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Pressure and Velocity Measure in the Pipeline for Leak Detection using COMSOL Multiphysics

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Abstract: ***COMSOL Multiphysics software is multipurpose software which can be used in every field. COMSOL Multiphysics to have less work in India. I have to review many papers on COMSOL but all the papers out of India. I have decided to work on COMSOL Multiphysics. This paper presents laminar flow inside the pipeline to calculate velocity and pressure to using valve in open and close case along the pipeline. I have research on leakage detection in water supply distribution network. For this purpose I have designed a multiple size pipes and multiple size valves in AutoCAD software.***

Keywords: COMSOL, Leakage,

I. INTRODUCTION

Water is necessary for every person, plants and other environment creatures in life. Firstly we save the water and store it for future. For to detected the leak in water to create a network. COMSOL Multiphysics 5.5 is element analysis and multiphysics simulation platform. In COMSOL engineers do the work at all platforms. I have do the research on leak detection in water supply distribution network. I have designed pipes in 0.5*10m", 4*10m", 16*10m" and valve designed 0.5*0.5" 100% open and close ,4*4"100% open and close, 6*6"100% open and close.I have also taken the three networks for simulation.

Water distribution network create for different size of pipes but i have started a single pipe and after simulation to show pressure and velocity can easily to compute. Further I have taken two pipes with one valve in open status and compute the pressure .Both the network simulated easily.

After this I have taken four pipes and three valves in different open conditions. First valve open 25%, second open 50%, and third open 100%.To set the laminar flow and other fluid properties.

Introduction described in first section and second briefly described literature review. In third section explain COMSOL simulation and fourth to show the results. At last to include the conclusion and references.

II. LITERATURE REVIEW

Leakage in the pipelines of oils, gas and water pipeline are dangerous for health. In cities many gallon of water are waste during supply It become a problem for every person [1]. The U.S. Department to give reported that 867 gas and hazardous gallon water pipeline leakage and more pipes burst in [2].

In England 5,600 million liters of water is lost every day it means leakage and pipeline burst [5].

In water distribution networking to use the control valves which control fluid flow in pipelines and many engineering applications.It is very difficult for engineers to understand all the actual working of control valves [4]

In this design, all the parameters optimized according to the simulation and can use the magnetic flux leakage sensor. Also use permanent magnets in carbon [5].

III. METHODOLOGY

3.1 Objectivesof COMSOL: This paper to have three objectives

- Detect the pressure and velocity in pipeline to detect a leakage in pipeline network.
- Designed a pipe network to using valve between two pipes.
- Designed a pipe network to using four pipes and three valves in different condition status.

COMSOL Multiphysics to have many properties and applications in engineering. In COMSOL to select all the assumptions:

1. In COMSOL software firstly to select a model wizard 3D. You can also select 2D and 1D.
2. Physics- fluid flow-single phase flow-laminar flow
3. Study-stationary and add.
4. Global right click and set the parameters
5. Geometry- right click-labels-pipe flow. Select pipe length in inch. After this import file 1 from build in selected from AutoCAD and also import others files.
6. Material selected water and liquid.
7. In laminar flow to select wall1 and select boundary of walls.

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8. Laminar flow- at inlet of pipe to select manual velocity field 0.001 and outlet select manual.
9. Mesh select manual (if error occur then free tetrahedral)
10. Study1 then compute and find the result

In the simulation you can find out the result in 3D graph, 2D graph and 1D graph. Also can change the property according to our need.

3.2 Mathematical equation: `Given mathematical equation to describe the time dependent in study. We can compute the pressure and flow in pipe using this time dependent formula.

ρ u/t + ρ (u. Δ) u

Δ. [-p t + μ (Δ u + (Δ u)т)] + F

P Δ. (u) = 0

Table1: Parameters of both pipes and valves

Name	Expression	Value
Pipe1 length	10[m]	10meter
Pipe2 length	10[m]	10meter
Valve diameter	4[inch]	4”
Pipe1 length	10[m]	10meter
Pipe2 length	10[m]	10meter
Pipe3 length	10[m]	10meter
Pipe4 length	10[m]	10meter
Pipe diameter	0.5[inch]	0.5”
Valve diameter	0.5[inch]	0.5”
Valve1	100[Percent]	Open
Valve2	50[Percent]	Open
Valve3	25[Percent]	Open

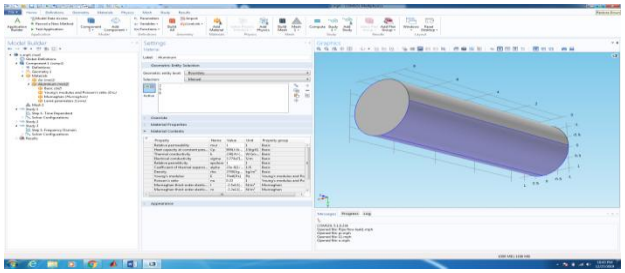

Figure1: Single Pipeline with dimensions

In the figure1 pipeline design in COMSOL but another pipelines design in AutoCAD then import.

