SKILL LYNC

Week 9 - Parametric study on Gate valve.

AIM: Parametric study of a gate valve. Introduction: This study is to understand the mass flow rate and the pressure drop to calculate the Flow coeffcient and flow factor to understand the efficiency of the Gate valve. The study includes parametrization in ANSYS Fluent. Defining properties 1) Flow coefficient:...

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Project Details

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Introduction: This study is to understand the mass flow rate and the pressure drop to calculate the Flow coeffcient and flow factor to understand the efficiency of the Gate valve.

The study includes parametrization in ANSYS Fluent.

Defining properties

1) Flow coefficient: Flow coefficient is a metric by which the flow inside a pipe is mesured.It is defines as, the volume of flow accross the pipe per minute at 60F with a pressure drop 1 psi.

It is given by,

$$Cv = Q\left(\frac{S}{\triangle p}\right)^{0.5}$$

Cv = Flow coefficient,

Q = Mass flow rate

S = Specific gravity of fluid (Water for this case = 1)

$\triangle p$ = Pressure drop

2) Flow factor: This is same as the flow coefficient used all over the world except United States.

$$Kv = 0.865.Cv$$

For the current study 5 cases are considered for gate opening:

10%	*5.5mm*
21%	*12mm*
40%	*22mm*
58%	*32mm*
80%	*44mm*

Snippets of the valve:

