**A MINI PROJECT REPORT**

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***BACHELOR OF TECHNOLOGY***

**IN**

**CHEMICAL ENGINEERING**

**BY**

**Bhavneet Kaur (20112019)**

**Anjali Balana (20112014)**

**Tarsem Singh (20112079)**

**Tajinder Singh (20112075)**

**TO**

**Dr. R K Arya**

**Department of chemical engineering**

**Dr. BR Ambedkar NIT, Jalandhar**

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**ABSTRACT**

This experiment was conducted in order to find the change in flowrate due to multiple outlets.

Numerical simulation is a technique used to investigate the fluid flow properties across various channels. Several methods were employed to investigate the flow characteristics.

The overall flow system can be treated as pipe network. And flowrate through each branch can be calculated by using some assumptions and list values for all coefficients to account for losses at T junctions.

The main purpose of this work is to establish the influence on the inflow velocity (flowrate) and system aspect ratio on the uniformity of the exit flows through the multi-slot channel that simulates equivalent pipe conditions as flow patterns in a fluid depend on three factors

1. Characteristics of the fluid
2. The speed of the flow
3. The shape of the solid surface

Using semiempirical formulas for the flow resistance and flow network methodology a finite solution method is used to calculate the local pressure patterns in the pipes and establish flow distribution trends and nonuniformity as a function of Re number and system aspect.

**LIST OF FIGURES**

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   * + 1. **INTRODUCTION**

The measurement of flow is the process of figuring out how much of a fluid—liquid or gas—passes through a pipe, duct, or open channel.

Pipe with many outputs can be utilized in a variety of technical sectors, particularly the water supply system, to distribute and collect fluids. Due to friction head losses, the discharge of the water from the pipe outlets varies along the manifold. The cumulative friction losses are the principal cause of the change in the head along the dead-end multi-outlet pipe. Additionally, it has been discovered that the distance between outlets and the DR (ratio of outlet diameter to main pipe diameter) are parameters that effect head loss throughout many outlets of pipe. The declining flow is what caused the Reynolds number to shift along the various pipe outlets. As a result, the coefficient of friction is adjusted appropriately. Many academic works made the convenient assumption that the coefficient of friction along pipelines with various outlets is constant. The findings of this investigation actually demonstrated that this presumption is incorrect.

W.H. Alawee et al. and other researchers concluded that the diameter ratio, S/d and diameter ratio, do/d, along with the multiple outlets of the pipe, are the governing factors affecting friction head loss and uniformity of the flow in order to more adequately explain the flow phenomena upstream and downstream of an aperture. The results showed that increasing the outlet spacing increased the uniformity for the same inlet head and area ratio. The smaller the ratio of the diameter, for fixed spacing, S/d, and fixed inlet head, the smaller the overall head loss. The diameter ratio and head ratio were shown to have a non-linear connection; generally, head loss rises as DR rises. The measured friction head losses in two pipes—one with outlets and the other without—for the same length, material, diameter, and discharge did not exhibit any discernible correlation. This is caused by variations in the outlet diameter, the main pipe length and diameter, the distance between the outlets, the intake head, and data recording inaccuracies. The intake head, pipe diameters, and outlet spacing all affect the experiment's G factor in different ways.

Yet, a number of researches investigated the use of several outlet pipes in an effort to lessen the significant pressure loss that was observed when using a single pipe. The evaluation and comparison of the flow characteristics of single and multiple outlets revealed that the multiple outlets have better flow characteristics. Several researchers have also shown how multiple outlets can reduce cavitation.

* + - 1. **DEVELOPMENT OF MATHEMATICAL MODEL**

This section presents the development of the mathematical model to predict the flow rate of fluid through the different outlets. We will consider 2, 3 and 4 pipes system with laminar flow.

**2 PIPES SYSTEM**

1

**3**

**2**

**4**

In order to determine the flow that whether it is laminar or turbulent, we will calculate maximum outlet velocity with no head losses and assuming pressure as atmospheric pressure and calculate the Reynolds number.

For maximum flow rate,

= 0

Applying Bernoulli equation at point 1 & 2 without considering the 3 & 4 pipes, we get

h =

(maximum)

Then, Reynold number will be

If the flow is laminar and Reynolds number is less than and equal to 2100, the friction factor may be determined by the equation

Now Applying Bernoulli eq. at point 1 & 3

atmospheric pressure

(ground level)

Assuming that,

L = L\2

D = D

= h

g = 10 m/s

=

=

So, the equation will be

H =

H = ------------- (A)

Now again Applying Bernoulli eq. at point 1 & 4

H =

H = -------------- (B)

From equation (A)

H = +

Put L\i = (where I = no. of outlets)

H = +

Now taking as

taking as

H = +

+ – H = 0

+ = 0

As

So, the equation will become

+ + = 0

Let =  ; =

And similarly,

Therefore, the value of velocity will be

From this, we can easily calculate the flow rate among these pipes

Q= AV

**3 PIPES SYSTEM**

Similarly, we will calculate for 3 pipe networks considering the same assumptions

