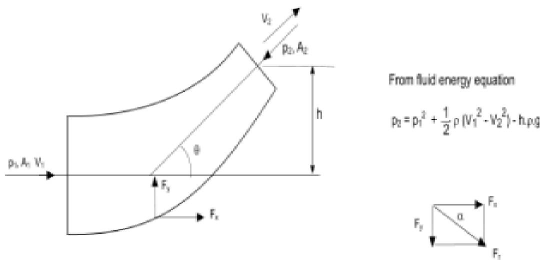


Figure 1: Force diagram of bend

Leakage Problem

Economic pressure, concern over public health risk, the need to conserve water and the increased treatment costs associated with infiltration (White et al. 1997) motivate water system operators to implement leakage control programs. Leakage control can forewarn asset managers of potential problems, including the impending collapse of a pipeline, which usually damages adjacent utilities such as gas and telephone, or damages nearby assets including roadways and buildings.

Fig 1 Ref from lauryheating.com

Fig 2 Ref from dontdig.com

Significant efforts were made in the past to develop such programs, and as a result procedures for systematic water loss control programs are now well established and widely used. There are two major steps in any systematic leakage control program:

Corrosion Problem

Pipeline corrosion is the oxidisation and electrochemical breakdown of the structure of a pipe used to convey any substance. Reactions to the substances carried by pipelines as well is external conditions such as weather all contribute. Its an expensive problem to put right if left untreated.

4. PROPOSED METHODOLOGY

A common elbow pipe bend with particulate air flows from the inlet as shown in Fig. 1 is considered. The pipe has a diameter D of 0.0254m and the elbow has a radius to pipe diameter ratio of 1.5. The length of the inlet pipe was assigned to be twelves times the pipe diameter to allow the flow to be fully developed before it enters the bend. The flow is turbulent with a velocity of 34.1m/s and Reynolds number of over 60,000. The particulate mass flowrate is 0.0217 kg/s and the corresponding mass loading is 0.013. Four cases are considered here, namely a common uniform inlet that is parallel the pipe, and three swirling inlets that are angled at 10, 20 or 30o from the normal direction, as shown in Figure 2.

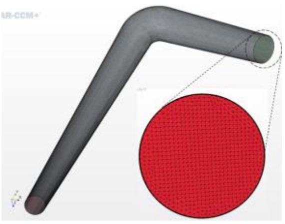


Figure 3 Geometry and meshing employed for the elbow pipe bend.

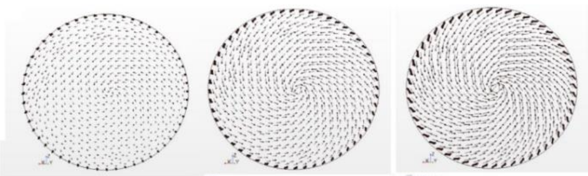


Figure 4 Geometry and meshing employed for the elbow pipe bend

The methodology that ensuing in this thesis is mainly through the software. In Ansys geometry model and 90-degree bend is being model from hexahedral meshing is being used in the discretize the model. model is then loaded into Ansys fluent under variety of situation.

The dimensions used for mesh generation are as follows: Preference in physics: CFD Active assembly of the initial size seed Medium levelling Slow transition Span angcentr: Excellent 1.6273e004 is the right size. 3.2546e002 is the maximum size. 1.6 002 is the maximum face size.2.e 002 .The shortest edge length is 0.159590 metre. In the upper window, the flow is considered turbulent. However, for multiphase flow, select multiphase flow, select Euler's model, and select Euler's parameters as DDPM (High Density Discrete Phase Model). This will assign the number of phases. In general, implicit languages are provided here. The liquid you see in this model is like a mixture of oil, gas, and gas. Oil is more viscous than gas, so choose a viscous model and consider the flow to be turbulent. Kepsilon

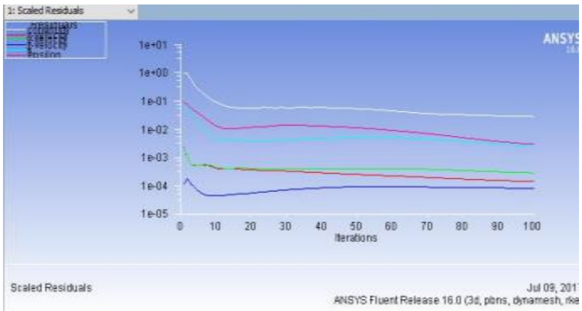


Figure 4: Iteration of Results

Realizable is the model of choice for standard walls. This phase model is a physical model in which erosion should occur due to continuous flow.

5. SIMULATION AND RESULTS

Here cleared seen above table bend pipe with different bend angle Pressure Turbulence kinetic energy velocity and velocity streamline velocity results find out. So Find out bend pipe pressure results on 95° degree with 3.0 bend ratio pipe, 95° degree with 2.5 bend ratio, 0° degree with 2.5 bend ratio, 50° degree with 2.5 bend ratio, 65° degree with 2.5 bend ratio, 35° degree with 2.5 bend ratio results are respectively. So Find out bend pipe Turbulence kinetic energy results on 95° degree with 3.0 bend ratio pipe, 95° degree with 2.5 bend ratio, 0° degree with 2.5 bend ratio, 50° degree with 2.5 bend ratio, 65° degree with 2.5 bend ratio, 35° degree with 2.5 bend ratio results are respectively $2.50E^{+00}$ m^2/sec^2, $4.00E^{+00}$ m^2/sec^2, $6.00E^{+00}$ m^2/sec^2, $6.50E^{+00}$ $m^2/sec2$ and $8.50E^{+00}$ m^2/sec^2