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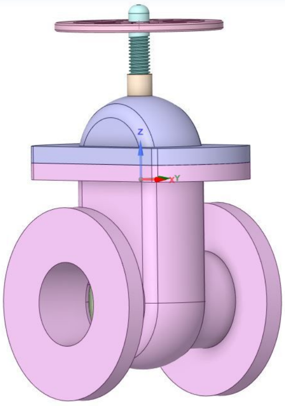
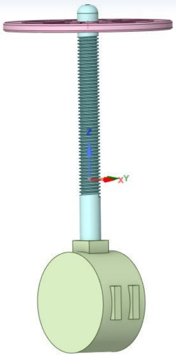
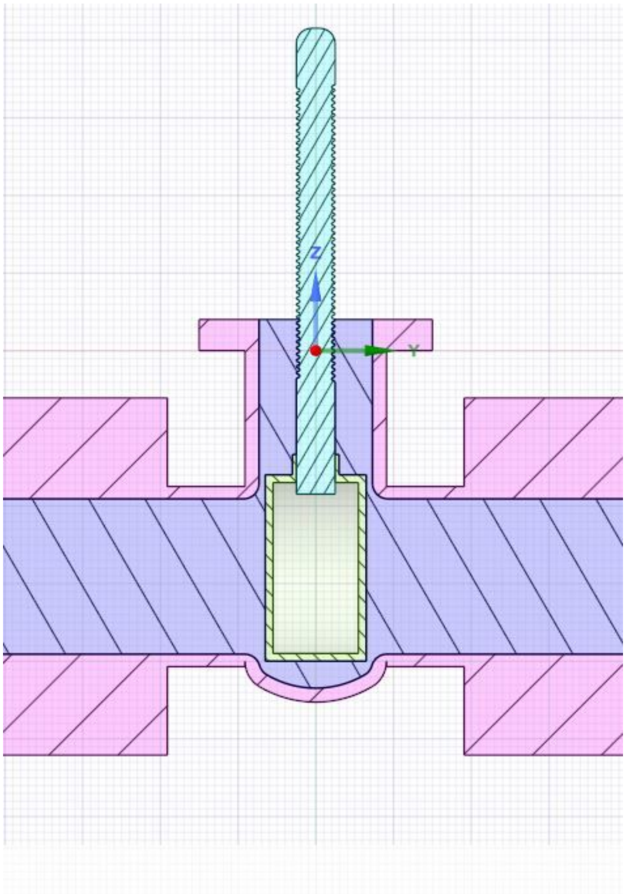
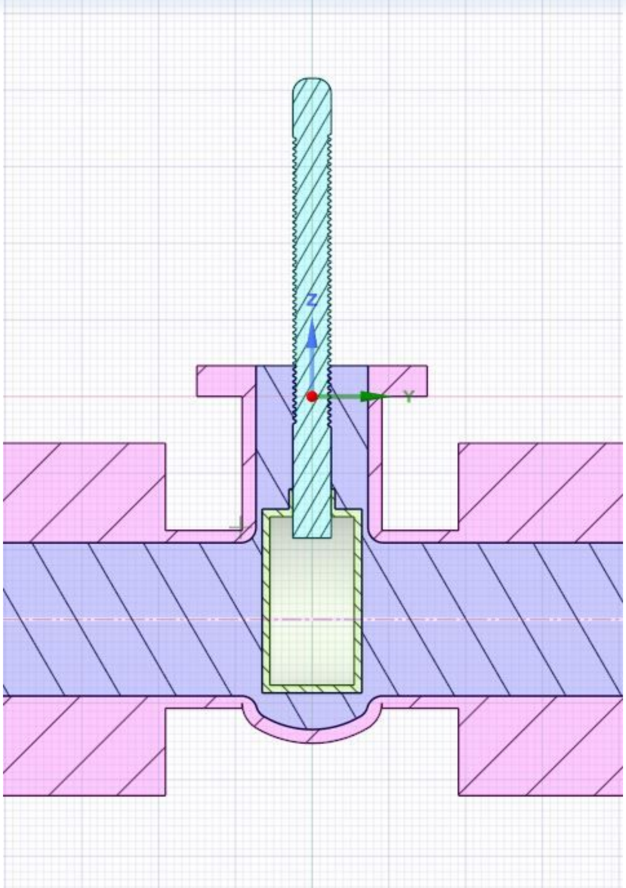
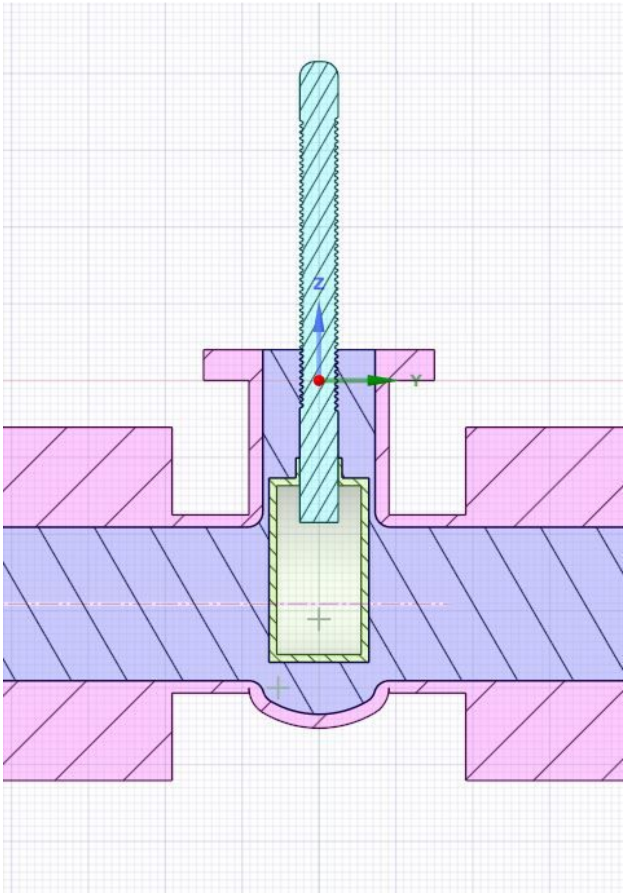