3.3 Pipe network designed in COMSOL:

In the figure1 to show the pipeline network to import the AutoCAD file in model builder. Given network can be rotate in any direction.

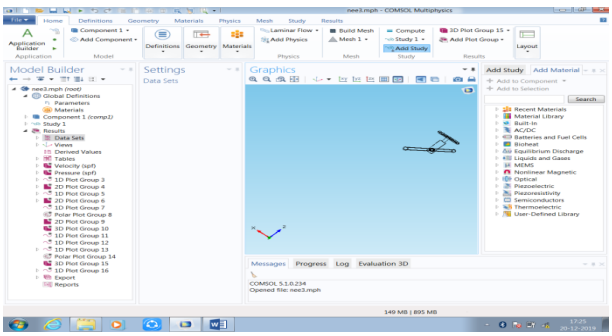

Figure2: Two pipelines with one valve in 100% open status

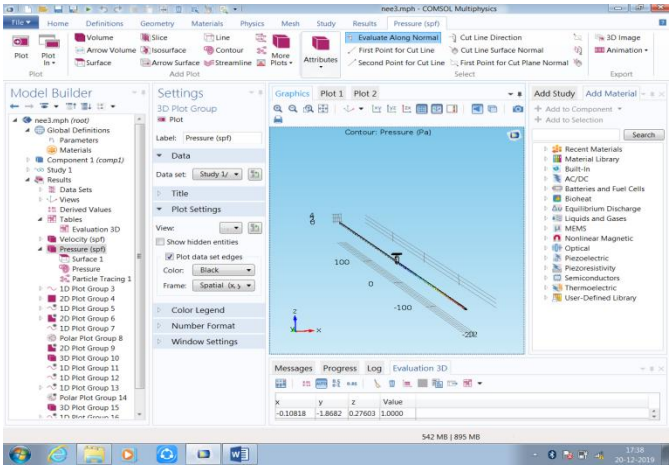

Figure3: Two pipelines and valve with dimensions

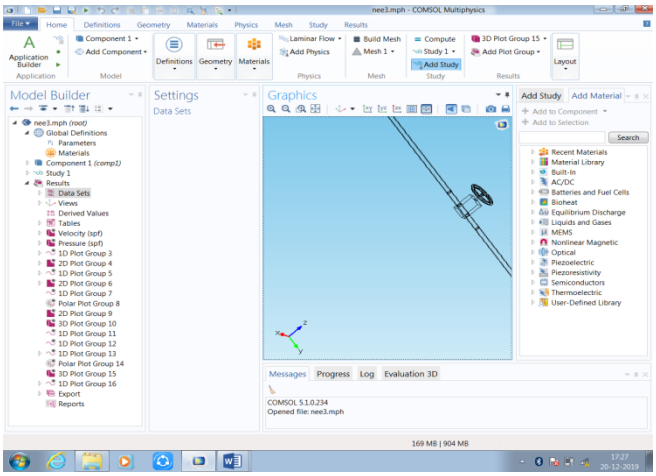

Figure4: Two pipelines and valve without dimensions

In figure 5 four pipes are connected with three valves in a network. I have taken four pipes with 10meter ength and valves in different conditions. First valve open 100%, second open 50% and third open 25%. In pipe two show the laminar flow.