5.1 Result Parameter 1

5.1 35° Degree Elbow

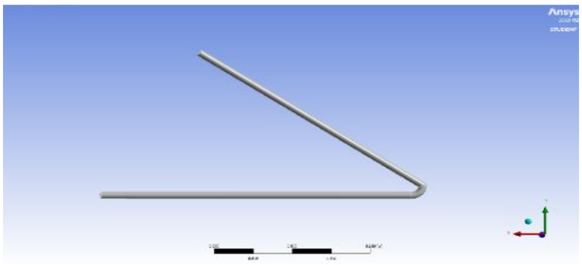


Fig. 5.1 35° Degree Elbow geometry import on ANSYS

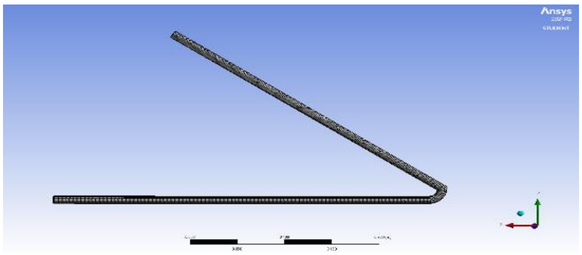


Fig. 5.2 30° Degree Elbow geometry meshing

Node: 2306

Elements: 20475

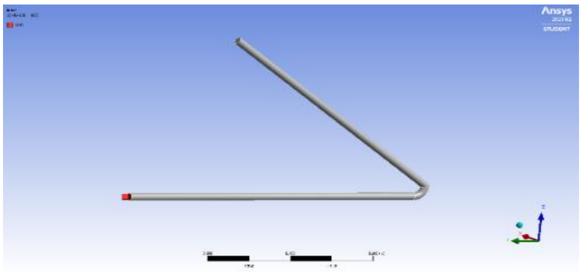


Fig. 5.3 35° Degree Elbow geometry inlet

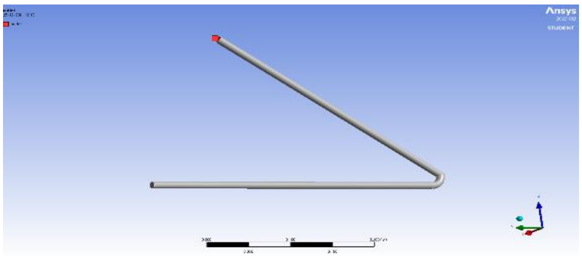


Fig. 5.4 35° Degree Elbow geometry outlet

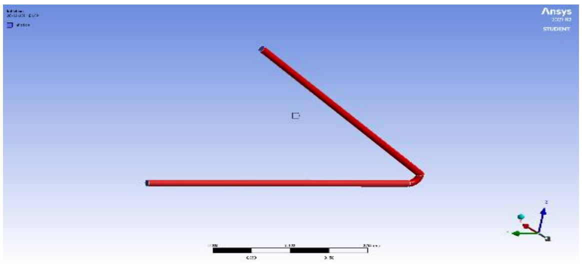


Fig. 5.5 35° Degree Elbow geometry wall

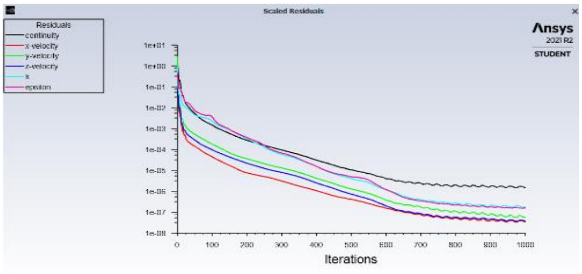


Fig. 5.6 35° Degree Elbow iterations up to 200

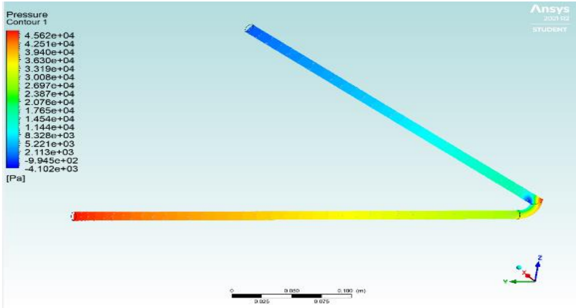


Fig. 5.7 35° Degree Elbow pressure results

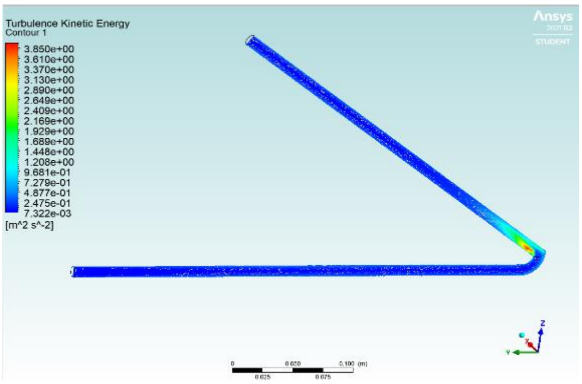


Fig. 5.8 35° Degree Elbow turbulence kinetic energy results

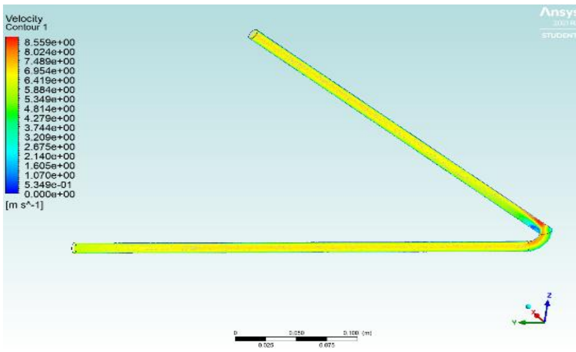