1

**3**

**2 4**

**5**

Applying Bernoulli equation at 1 & 3

H =

H = -------------- (A)

Applying Bernoulli equation at 1 & 4

H =

H = -------------- (B)

Applying Bernoulli equation at 1 & 5

H =

H = ----------(C)

From equation (A)

H = +

Put L\i = (where I = no. of outlets)

H = +

Now taking as

H = +

+ – H = 0

+ = 0

As

So, the equation will become

+ + = 0

Let = ; =

And similarly,

Therefore, the value of velocity will be

From velocities, we can calculate the flow rate among different outlets with the formula

Q= AV

**4 PIPES SYSTEM**

Now, we will evaluate the same with 4 pipe networks considering same assumptions

1

4 Number PNG Transparent Images - PNG All **3**

 **2**

Applying Bernoulli equation at 1 & 3

H =

H = ------------- (A)

Applying Bernoulli equation at 1 & 4

H =

H = -------------- (B)

Applying Bernoulli equation at 1 & 5

H =

H = -----------------(C)

Applying Bernoulli equation at 1 & 6

H =

H = ----------------- (D)

From equation (A)

H = +

Put L\i = (where I = no. of outlets)

H = +

Now taking as

H = +

+ – H = 0

+ = 0

As

So, the equation will become

+ + = 0

Let = ; =

And similarly,

Therefore, the value of velocity will be

From this, we can calculate the flow rate with the formula

Q= AV

GENERAL DERIVED EQUATION

Where i = no. of outlets

Q= A

* + - 1. **RESULTS AND DISCUSSION**

The mathematical model was designed to study the variation of flow along the multiple outlets pipes. The flow rates were examined with the variation of diameter and height with the increasing number of outlets. Figure 4 shows the data with different diameter and pressure remains constant as atmospheric pressure with constant density and viscosity of the fluid. Figure 5 shows the graphical representation of flow rate along different diameter. Figure 6 shows the data with different height and pressure; density and viscosity remain same as that in previous case. Figure 7 shows the graphical representation of flow rate along different height.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **diameter** | **length** | **elevation(z1)** | **elevation(z2)** | **k effective** | **velocity v1** | **max velocity** | **actual velocity** | **flow rate** | **max flow rate** |
| 20 | 1 | 100 | 0 | 0.5 | 0 | 44.29 | 35.36 | 11103.04 | 13907.06 |
| 19 | 1 | 95 | 0 | 0.5 | 0 | 44.29 | 35.36 | 10020.49 | 12551.12 |
| 18 | 1 | 90 | 0 | 0.5 | 0 | 44.29 | 35.36 | 8993.46 | 11264.72 |
| 17 | 1 | 85 | 0 | 0.5 | 0 | 44.29 | 35.36 | 8021.95 | 10047.85 |
| 16 | 1 | 80 | 0 | 0.5 | 0 | 44.29 | 35.36 | 7105.95 | 8900 |
| 15 | 1 | 75 | 0 | 0.5 | 0 | 44.29 | 35.36 | 6245.46 | 7822.72 |
| 14 | 1 | 70 | 0 | 0.5 | 0 | 44.29 | 35.36 | 5440.49 | 6814.46 |
| 13 | 1 | 65 | 0 | 0.5 | 0 | 44.29 | 35.36 | 4691.03 | 5875.73 |
| 12 | 1 | 60 | 0 | 0.5 | 0 | 44.29 | 35.36 | 3997.09 | 5006.54 |
| 11 | 1 | 55 | 0 | 0.5 | 0 | 44.29 | 35.36 | 3358.67 | 4206.89 |
| 10 | 1 | 50 | 0 | 0.5 | 0 | 44.29 | 35.36 | 2775.76 | 3476.77 |
| 9 | 1 | 45 | 0 | 0.5 | 0 | 44.29 | 35.36 | 2248.37 | 2816.18 |
| 8 | 1 | 40 | 0 | 0.5 | 0 | 44.29 | 35.36 | 1776.49 | 2225.13 |
| 7 | 1 | 35 | 0 | 0.5 | 0 | 44.29 | 35.36 | 1360.12 | 1703.61 |
| 6 | 1 | 30 | 0 | 0.5 | 0 | 44.29 | 35.36 | 999.29 | 1251.64 |
| 5 | 1 | 25 | 0 | 0.5 | 0 | 44.29 | 35.36 | 693.94 | 869.19 |
| 4 | 1 | 20 | 0 | 0.5 | 0 | 44.29 | 35.36 | 444.12 | 556.28 |
| 3 | 1 | 15 | 0 | 0.5 | 0 | 44.29 | 35.36 | 249.82 | 312.91 |
| 2 | 1 | 10 | 0 | 0.5 | 0 | 44.29 | 35.36 | 111.03 | 139.07 |
| 1 | 1 | 5 | 0 | 0.5 | 0 | 44.29 | 35.36 | 27.76 | 34.77 |

