Engineering Hydraulics

**SHEET (1)**

1. The diameter of a pipe changes from 20 cm at a section 5 m above datum, to 5 cm at a section 3 m above datum. The pressure of water at first section is 5 kg/cm2. If the velocity of flow at the first section is 1 m/sec, determine the intensity of pressure at the second section.

2. For the shown figure, determine the values of Q3 and V3.

If D1 = 1 in, D2 = 2 in, D3 = 1.5 in, D4 = 1.2 in, V1 = V2 = 50 ft/sec, and V4 = 95.5 ft/sec

Tank

(*Q1*)

(*Q2*)

(*Q3*)

(*Q4*)

(1)

(2)

(3)

(4)

3. Determine the velocity and pressure at section (2) and section (3) if water flows steadily through the pipe system shown in figure. Assume a head loss of 10 ft is occurred from section (1) to section (2) and 14 ft from section (2) to section (3). Again, re-solve the problem if the head losses equals zero. Comment on your results.

(1)

(2)

(3)

22 ft

16 ft

12 ft

D1 = 18 in

P1 = 25 psi

V1 = 5 ft/sec

D2 = 10 in

P2 = ???

V2 = ???

D3 = 14 in

P3 = ???

V3 = ???

Datum

4. A siphon shown in figure has a uniform circular bore of 2.0 in diameter and consists of a bend pipe with its crest at 6.0 ft above water level discharging into atmosphere at level 14.0 ft below water level. Find the velocity of flow, the discharge and the absolute pressure at crest level if the atmospheric pressure is equivalent to 33 ft of water. (Neglecting head losses)

8ft

10 ft

*B*

*A*

*C*

5. Solve the previous problem if head losses between A and B equals 3 ft. and between B and C equals 6 ft. comment on yours results. A venturimeter with a 15 cm diameter at inlet and 10 cm throat is laid with its axis horizontal and is used for measuring the flow oil (S.g = 0.9 ) the oil mercury differential monometers shows a gauge difference of 20 cm . Assume coefficient of the meter as 0.98. Calculation the discharge in liters per minute (Ans.= 3835.8 lit /min)

6. A horizontal venturimeter 160 mm × 80 mm used to measure the flow of an oil of (S.g = 0.8). Determine the deflection of the oil mercury gauge, if the discharge of the oil is 50 liters/sec. (Ans. = 29.6 cm)

7. Fined the throat diameter of a venturimeter, when fitted to a horizontal main 10 cm diameter having a discharge of 20 liters/sec. The differential U- tube mercury manometer shows a deflection giving a reading of 60 cm. Venture coefficient is 0.95 (Ans. =4.636 cm)

8. A 30 cm × 15 cm venturimeter is provided in a vertical pipe – line carrying oil of (S.g = 0.9), the flow being up –wards. The difference in elevations of the throat section and entrance section of the venturimeter is 30 cm .The differential U- tube mercury manometer shows a gauge deflection of 25 cm. Calculate (i) the discharge of the oil, and (ii) the pressure difference between the entrance and throat section , tack (Cd = 0.98) (Ans. = 148.8 lit/ sec and =3.687m)

9. An orifice meter consisting of 10 cm diameter orifice in a 25 cm diameter pipe has coefficient = 0.65. The pipe delivers oil (S.g = 0.8). The pressure difference on the two sides of the orifice plate is measured by a mercury oil differential manometer. If the differential gauge reads 80 cm of mercury, Calculate the rate of flow in liter/sec. (Ans. =81.97 lit/ sec)

**SHEET (2)**

1. Compute the friction factor *f* for the flow of 1700 gpm of water at normal temperature in a 12 in cast iron pipe. (Take *ν* = 1.3×10-5 ft2/sec, *e* = 0.25 mm).

2. Select a pipe to convey 22 cfs of water between two reservoirs 6 mile apart (1 mile = 5282 ft) and 200 ft different in elevation. Use welded steel pipe and Hazen-Williams's equation. (*CH.w*= 130)

3. A cast iron pipe connects two reservoirs. The line is 1300 ft long and has a diameter of 10 in. If it were convey 10 cfs, what would be the frictional head loss for this pipe? (Take *ν* = 1.2×10-5 ft2/sec).