Fig. 5.9 35° Degree Elbow velocity results

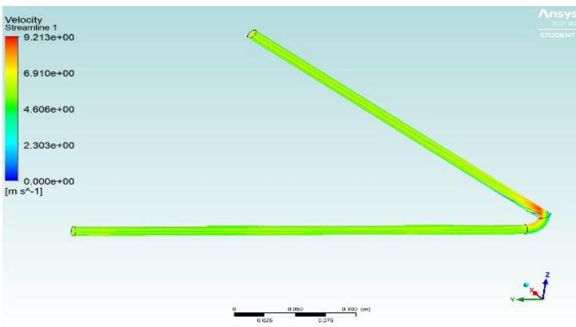


Fig 5.10 35° Degree Elbow stream line velocity results

5.2 Result Parameter 2

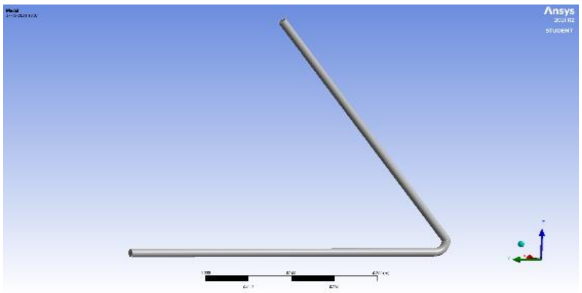


Fig. 5.11 50° Degree Elbow geometry import on ANSYS

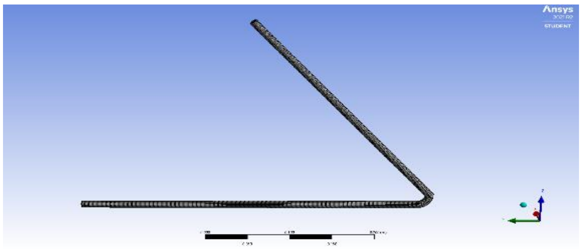


Fig. 5.12 50° Degree Elbow geometry meshing

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Elements: 35495

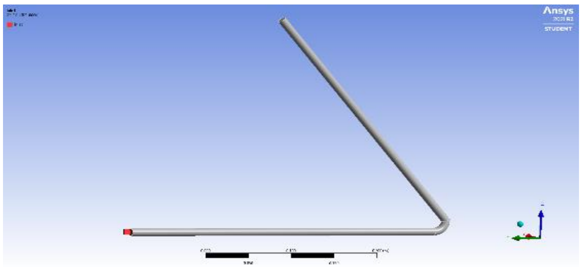


Fig. 5.13 50° Degree Elbow geometry inlet

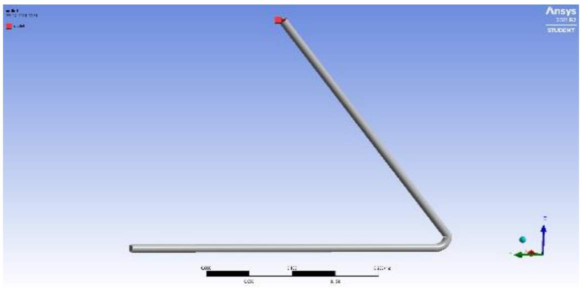


Fig. 5.14 50° Degree Elbow geometry outlet

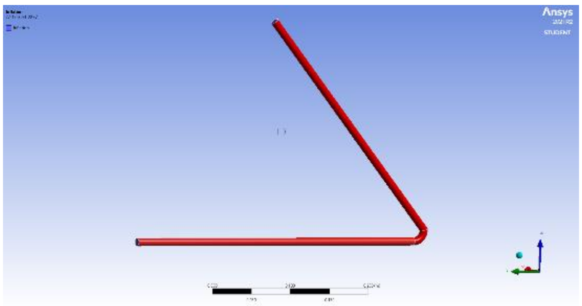


Fig. 5.15 50° Degree Elbow geometry wall

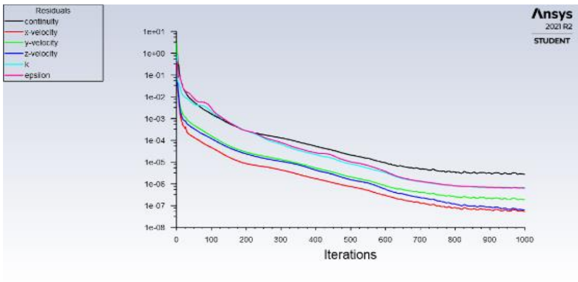


Fig. 5.16 50° Degree Elbow iterations up to 1000

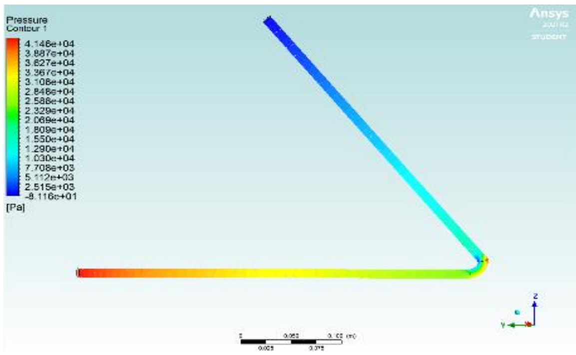


