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Calculation of Coefficient of Discharge of Orifice Plate and Flow Nozzle Using CFD Analysis

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ABSTRACT:

An orifice plate is a device used for measuring flow rate. Either a volumetric or mass flow rate may be determined, depending on the calculation associated with the orifice plate.A nozzle is a device designed to control the direction or characteristics of a fluid flow (especially to increase velocity) as it exits (or enters) an enclosed chamber or pipe. Flow nozzle has high coefficient of discharge than orifice plate .The present work is directed towards the to study the flow through an orifice plate and a long radius flow nozzle' obstruction flow meters are commonly in use to measure flow rates in pipes. Both the orifice and nozzle are modeled inside a pipe with an inner diameter of 50 mm and a length of 1m water in the pipe flows with a mean velocity of 1m/s corresponding to Reynolds number 50,000.Thedischarge coefficients are determined and compared with experimental values.The cut plots ,XY-plots ,flow trajectories for orifice plate and flow nozzle are displayed.The centerline velocity varies along the length of the pipe for both the cases and plotted pressure , velocity fields .

INTRODUCTION TO ORIFICE PLATE :

An orifice plate is a device used for measuring flow rate. Either a volumetric or mass flow rate may be determined, depending on the calculation associated with the orifice plate. It uses the same principle as a Venturi nozzle, namely Bernoulli's principle which states that there is a relationship between the pressure of the fluid and the velocity of the fluid. When the velocity increases, the pressure decreases and vice versa.

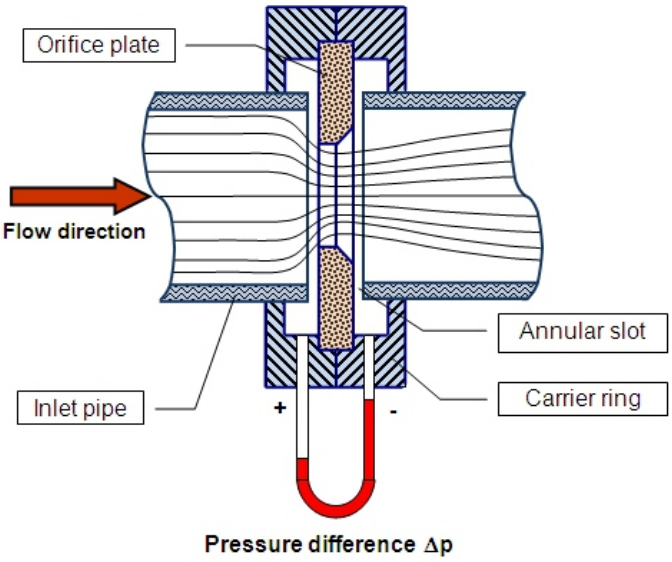

Figure : Orifice plate

MODELLING OF ORIFICE PLATE AND FLOW NOZZLE

MODELLING OF ORIFICE PLATE :

Firstly on front plane extruding the pipe of50 mm diameter as shown.

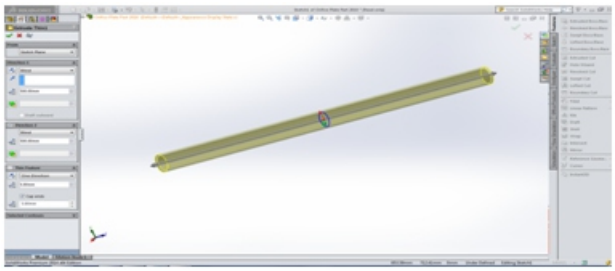

Figure : extrusion of pipe

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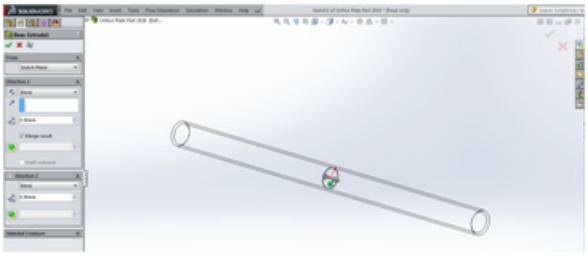

Figure : extrusion of plate for 0.5mm depth

Then extrude cut of plate is done. A 10mm radius circle is drawn and extrude cut is performed as shown.

