

Hydraulics

CVG 3116 - Fall 2017

Tutorial 2

Lecture 3

September 26, 2017

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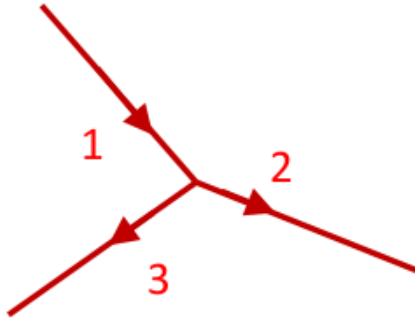


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Lecture 3: Junctions

Q1

- Inflow must be equal to outflow at the junction



$$\sum_{i=1}^n q_i = 0 \quad (\text{continuity})$$

- Convention: Flow into the junction is positive and the flow out of the junction is negative

$$q_1 - q_2 - q_3 = 0$$

Junctions – Solution Procedure

Q1

- Junction piezometric head

$$\frac{P_1}{\rho g} + z_1 + \frac{V_1^2}{2g} = \frac{P_J}{\rho g} + z_J + \frac{V_J^2}{2g} + \sum (h_{L1} + h_{f1})$$

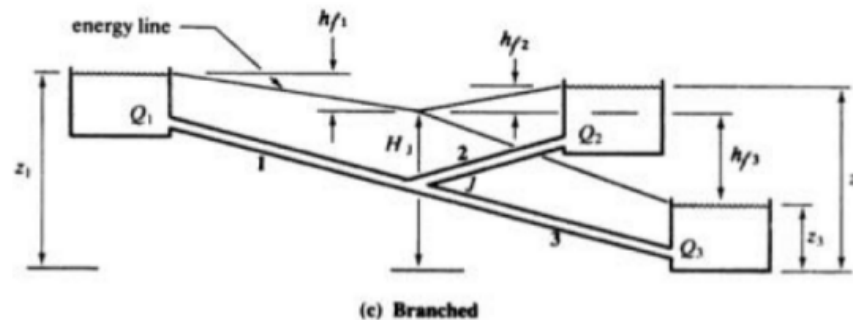


Figure 12.3 Series, parallel and branched pipes.

$$H_J = \frac{P_J}{\rho g} + z_J$$

- Write the energy equation in each pipe
- Ignore velocity head and local head losses

Junctions – Solution Procedure (cont.)

Q1

$$(1) \quad \frac{P_1}{\rho g} + z_1 + \frac{V_1^2}{2g} = \frac{P_J}{\rho g} + z_J + \frac{V_J^2}{2g} + \sum (h_{L1} + h_{f1})$$

$$(2) \quad P_1 = V_1 = 0$$

$$(3) \quad \text{Ignore } h_{L1} \text{ and } \frac{V_J^2}{2g}$$

$$(4) \quad \frac{P_J}{\rho g} + z_J = H_J$$

$$\Rightarrow h_{f1} = z_1 - H_J = \frac{\lambda_1 L V_1^2}{D 2g}$$

$$Q_1 = V_1 A_1$$

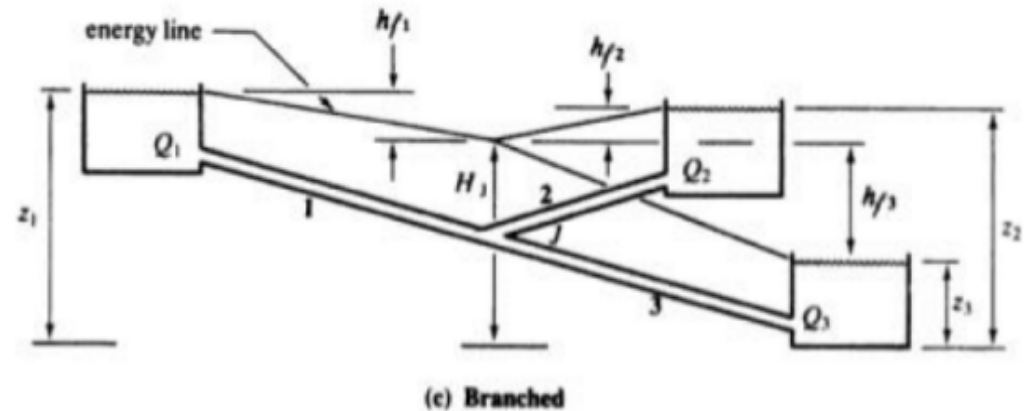


Figure 12.3 Series, parallel and branched pipes.

- Repeat for all the pipes in the system and check continuity
- Iterate initial assumption for H_J until continuity

Junctions – Solution Procedure (cont.)