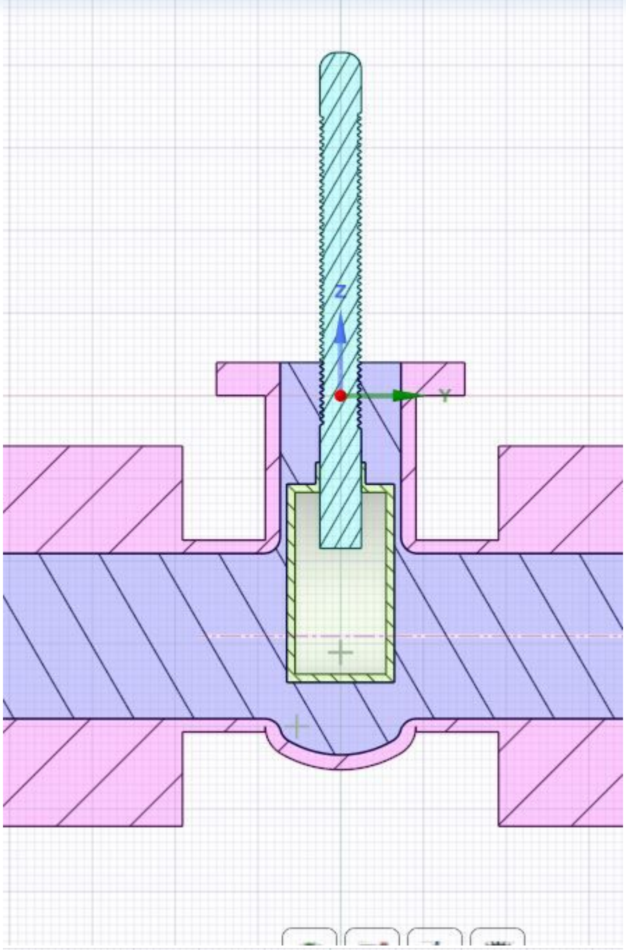
Case	**Gate valve**
5.5 mm	
12 mm	



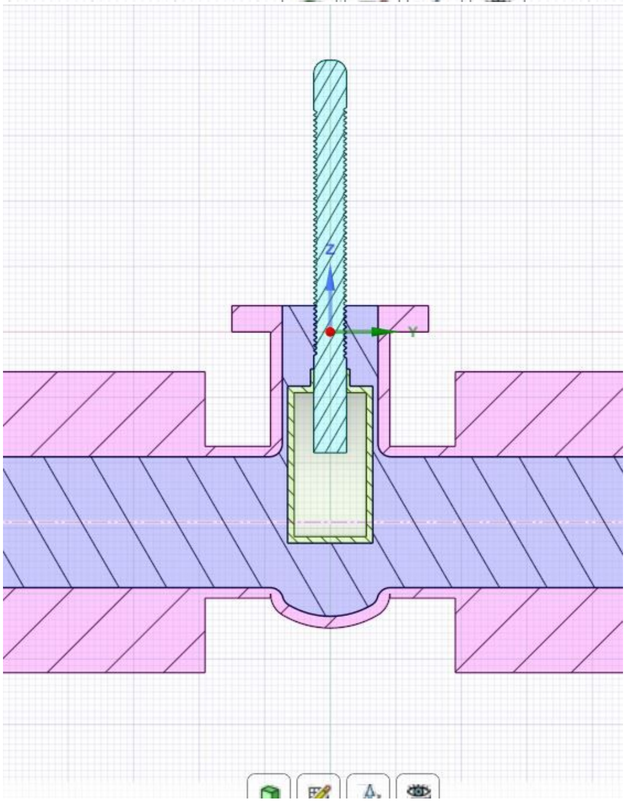


22 mm

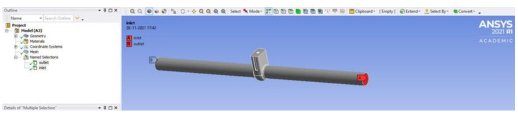
32 mm

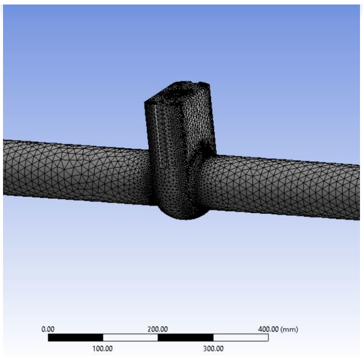