FIGURE 4

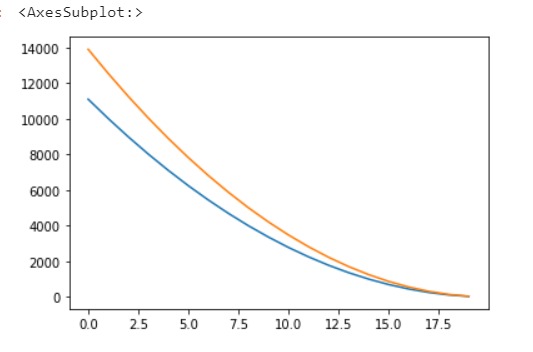


FIGURE 5

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **diameter** | **length** | **elevation(z1)** | **elevation(z2)** | **k effective** | **velocity v1** | **max velocity** | **actual velocity** | **flow rate** | **max flow rate** |
| 1 | 1 | 100 | 0 | 0.5 | 0 | 44.29 | 35.36 | 27.76 | 34.77 |
| 1 | 1 | 95 | 0 | 0.5 | 0 | 44.29 | 35.36 | 27.05 | 33.89 |
| 1 | 1 | 90 | 0 | 0.5 | 0 | 44.29 | 35.36 | 26.33 | 32.99 |
| 1 | 1 | 85 | 0 | 0.5 | 0 | 44.29 | 35.36 | 25.59 | 32.06 |
| 1 | 1 | 80 | 0 | 0.5 | 0 | 44.29 | 35.36 | 24.82 | 31.1 |
| 1 | 1 | 75 | 0 | 0.5 | 0 | 44.29 | 35.36 | 24.04 | 30.11 |
| 1 | 1 | 70 | 0 | 0.5 | 0 | 44.29 | 35.36 | 23.22 | 29.09 |
| 1 | 1 | 65 | 0 | 0.5 | 0 | 44.29 | 35.36 | 22.37 | 28.03 |
| 1 | 1 | 60 | 0 | 0.5 | 0 | 44.29 | 35.36 | 21.5 | 26.93 |
| 1 | 1 | 55 | 0 | 0.5 | 0 | 44.29 | 35.36 | 20.58 | 25.79 |
| 1 | 1 | 50 | 0 | 0.5 | 0 | 44.29 | 35.36 | 19.63 | 24.59 |
| 1 | 1 | 45 | 0 | 0.5 | 0 | 44.29 | 35.36 | 18.62 | 23.32 |
| 1 | 1 | 40 | 0 | 0.5 | 0 | 44.29 | 35.36 | 17.55 | 21.99 |
| 1 | 1 | 35 | 0 | 0.5 | 0 | 44.29 | 35.36 | 16.42 | 20.57 |
| 1 | 1 | 30 | 0 | 0.5 | 0 | 44.29 | 35.36 | 15.2 | 19.04 |
| 1 | 1 | 25 | 0 | 0.5 | 0 | 44.29 | 35.36 | 13.88 | 17.39 |
| 1 | 1 | 20 | 0 | 0.5 | 0 | 44.29 | 35.36 | 12.41 | 15.55 |
| 1 | 1 | 15 | 0 | 0.5 | 0 | 44.29 | 35.36 | 10.75 | 13.47 |
| 1 | 1 | 10 | 0 | 0.5 | 0 | 44.29 | 35.36 | 8.78 | 11 |
| 1 | 1 | 5 | 0 | 0.5 | 0 | 44.29 | 35.36 | 6.21 | 7.77 |

FIGURE 6

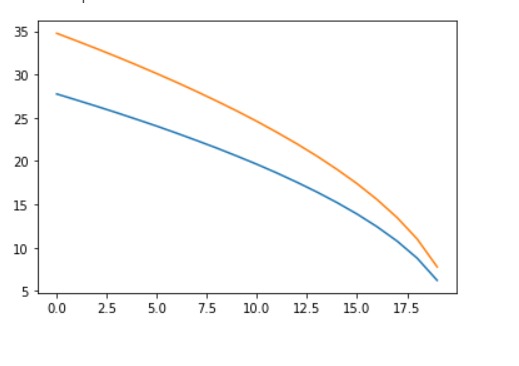


FIGURE 7

* + - 1. **CONCLUSION**

For the purpose of calculating the fluid flow rate in a pipe with various outputs, a fresh mathematical model was created. The continuity equation and application of the Bernoulli equation were used in the model. From this study, the following can be concluded:

* With the increase in outlets, there will be decrease in flowrate of fluid.
* With increasing the diameter of the outlets in the pipe, the flowrate of fluid decreases.
* With increasing the height i.e. elevation of the outlets, there will be increase in flowrate of fluid.

**NOMENCLATURES**

P = Pressure across different elevation

V = Velocity of fluid

Z = Height of elevation

g = Acceleration due to gravity

ρ = Fluid density

μ = Dynamic viscosity of fluid

HL = Head loss

D = Diameter of pipe

Re = Reynolds number

f = Friction factor

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