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Simulation And Theoretical Calculation Of Fluid Pass Through Straight Circular Pipe And Nozzle

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Abstract

In this paper I presented my simulation work of simple circular pipe andnozzle in which included modeling, meshing, pressure drop contour, velocity contour and velocity vector contour this simulation is done in ANSYS fluent software. I also make the theoretical solution of given pressure drop problem and compare this both result.

Keywords— Fluid, Circular Pipe, Nozle

Water flow through diverging nozzle

First of all we take dimension of pipe as shown in bellow and water is passing through this pipe

- Diameter = 60 mm
- Length of the tube= 3 m
- Inlet Velocity = 5 m/s

Property Of Water

Sr. No	Density (kg/m3)	993.95
1	Viscosity(Pa Sec)	$7.282x10^{-4}$
2	Specific Heat (J/Kg K)	4174
3	Conductivity (W/m K)	0.6253

Theoretical Calculation

Reynolds's Number:[1]

$$\mathrm{Re} = \frac{\rho x V x d}{\mu}$$

$$= \frac{993.95x3x0.06}{7.282x10^{-4}}$$

= 409201.3

Hence, Flow is turbulent

Friction Factor: [2]

$$f = \frac{0.0791}{\mathrm{Re}^{1/4}} \qquad = \frac{0.0791}{(409201.3)^{1/4}} =$$

$3.127x10^{-3}$

Head loss due to friction: [1]

$$hf = \frac{4xfxlxv^2}{2xgxd}$$

$$= \frac{4x3.127x10^{-3}x3x(5)^2}{2x9.81x0.06}$$

= 0.796 m

Pressure drop due to friction

$$\Delta Phf = hfx\rho xg$$

$= 0.796x993.95x9.81$

= 7761.52 Pa

Model & Meshing Of Circular Pipe

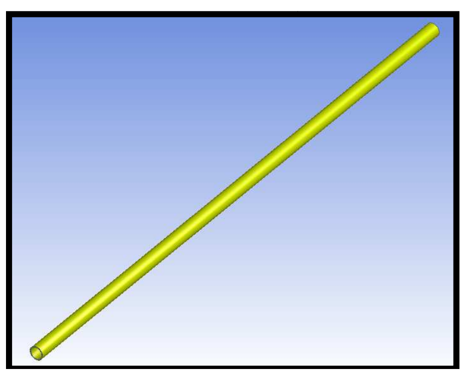

Fig-1 Model of circular pipe

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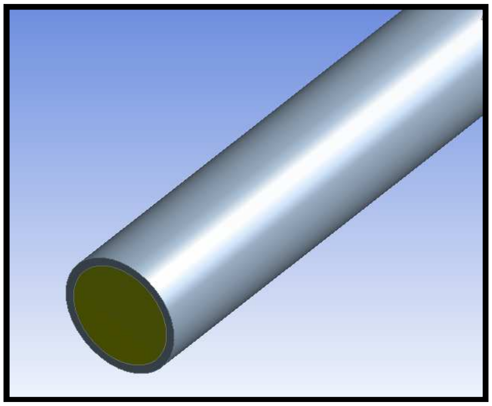