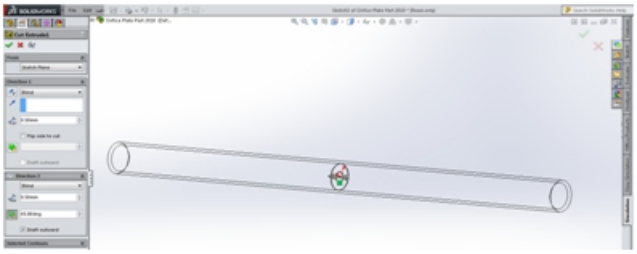

Figure : extrude cut of plate

Final orifice plate in pipe is as below:

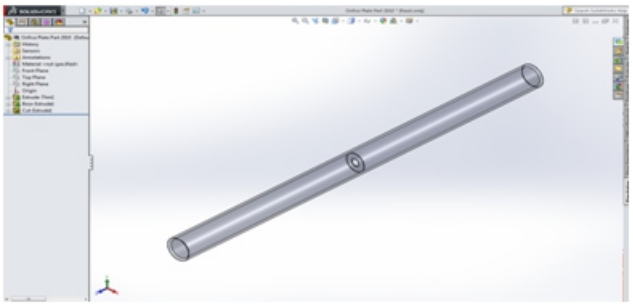

Figure : orifice plate in pipe

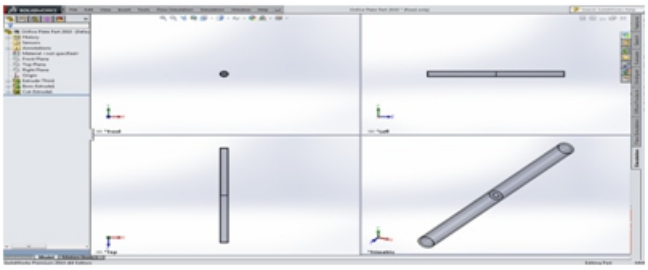

Figure : different views of orifice plate

MODELLING OF FLOW NOZZLE :

Firstly on front plane extruding the pipe of50 mm diameter as shown.

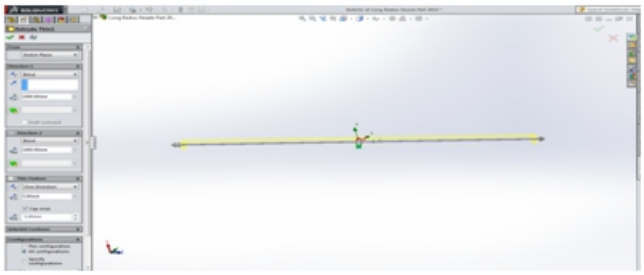

Figure : extrusion of pipe of dia 50mm

Then by using a revolve option flow nozzle is obtained as shown

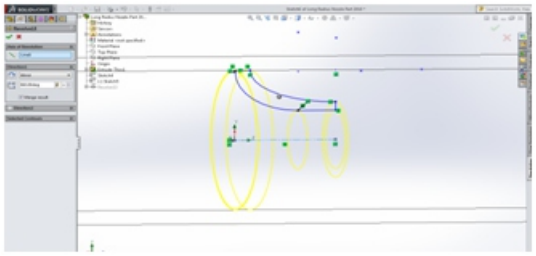

Figure : flow nozzle extrusion

The four different views of flow nozzle is shown below.

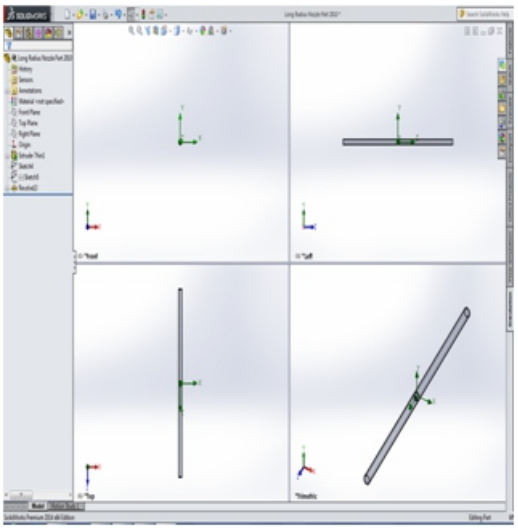

Figure : different views of flow nozzle.

RESULTS :

INSERTING CUT PLOTS :

Inserting cut plot by selecting z-velocity component and the velocity distribution befire and after orifice plate can be determined.

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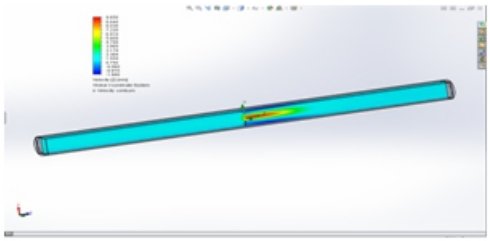

Figure : z-velocity distribution before and after orifice plate.