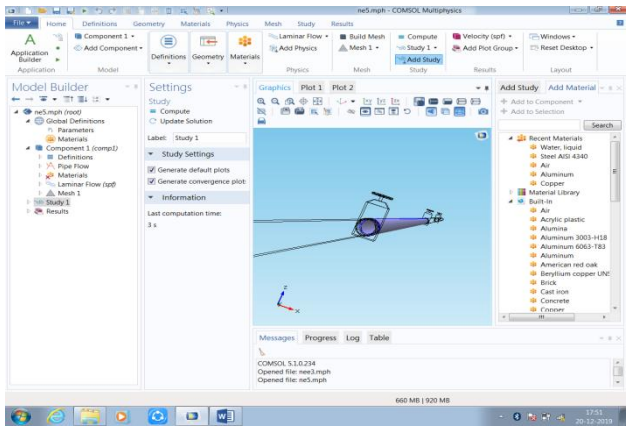

Figure5: Four pipelines and three valves connected in a network

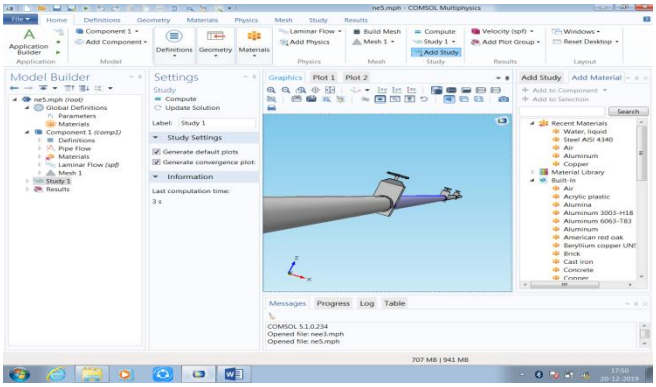

Figure6: Four pipelines and three valve connected in a network

In figure 7 to show the laminar flow at all pipes after domain selection. After this to set the fluid property, initial valve, wall 1, inlet1 and outlet 1.

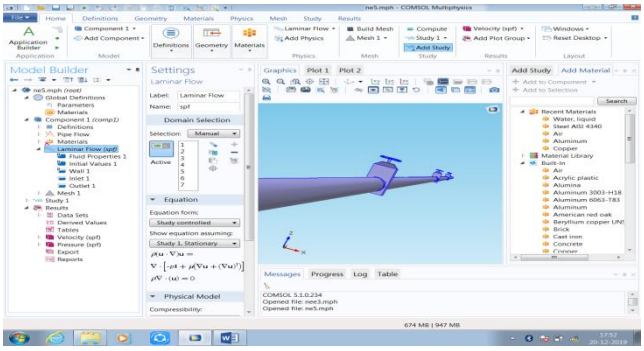

Figure7: Four pipelines and three valve connected in a network

IV. RESULT

In COMSOL Multiphysics can be calculated and derived all the data set, views, derived values, tables, velocity and pressure. I have detected pressure and velocity magnitude in pipeline.

4.1. Simulation result: find out the result in different graphs in 1D polar group, 2D polar group and 3D polar group.

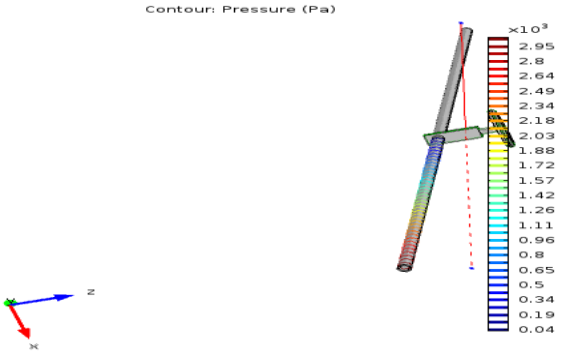

Figure8: Pipelines with valve to show pressure

In the figure 1 to show the one valve connected between two pipes. Valves in open status. After simulation in pipeline to show the pressure in pipeline.

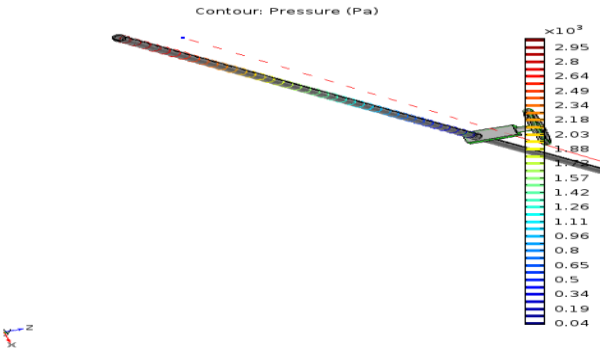

Figure9: Pipelines with valve to show pressure

In the figure 2 to show the pressure in y-z direction with one valve in open status.

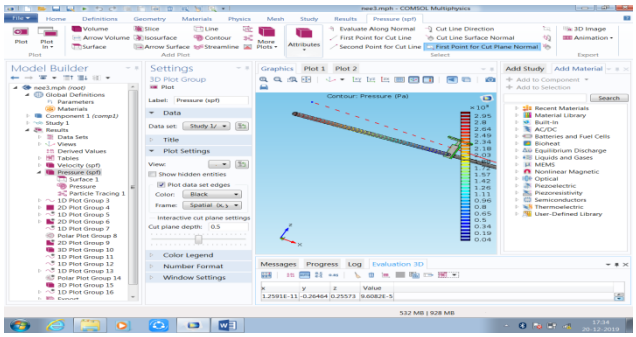

Figure10:Pipelines with valve to show pressure in COMSOL window

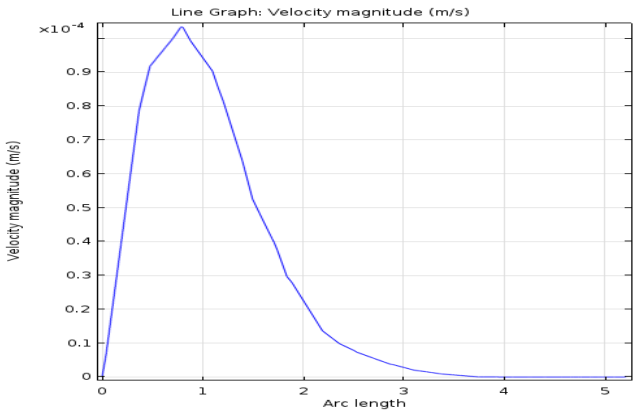

Figure11: Line graph to show velocity magnitude

In figure 5 to show the velocity magnitude in line graph . Include velocity can be calculate flow in pipe.