44 mm

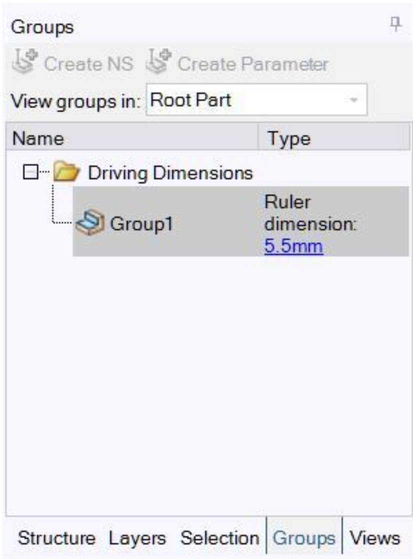
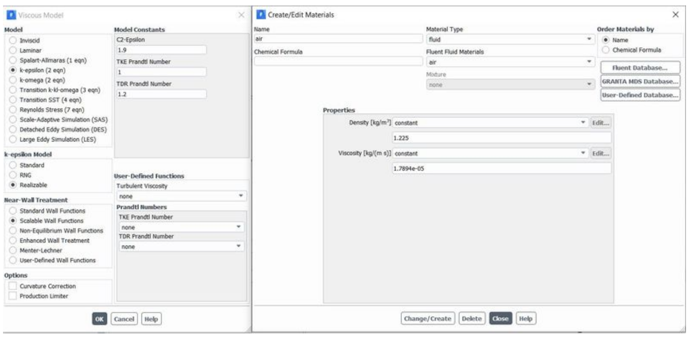


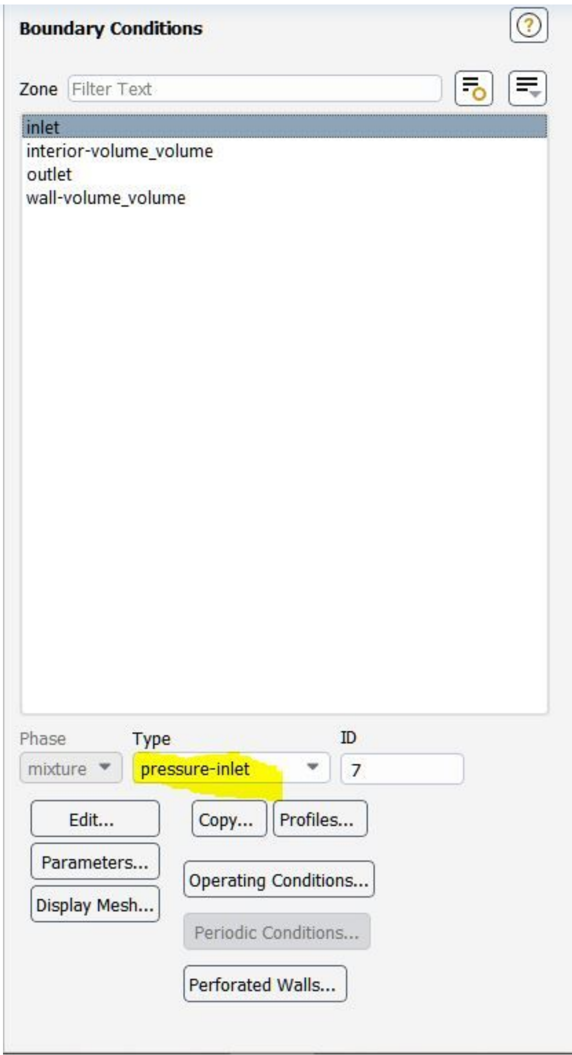
Mesh:

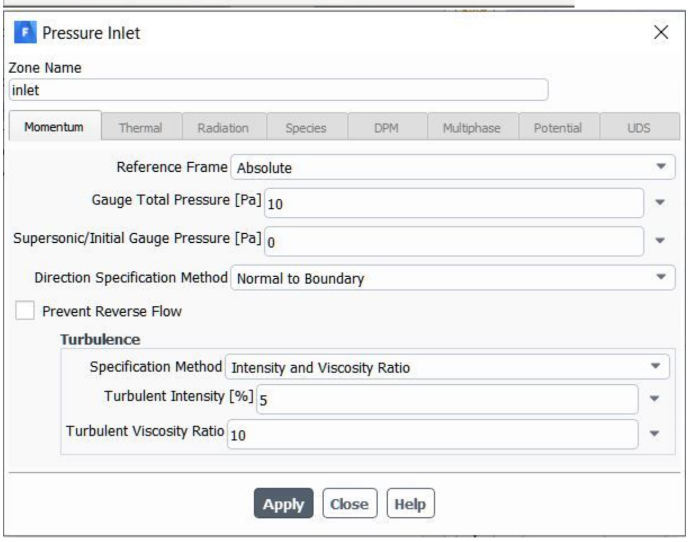




Snippets of the setup:

Sr No.	Images
	
Parametrization	
Viscous model and Material	
Inlet boundary condition (Pressure inlet)	

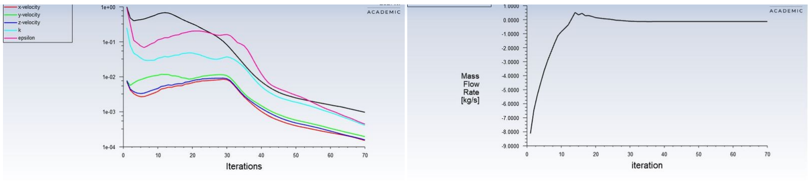




Assigning the values for inlet.

Residual plots and mass flow rate plots:

Cases (mm)	Residual	Mass Flow rate
5.5		



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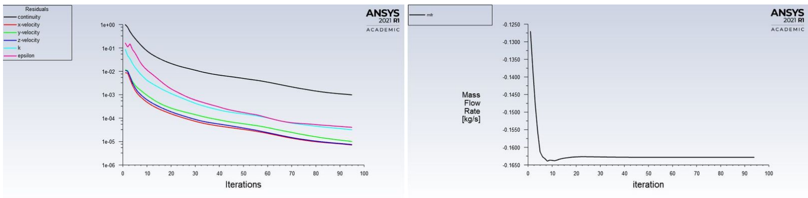

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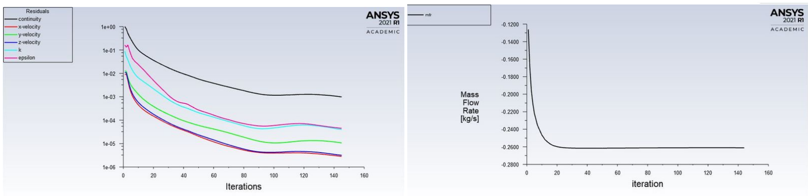

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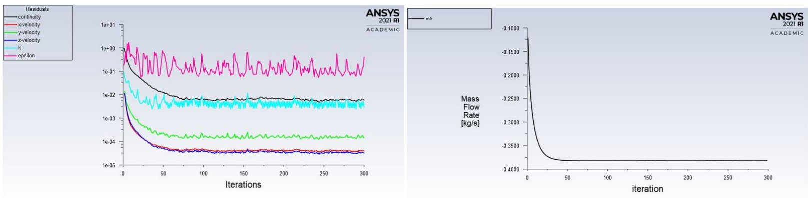

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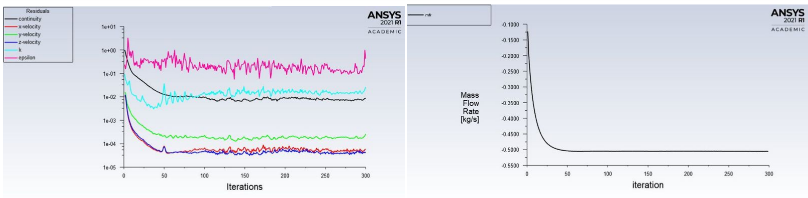


Calculating the Flow coefficient and Flow factors for each case:

For the mass flow rate and the pressure at the outlet is given by:

Mass flow rate

Table of Design Points

	A	B	C	D	E	F	G
1	Name	P1 - Group1	P2 - mfr-op	P3 - press-op	Ret...	Retained Data	Note
2	Units	mm	kg s^-1	Pa			
3	DP 0 (Current)	5.5	-0.12556	0	☑	✓	
4	DP 1	12	-0.16283	0	☑	✓	
5	DP 2	22	-0.26112	0	☑	✓	
6	DP 3	32	-0.38213	0	☑	✓	
7	DP 4	44	-0.50534	0	☑	✓	
*					☐		