Fig-2 Model of circular pipe with fluid

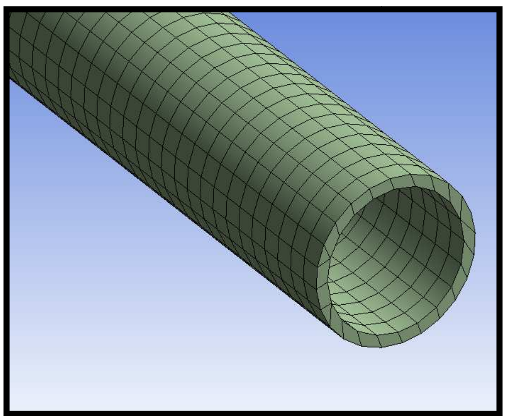

Fig-3 Meshing of circular pipe

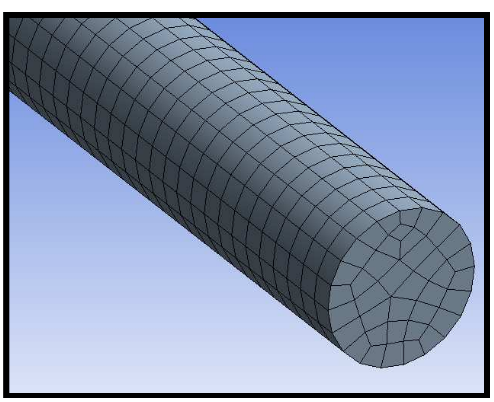

Fig-4 Meshing of circular pipe

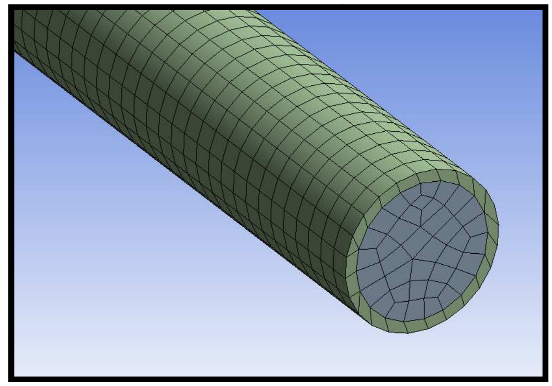

Fig-5 Meshing of circular pipe & fluid

Simulation Result Of Circular Pipe

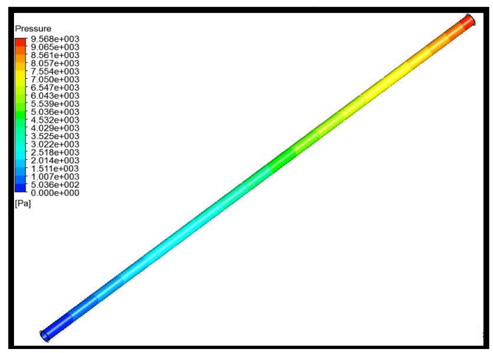

Fig-6 Pressure drop contours

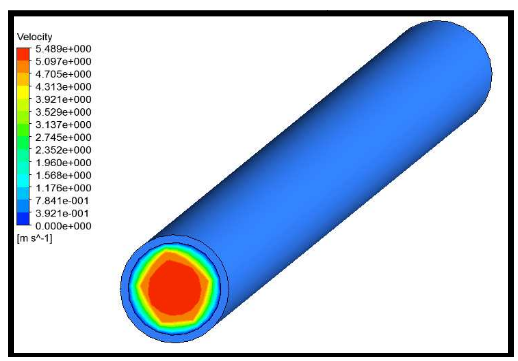

Fig-7 Velocity contours

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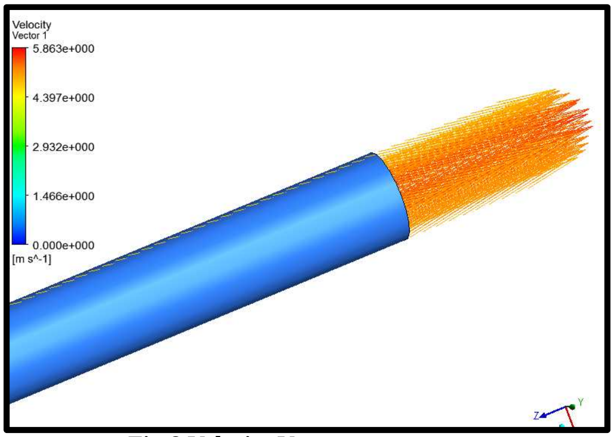


Fig-8 Velocity Vector contours

Results Comparison:

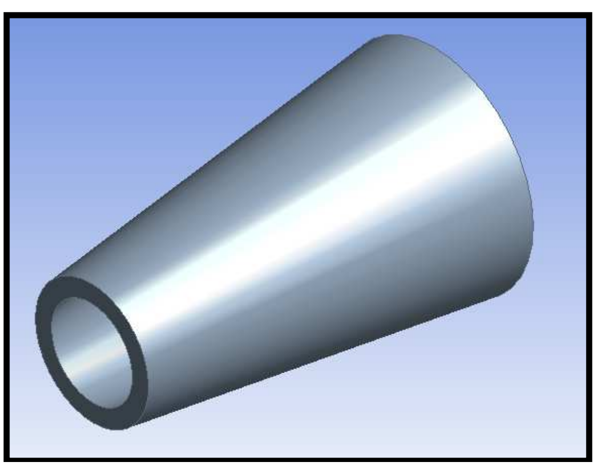
Sr. No	Parameters	Theoretical	ANSYS
1	Pressure (N/m^2)	7761.52	9568
2	Velocity (m/s)	5	5.4

Water Flow Through Diverging Nozzle

First of all we take dimension of pipe as shown in bellow and water is passing through Nozzle

1) Diameter d_1 = 100 mm
2) Diameter d_2 = 50 mm
3) Length of the nozzle = 200 mm
4) Inlet Velocity = 5 m/s