4. The pipe in problem 3 actually connects two reservoirs having difference in water surface level of 20 ft, so that pipe is clearly incapable of conveying 8 cfs. Now a new pipe has been installed between the reservoirs. It is made of welded steel and has a diameter of 18 in.

(a) If only pipe friction is considered, what is the new discharge?

(b) If local losses for a sharp-edged entrance, a fully open gate valve near the pipe exit, and the pipe exit itself are also considered, how much does the computed discharge change?

(c) If the gate valve in part (b) were only (1/4) open, what would then be the discharge?

5. Oil (*ρ* = 870 kg/m3, *μ* = 0.006 Pa. s) flows through a 120 mm diameter, 6 km long pipeline at a rate of 8 m3/h. Find the head loss due to friction.

6. Find the diameter of a new 1500 m long cast iron pipe to carry water at a rate of 3000 L/min, if the permissible head loss is 20. (Use Darcy-Weisbach equation)

7. Water stands at a constant elevation of 120 m in a tank feeding water at a constant rate of 0.2 m3/sec in a horizontal pipe shown in the following figure. Find the elevation of the water level in lower tank. (Take *Ksc* = 0.5)

(120.0)

(????)

*D1* = 22 cm

*L1* = 50 m

*f1* = 0.032

*D2*= 42 cm

*L2* = 200 m

*f2* = 0.04

*D3* = 16 cm

*L3* = 30 m

*f3* = 0.02

8. If 0.12 m3/sec of water flows in system shown in the following figure. What pressure head must be added to the water by the pump? The pipe is 16 cm diameter, *f* = 0.016. (Neglect minor losses)

(10.0)

(20.0)

50.0 m

50.0 m

P

9. What will be the total discharge in the pipeline shown in the following figure? (Neglecting minor losses, *f* = 0.01)

24 in, 10000 ft

12 in, 10000 ft

12 in, 10000 ft

25 ft

**Solution:**

10. Make the manual hydraulic analysis for the simple system shown in the following figure using ELGT. (Neglecting minor losses)

(100.0)

(60.0)

*D1* = 42 cm

*L1* = 200 m

*f1* = 0.05

*D1* = 22 cm

*L1* = 100 m

*f1* = 0.032

(1)

(2)

(3)

[1]

[2]

***First, using simple calculation:***

11. (a) Determine the flow values through pipes [1] and [2], and the head at intermediate node (2) using simple calculation. Values of Darcy – Weisbach coefficients can initially be assumed equal to 0.02 and 0.015 for pipe [1] and pipe [2] respectively. Take kinematic viscosity equal to 1.575×10-6 m2 /sec and neglecting minor losses. (Use Moody Diagram)

(b) Make the manual hydraulic analysis for the simple system shown in figure using the ELGT method. Values of pipe flows can be assumed in the first trial equal to 0.2485 m3/sec and 0.1235 m3/sec through pipe [1] and pipe [2] respectively. Trials should be continued until the tolerance less than or equal to 0.01. (neglecting minor losses)

(100.00) m

(50.00) m

**125 L/sec**

D1 = 500 mm

L1 = 500 m

e1 = 0.5 mm

D2 = 250 mm

L2 = 2500 m

e2 = 0.025 mm

**(1)**

**(2)**

**(3)**

**[1]**

**[2]**

**SHEET (3)**

1. A reservoir discharge water through a large orifice 1m wide and 1.50 m deep. The top of the orifice is 80 m below the water level in the reservoir. Assuming that the downstream water level is below the bottom of the orifice, calculate (a) the discharge through the orifice if Cd =0.6, (b) the percentage error if the orifice is treated as small. (Ans. 4.91 m3/sec and 1.02%)

2. A vertical triangular orifice has base width 1m and height 0.60 m, with its vertex at the top. If the depth of water above the vertex is 0.60 m, find the discharge. Take Cd=0.60 (Ans. 0.80 m3/sec)

3. An orifice, in one side of a large tank is rectangular in shape 2 m broad and 1m deep. The water level on one side, of the orifice, is 4 m above its top edge. The water level on the other side, of the orifice, 0.5 m below its top edge. Calculate the discharge through the orifice per second, if Cd = 0.625. (Ans. 11.58 m3/sec)