Fig. 5.17 50° Degree Elbow pressure results

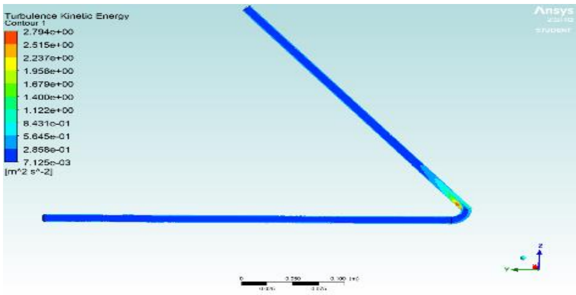


Fig. 5.18 50° Degree Elbow turbulence kinetic energy results

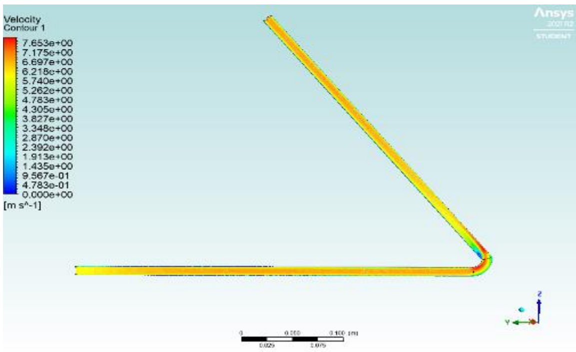


Fig. 5.19 50° Degree Elbow velocity results

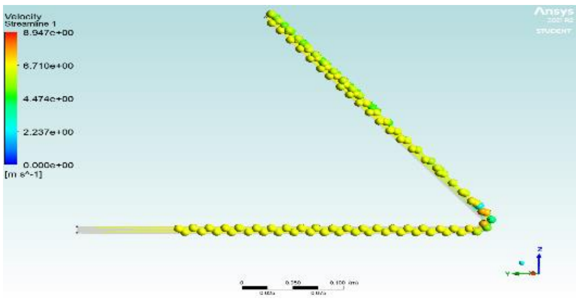


Fig. 5.20 50° Degree Elbow stream line velocity results

5.3 Result Parameter 3

5.3 65° DEGREE ELBOW

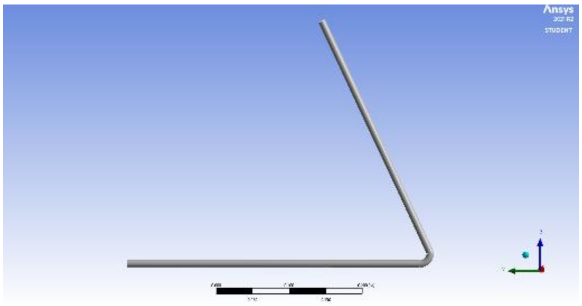


Fig. 5.21 65° Degree Elbow geometry import on ANSYS

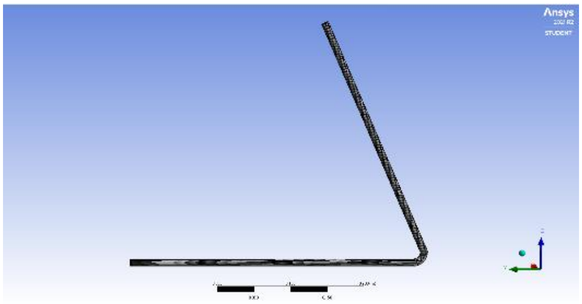


Fig. 5.22 65° Degree Elbow geometry meshing

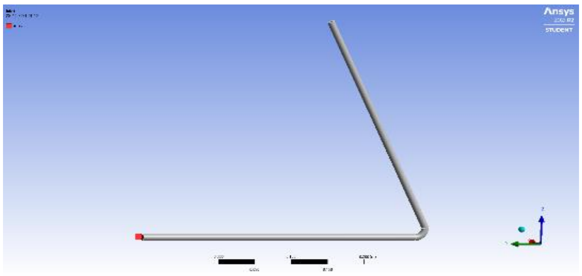


Fig. 5.23 65° Degree Elbow geometry inlet

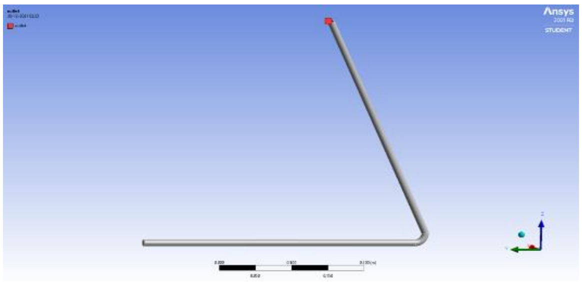


Fig. 5.24 65° Degree Elbow geometry outlet

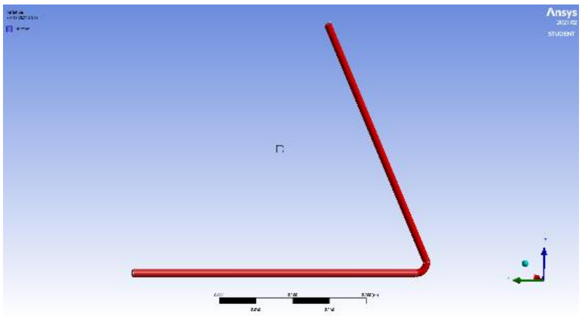