Model & Meshing of Convergent Nozzle



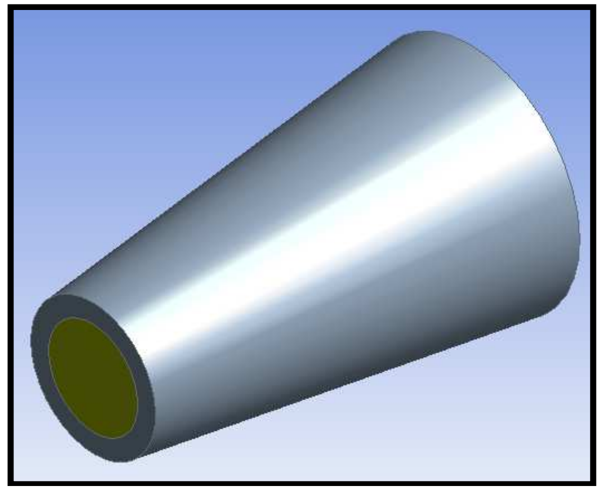


Fig-9 Model of convergent Nozzle

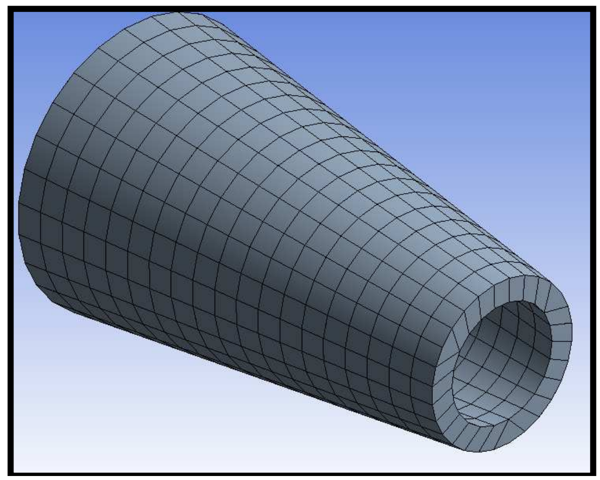


Fig-10 Model of convergent Nozzle

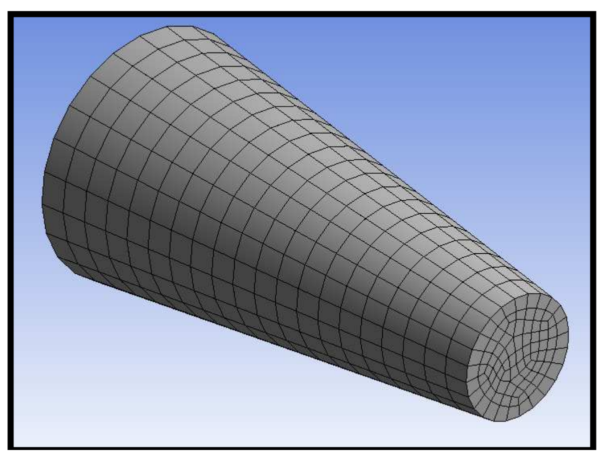


Fig-11 Model of convergent Nozzle

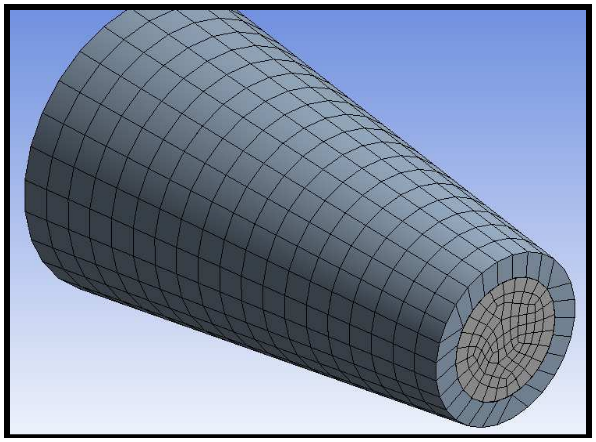


Fig-12 Model of convergent Nozzle

Simulation Result Of Circular Pipe

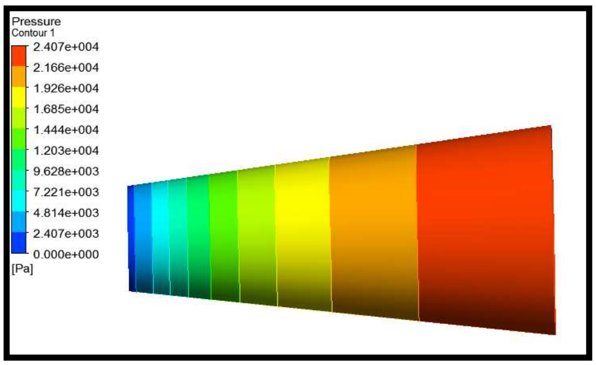


Fig-13 Pressure drop contours

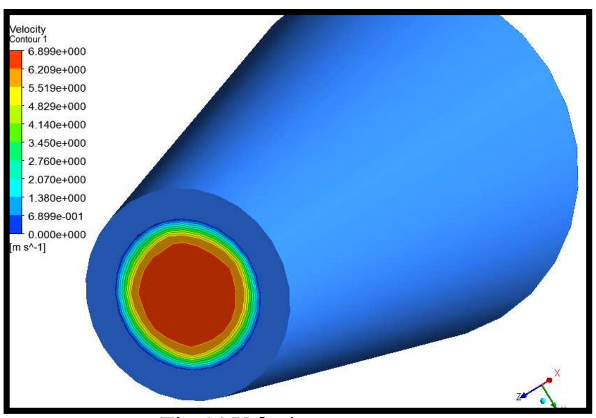


Fig-14 Velocity contours

Theoretical Calculation

$A1V1 = A2V2$[1]

$(\pi/4) \times (0.1)^2 \times 1.5 = (\pi/4) \times (0.05)^2 \times V2$

$V2 = 6$ m/s

$P1/\rho g + Z1 + V1^2/2g = P2/\rho g + Z2 + V2^2/2g$[1]

$P1 - P2 = \rho (V2^2 - V1^2)/2$

$= 993.95 \times (6^2 - 1.5^2)/2$

$= 16772.9$ Pa

Results Comparison:

Sr. No	Parameters	Theoretical	ANSYS
1	Pressure (N/m^2)	16772.9	9568
2	Velocity (m/s)	5	6.8

Conclusion & Future Scope

We can compare simulation, theoretical and practical result successfully and conclude that simulation is nearest to practical than theoretical result. This is the simple system if the system become complicated then theoretical result is go to away from practical result and sometime system become such type complicated then theoretical calculation become impossible at that time we get the answered from such type of analysis software such that ANSYS,CFX,FLUENT etc.

Future scope:-

1. We can get pressure drop by changing different fluid material and pipe material
2. We can get pressure drop and velocity contour at different location so take proper action at high intensity region
3. We can simulate pipe network and different pipe fitting

References

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