Pressure at the outlet

Table of Design Points

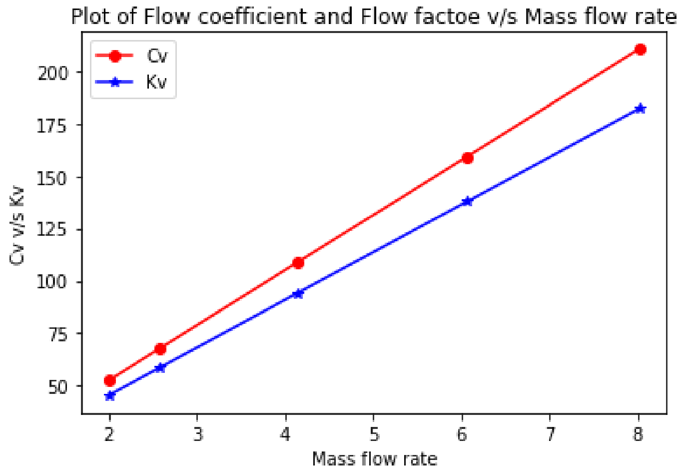
	A	B	C	D	E	F
1	Name	P1 - Group1	P2 - press-op	Ret...	Retained Data	Note
2	Units	mm	Pa			
3	DP 0 (Current)	5.5	0.00080489	☑	✓	
4	DP 1	12	0.0012933	☑	✓	
5	DP 2	22	0.0034015	☑	✓	
6	DP 3	32	0.0083144	☑	✓	
7	DP 4	44	0.0073704	☑	✓	
*				☐		

NOTE 1: The simulation was done 2 times as for the first time the pressure at the outlet was giving a zero value because of wrong setup. The next case is same in terms of the setup but solely for pressure at the outlet.

NOTE 2: The calculation for the Flow coefficient and Flow factor was done using Python and also the visualization.

```
import matplotlib.pyplot as plt
import numpy as np

q = [0.12556, 0.16283, 0.26112, 0.38213, 0.50534]              #Mass-flow rate          #unit
Q = [i/0.063 for i in q]                                                                 #Conv
Sg = 1                                                         #Specific Gravity of water
P = [0.00080489, 0.00112933, 0.0034015, 0.0083144, 0.0073704]  #Pressure                #Valu
del_p = [(10-i)*0.000145038 for i in P]                                                  #Conv

Cv = np.zeros(len(Q))                      #Initiating a list with zeros
for i in range(len(Q)):

    Cv[i] = Q[i]*((Sg/del_p[i])**(0.5))    #Formual to calculate Flow coefficient

Kv = 0.865*Cv                              #Flow factor conversion from Flow coefficient
```

```
plt.plot(Q, Kv, 'b', marker = '*')
plt.title("Plot of Flow coefficient and Flow factoe v/s Mass flow rate")
plt.xlabel("Mass flow rate")
plt.ylabel("Cv v/s Kv")
plt.legend(["Cv", "Kv"])
plt.show()
```



Result Table:

Sr No.	Case (length of valve opening in mm)	Mass flow rate (Kg/s)	Pressure drop	Flow coefficient	Flow factor ($\frac{m^3}{h}$)
1	5.5	0.122556	0.00080489	52.33441	45.26926
2	12	0.16283	0.00112933	67.86994	58.70750
3	22	0.26112	0.0034015	108.8510	94.15614
4	32	0.38213	0.0083144	159.3346	137.8244
5	44	0.50534	0.0073704	210.6989	182.2545

Discussion of the result:

The study conducted gives substantial information about the efficiency of the gate valve. Few observation that can be made here are as follows:

a) As the gate opening length increases the mass flow rate increases and so does the pressure drop. Although, the pressure at the outlet is too small it does have an impact on the flow coefficient.

b) As the mass flow rate is essential to the efficiency of the GateValve, the flow coefficient is tied to the same as the mass flow rate incresaes so does the flow coefficient.

c) The graph shows the information about the flow factor and flow coefficient. As from the formula for flow coefficient it is evident that the mass flow rate is directly proportional to the mass flow rate hence it increases.