Fig. 5.25 65° Degree Elbow geometry wall

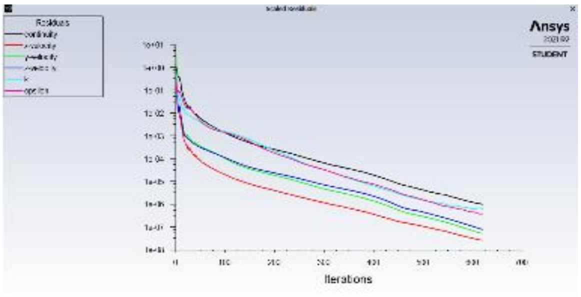


Fig. 5.26 65° Degree Elbow iterations up to 1000

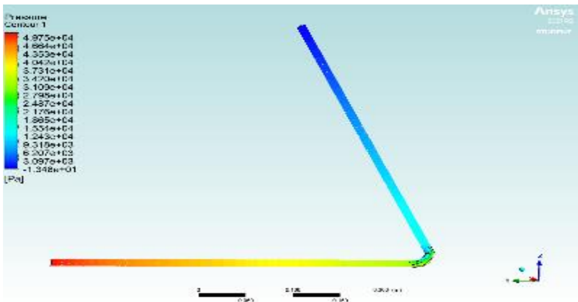


Fig. 5.27 65° Degree Elbow pressure results

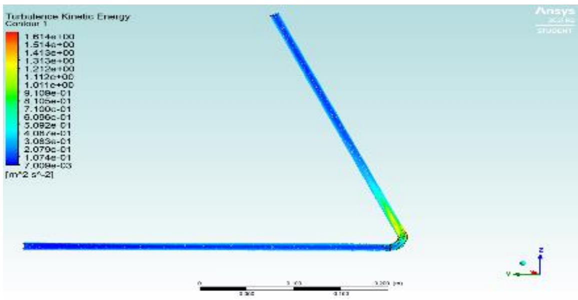


Fig 5.28 65 Degree Elbow turbulence kinetic energy results

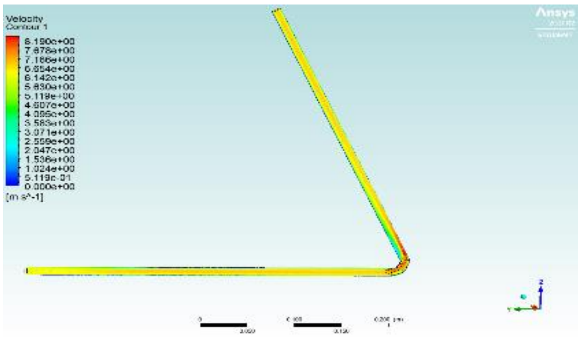


Fig. 5.29 65° Degree Elbow velocity results

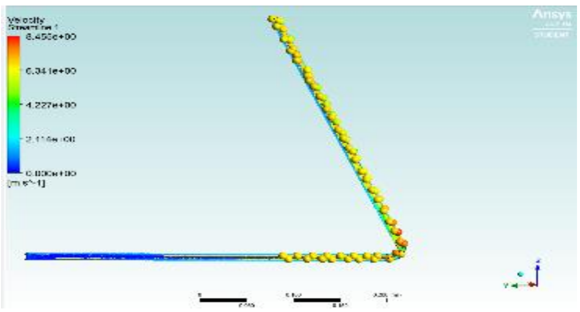


Fig. 5.30 65° Degree Elbow stream line velocity results

5.4 Result Parameter 4

5.4 95° DEGREE ELBOW PIPE

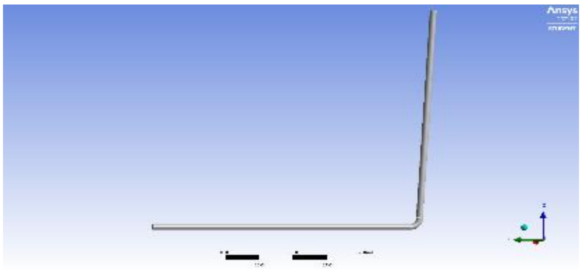


Fig. 5.31 95° Degree Elbow geometry import on ANSYS

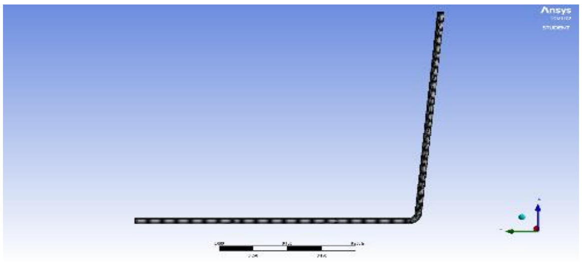


Fig. 5.32 95° Degree Elbow geometry meshing

Elements 237621

Nodes: 87267

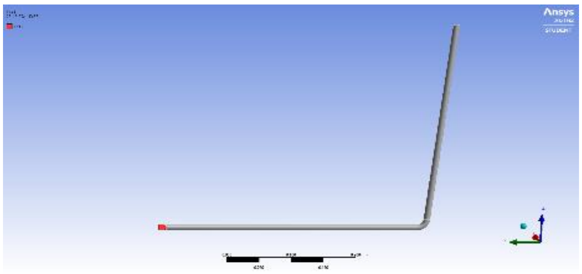