4. A tank has an upper cylindrical portion of 3 m diameter and 4 m high with a hemispherical base. The cylinder is full of water. Determine the time taken to empty it through an orifice of 10 cm diameter at its bottom, Take Cd =0.62 ( Ans. 1108 sec )

5. A vertical circular tank of 60 cm diameter and 2.5 m high is full of water. It contains two orifices each of 13 square cm area , one at the bottom of the tank and the other at a height of 1.25 m above the bottom . Determine the time required to empty the tank. Take Cd for both the orifices as 0.6. (Ans. 134.9 sec)

6. A swimming pool 30 m long and 8 m wide has vertical sides, and the bottom slopes uniformly from a depth of 1 m of the shallow end to 2.50 at and the deep end . There are two orifices each of 0.20 square m area one at the deep end and the other of the shallow end. Find the time required to empty the tank completely, if the coefficient of discharge for both the orifices is 0.64 (Ans. 721 sec)

**SHEET (4)**

1. A trapezoidal notch 120 cm wide at the top and 45 cm at the bottom is 30 cm high. Find the discharge through the notch, if the head of water is 22.5 cm. Take coefficient of discharge as 0.6. (Ans . 127.6 lit/ sec)

2. A narrow-crested weir 10 m long is discharge water under a constant head of 40 cm. Find the discharge over the weir in lit/ sec. Assume coefficient of discharge as 0.623. (Ans. 4654 lit / sec)

3. A broad – crested weir 10 m long has a maximum discharge of 10000 lit/sec. If the head of water on the upstream side of the weir 96 cm, head over weir crest 50 cm. Find the discharge over the weir in lit/ sec, if coefficient of discharge is 0.62. (Ans.9313 lit/ sec)

4. A triangular notch 100 cm wide at the top and apex angle =90 degree. Find the discharge through the notch, if the height of notch is full of water. Take Cd = 0.60. (Ans. 250.6 lit/sec)

5. A steeped weir consists of two steeps, it is width at top 120 cm, this width decreased by 10 cm from both sides and height of both steeps 30 cm. Find the discharge over the weir in lit/sec. Take Cd = 0.62. (Ans. 911 lit/ sec)

6. A broad- crested weir 20 m long is discharge water under head of water on the upstream side of weir 90 cm and submerged by head of 60 cm. Find the discharge over the weir in lit/sec .Take Cd = 0.62. (Ans. 24070 lit/sec)

**SHEET (5)**

1. A hose and nozzle discharge a horizontal water jet against a nearby vertical plate, as shown in figure. The flow rate of water is 0.025 m3/s, and the diameter of the nozzle tip is 30 mm. Find the horizontal force necessary to hold the plate in place.



2. Water flows from a large tank through an orifice of 3 in diameter and against a block, as shown in figure. The water jet strikes the block at the vena contracta. The block weight 50 Lb, and the coefficient of friction between block and floor is 0.57. The orifice coefficient of discharge is 0.6, and its coefficient of contraction is 0.62. What is the minimum height to which water must rise in the tank (y in figure) in order to start the block moving to the right.



3. The water jet in figure, moving at 45 ft/s, is split so that one-third of the water moves towards A. Calculate the magnitude and direction of the force on the stationary splitter. Assume ideal flow in horizontal plan.



4. Rework prob. 4, if the splitter is moving to the right at 8 fps.

5. A jet of water flowing freely in the atmosphere is deflected by a curve vane, as shown in figure. If the water jet has a diameter of 1.5 in and a velocity of 25.5 fps, what is the force required to hold the vane in place.



6. The pipe bend shown in figure is in horizontal plan. A fluid of weight density 8.615 KN/m3 enters the bend with a velocity of 3.5 m/s and a pressure of 280 kpa. Neglected any energy losses in the bend, find the force required to hold the bend in place.



7. The pipe bend shown in figure is in horizontal plan. Oil with a specific gravity of 0.86 enters the reducing bend at section A with a velocity of 3.2 m/s and a pressure of 150 KPa. Determine the force required to hold the bend in place. Neglected any energy losses in the bend.