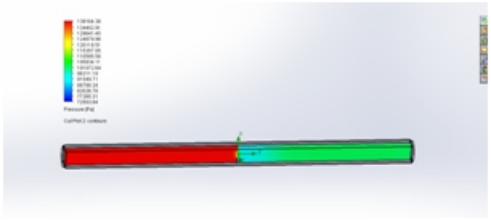

Figure : pressure distribution before and after orifice plate

INSERTING FLOW TRAJECTORIES :

Flow trajectories show the streamlines of the flowfor the orifice plate .On the flow simulation tree inserting flow trajectories on front plane by selecting velocity as parameter.

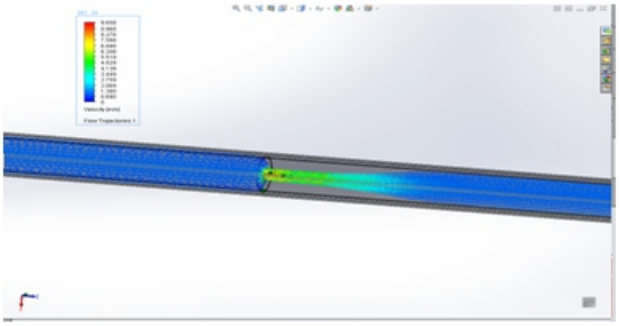

Figure : flow trajectories for orifice plate

FLOW SIMULATION OF FLOW NOZZLE

Creating study as flow nozzle study .setting SI units ,default INTERNAL ANALYSIS type,default wall and initial conditions and result resolution to 5 then the flow simulation tree will appear on the left side.

INSERTING BOUNDARY CONDITIONS AND GOALS :

Inserting same boundary conditions and point goals to the flow nozzle as applied to the orifice plate.

RESULTS :
INSERTING CUT PLOTS :

Inserting cut plot by selecting z-velocity component and the velocity distribution befire and after flow nozzle can be determined.

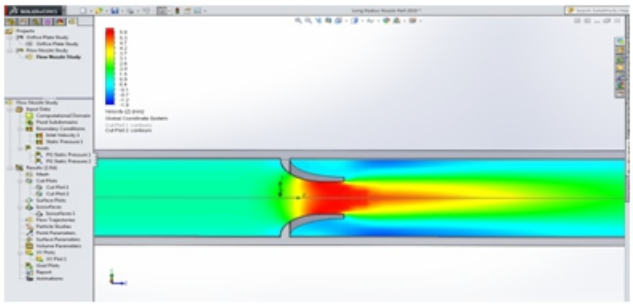

Figure :z-velocity distribution before and after flow nozzle.

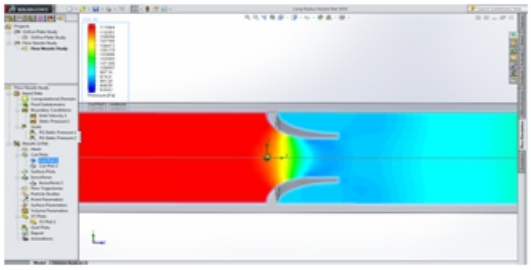

Figure pressure distribution before and after flow nozzle.

INSERTING FLOW TRAJECTORIES :

Flow trajectories show the streamlines of the flow for the orifice plate .On the flow simulation tree inserting flow trajectories on front plane by selecting velocity as parameter.

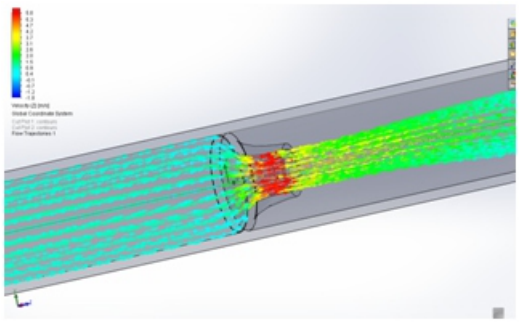

Figure : flow trajectories for flow nozzle

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CONCLUSIONS:

» The orifice plate and flow nozzle terminology ,working and applications has been studied.
» The orifice plate and flow nozzle in the pipe has been modeled in a CAD tool called SOLIDWORKS 2014.
» SOLIDWORKS FLOW SIMULATION has been studied .
» Flow simulation is performed on orifice plate and flow nozzle.
» Coefficient of discharge of orifice plate from flow simulation result and experimental equation has been compared. There exists a difference of 6.5% between those two.
» Coefficient of discharge of flownozzle from flow simulation result and experimental equation has been compared. There exists a difference of 13%.
» Cut plots ,XYplots and flow trajectories has been displayed for orifice plate.
» Cut plots ,XYplots and flow trajectories has been displayed for flow nozzle.
» The centerline velocity varies along the length of the pipe for both the cases and plotted pressure , velocity fields .

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