Fig. 5.33 95° Degree Elbow geometry inlet

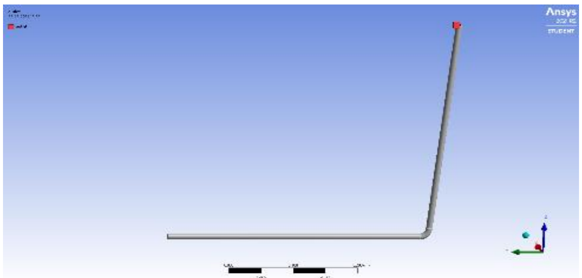


Fig. 5.34 95° Degree Elbow geometry outlet

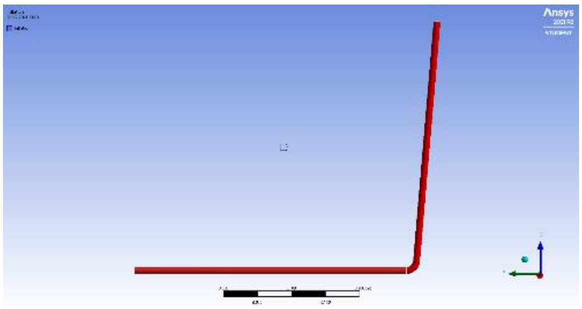


Fig. 5.35 95° Degree Elbow geometry wall

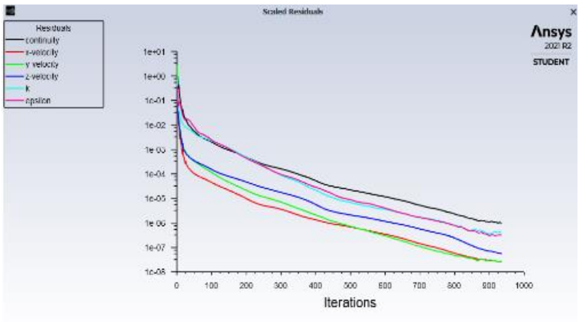


Fig. 5.36 95° Degree Elbow iterations up to 1000

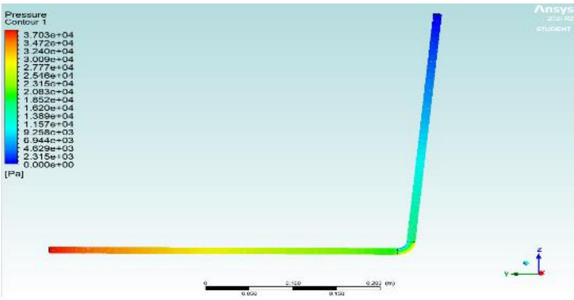


Fig. 5.37 95° Degree Elbow pressure results

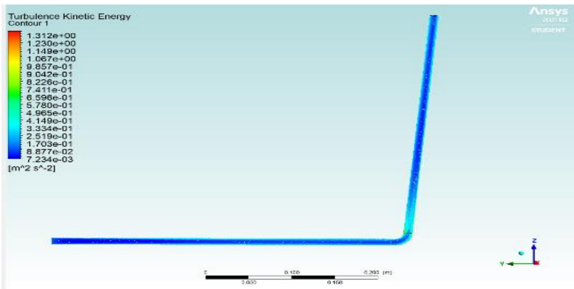


Fig. 5.38 95° Degree Elbow turbulence kinetic energy results

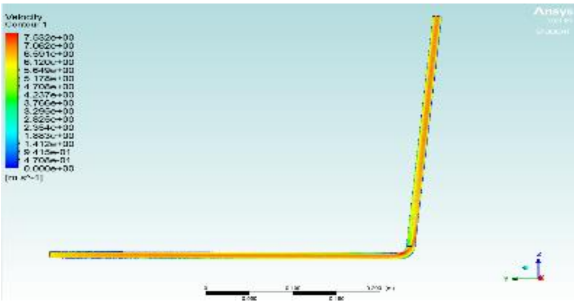


Fig. 5.39 95° Degree Elbow velocity results

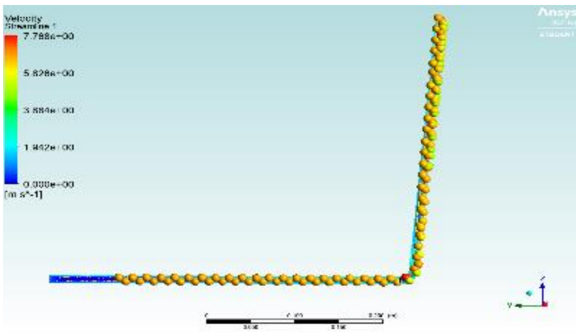
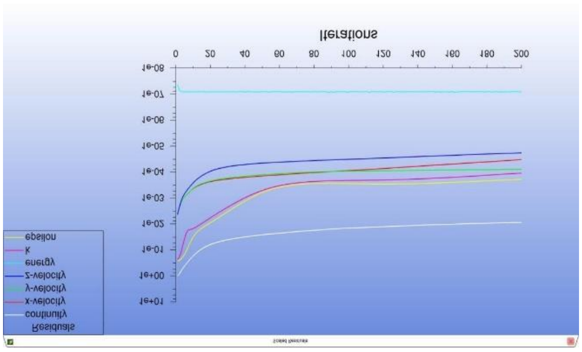


Fig. 5.40 95° Degree Elbow stream line velocity results

5.5 Result Parameter 5



95° DEGREE ELBOW 3.0 RATIO

Fig. 5.40 95° Degree Elbow 3.0 ratio iterations.