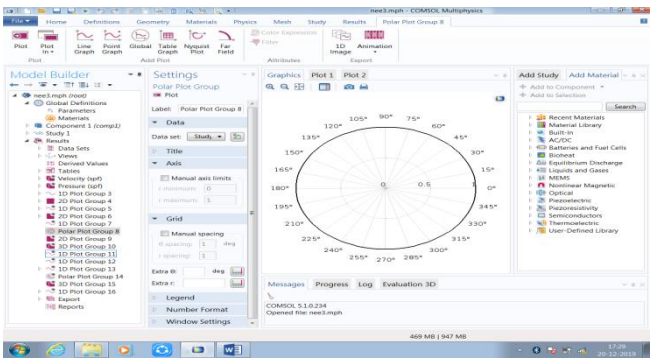

Figure121D plot graph for the pressure

In the figure 12to show the 1D plot graph of pressure.

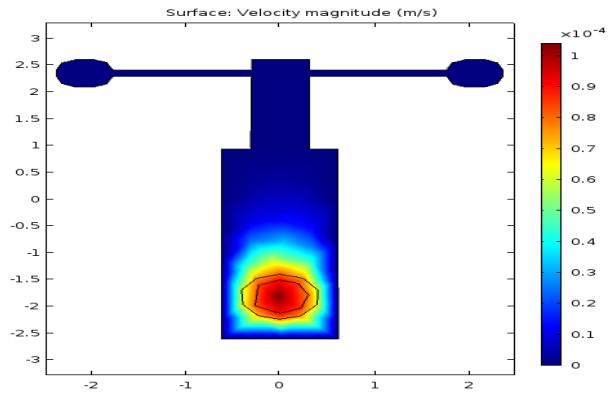

Figure13: surface velocity magnitude in pipeline

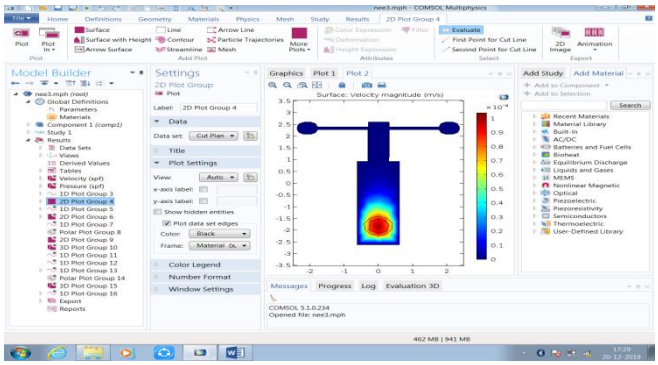

Figure14: surface velocity magnitude in pipeline

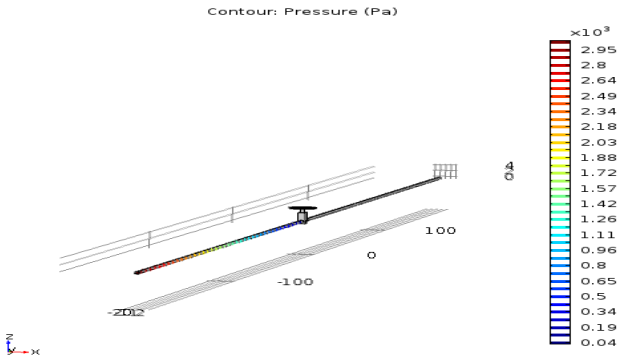

Figure15: Pressure with dimensions

V. CONCLUSIONS

COMSOLMultiphysics is a useful tool for simulation in the research work in water supply distribution network. I also have to create a two pipeline network with a valve 100% open status and to find out the velocity and pressure. It can be analyze with laminar flow. I have also used a single pipe, two pipes with one valve. This is a success simulation result in this pipe network. In future I have create a network with different pipes means 16", 4", 0.5" and valves with 25%, 50%,100% in open and close status and also using reducer, elbow, T joint. I have already designed all this tools in AutoCAD but only to create a network in COMSOL and simulate. COMSOL helpful to detected a leakage in water supply distribution network.

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