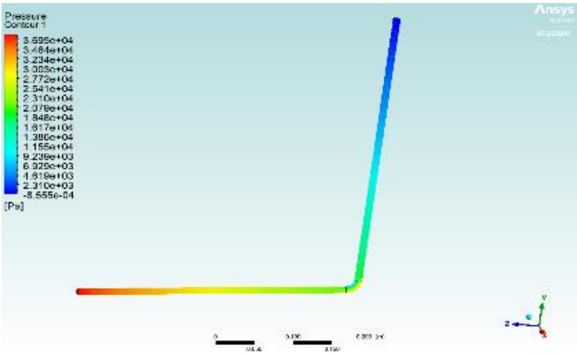


Fig. 5.41 95° Degree Elbow 3.0 ratio pressure result

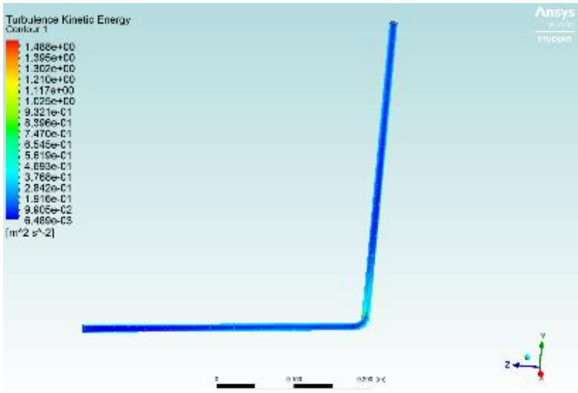


Fig. 5.42 90° Degree Elbow 3.0 ratio turbulence kinetic energy results

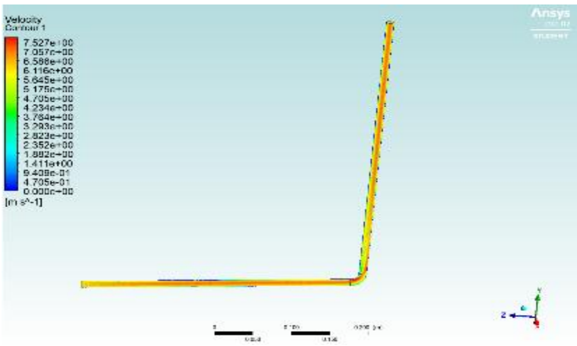


Fig. 5.43 95° Degree Elbow 3.0 ratio velocity result

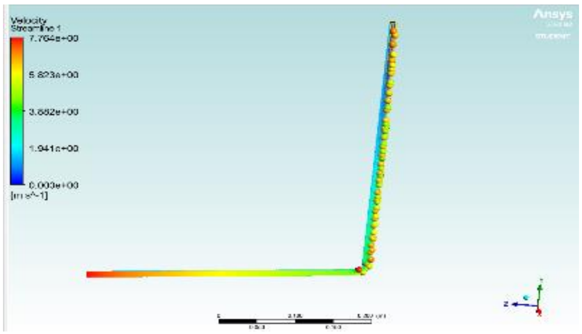
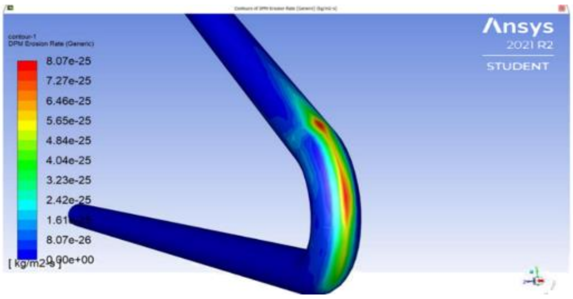


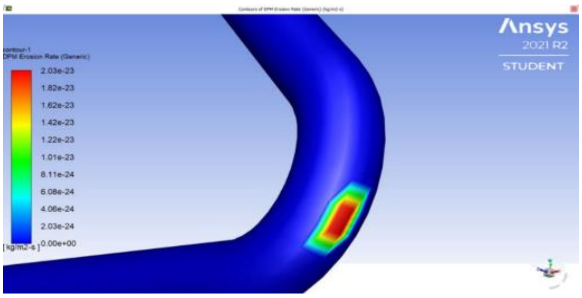
Fig. 5.44 95° Degree Elbow 3.0 ratio streamlines velocity results

5.6 DPM Erosion Rate Results of Angels

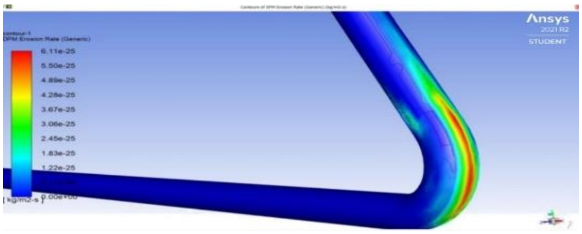
1. 35-degree DPM erosion rate result in pipe.



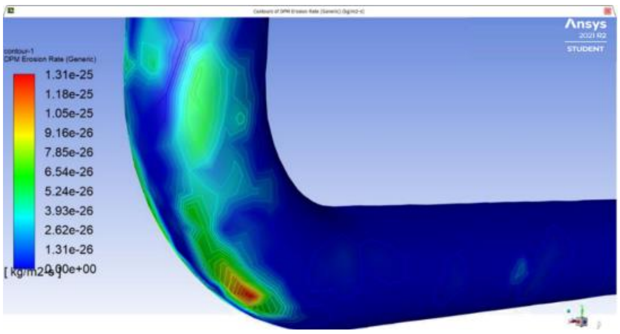
2. 50-degree DPM erosion rate result in pipe.



3. 65-degree DPM erosion rate result in pipe.



4. 95-degree DPM erosion rate result in pipe at 2.5 ratio.



5.95-degree DPM erosion rate result in pipe at 3.0 ratio.

6. RESULTS

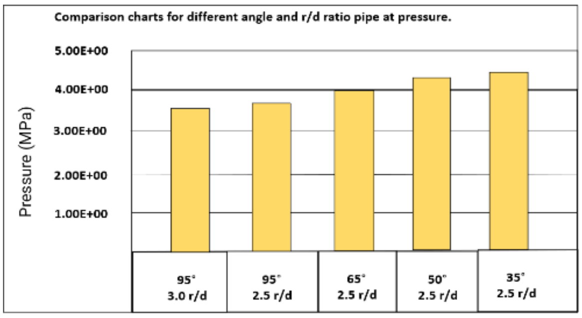


Fig. 6.1 comparison charts for different angle and r/d bend ratio pipe pressure result.

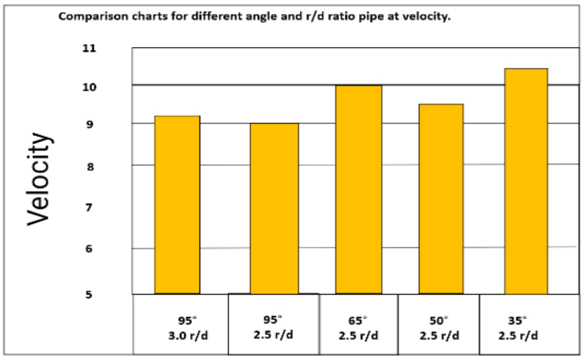


Fig. 6.2 comparison charts for different angle and r/d bend ratio pipe velocity result.

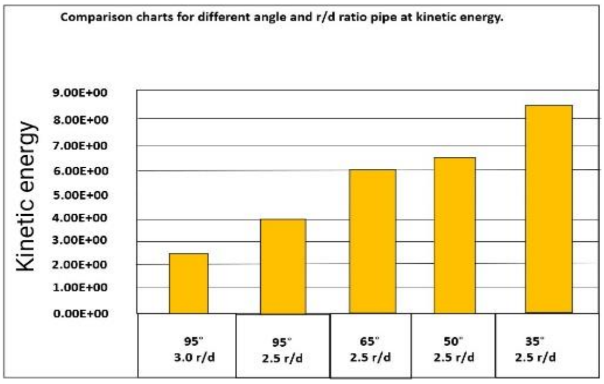


Fig. 6.3 comparison charts for different angle and r/d bend ratio pipe kinetic energy result.

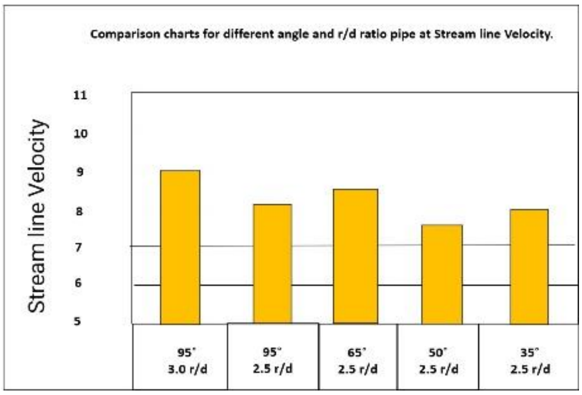


Fig. 6.4 comparison charts for different angle and r/d bend ratio pipe Stream line velocity result

Bending Ratio(r/d)	3.0 r/d	2.5 r/d	2.5 r/d	2.5 r/d	2.5 r/d
Bend Angle	95°	95°	65°	50°	35°
Pressure (Pa)	3.70E+00	3.80E+00	4.00E+00	6.00E+04	4.56E+04
Turbulence kinetic energy (m^2/sec^2)	2.50E+00	4.00E+00	6.00E+04	6.50E+00	8.50E+00
Velocity(m/sec)	9.3	9.0	10.0	9.5	10.0
velocity streamline velocity	9.00E+00	8.20E+00	8.50E+00	7.50E+00	8.00E+00

6.1 Discussion

Here cleared seen above table bend pipe with different bend angle Pressure Turbulence kinetic energy velocity and velocity streamline velocity results find out.

So, find out bend pipe pressure results on 95° degree with 3.0 bend ratio pipe, 95° degree with 2.5 bend ratio, 0° degree with 2.5 bend ratio, 50° degree with 2.5 bend ratio, 65° degree with 2.5 bend ratio, 35° degree with 2.5 bend ratio results are respectively.

So, Find out bend pipe Turbulence kinetic energy results on 95° degree with 3.0 bend ratio pipe, 95° degree with 2.5 bend ratio, 0° degree with 2.5 bend ratio, 50°

degree with 2.5 bend ratio, 65° degree with 2.5 bend ratio, 35° degree with 2.5 bend ratio results are respectively 2.50^{E+00} m^2/sec^2, 4.00^{E+00} m^2/sec^2, 6.00E+00 m2/sec2, 6.50E+00 m2/sec2 and 8.50^{E+00} m^2/sec^2

So, find out bend pipe velocity results on 95° degree with 3.0 bend ratio pipe, 95° degree with 2.5 bend ratio, 0° degree with 2.5 bend ratio, 50° degree with 2.5 bend ratio, 65° degree with 2.5 bend ratio, 35° degree with 2.5 bend ratio results are respectively 9.3m/s, 9.0 m/s, 10.0 m/s, 9.50 m/s and 10.5 m/s

So, Find out bend pipe streamline velocity results on 95° degree with 3.0 bend ratio pipe, 95° degree with 2.5 bend ratio, 0° degree with 2.5 bend ratio, 50° degree with

2.5 bend ratio, 65° degree with 2.5 bend ratio, 35° degree with 2.5 bend ratio results are respectively 9.0 m/s , 8.20 m/s, 8.50 m/s, 7.50 m/s and 8.00 m/s.

So, it is cleared that results on 95° degree with 3.0 bend ratio pipe has low erosion DPM rate compared to all different bend angle and its results is better than all bend angle pipe with all parameters. so we can suggest this modified geometry of bend pipe with 3.0 bend ratio 95 degree because it has very low DPM erosion rate and reduce the leak pressure.

7. CONCLUSION AND FUTURE WORK

7.1 Conclusion

Computation fluid dynamics code FLUENT was used analyze the analysis of fluid flows using numerical solution methods. And it is also used in slurry erosion in pipe bend. for the flow bottom ash slurry. based on the results conclusions are given below:

It is found that CFD modeling gaves best results for all the data considered in this study.

The erosion wear in the horizontal pipe bend is greatly influenced with velocity of the flowing medium. slurry flow through pipe and bends accomplishes us to find the causes of wear in pipeline. At low velocity settling takes place in the pipe bend due to low inertia and gravitational effect on the solid particulate, leads to erosion at bottom side of pipe line.

Erosion wear found in many times in the curved sections at the straight once. solid concentration significant is low in the erosion wear. The erosion rate is also varies with bend angle of pipe.

7.2 Future Work

The present study has been done to predict the erosion rate and the, velocity and particles size at the horizontal 95o pipe-bend. So, this work can also be continuing for the long radius bend and centrifugal slurry pump impeller –section by numerical simulation.

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