Q1

Notes:

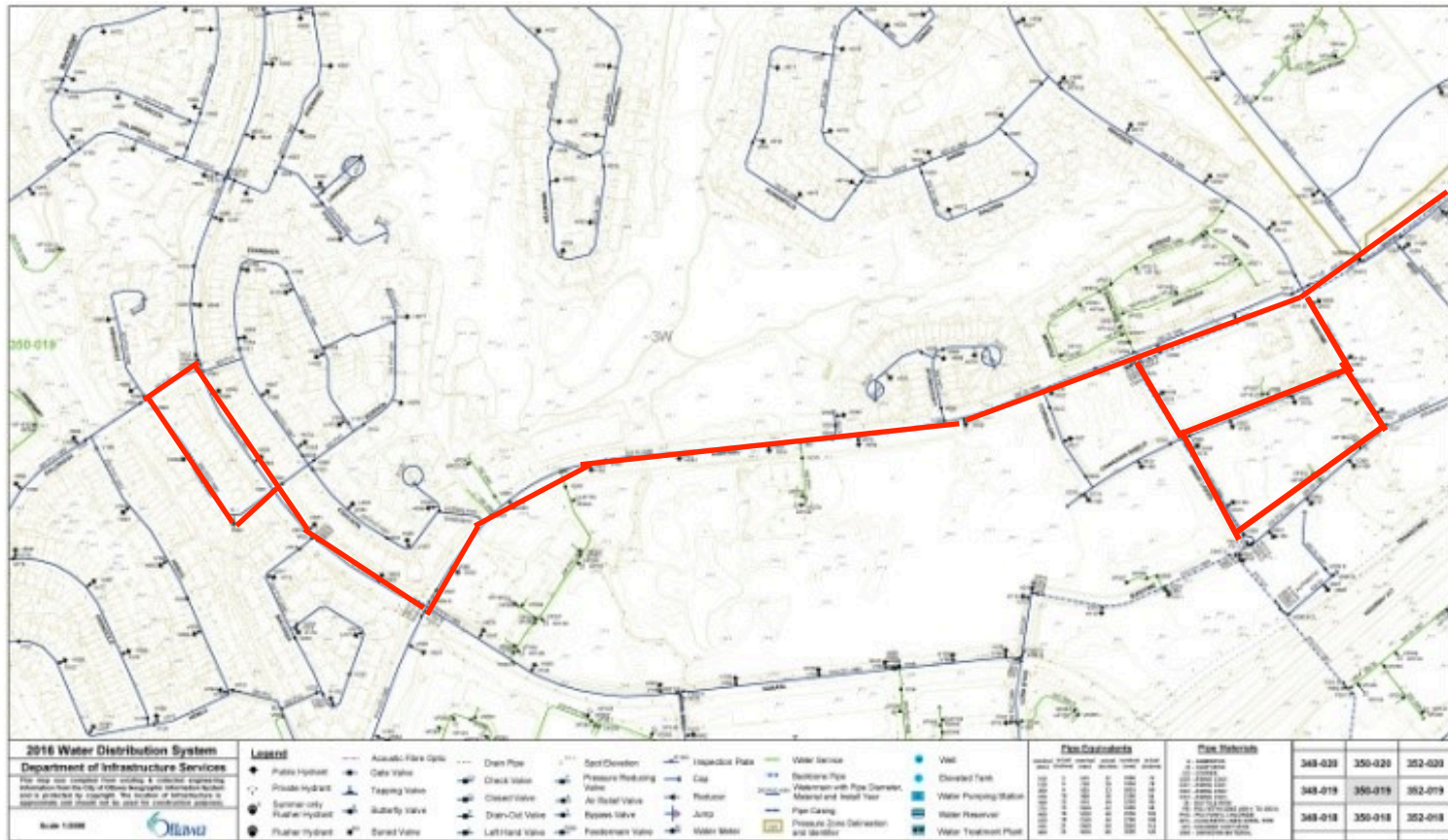
if $H_j < z_1$, the flow direction is from the reservoir 1 to the junction.

if $H_j > z_1$, the flow direction is from the junction to the reservoir 1.

In this case, you must reapply the energy equation between the reservoir and the junction (the flow direction in the pipe is reversed).

Pipe Systems – Loops

Q2



Pipe Systems – Loops

Q2

- Solution must satisfy two conditions

1- *The inflow must be equal to outflow at each junction:*

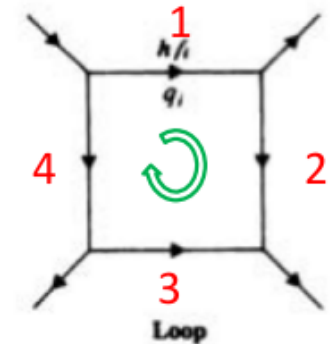
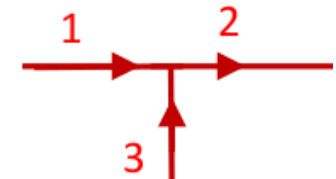
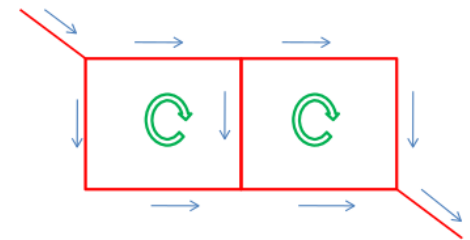
$$q_1 + q_3 = q_2$$

2- In each loop, *the head must be the same when you start from a point and return to the same point. Therefore:*

$$\sum_{i=1}^m h_{fi} = 0$$

Convention: Head loss is positive if the flow is in the clockwise direction .

$$h_{f1} + h_{f2} - h_{f3} - h_{f4} = 0$$



Loops- Solution Procedure

Q2

Algorithm

1. Assume initial values for discharge at each pipe q_i such that inflow=outflow at each junction.
2. Calculate *friction loss* h_{fi} in each pipe using the corresponding discharge q_i
3. *In each loop:*

1. if $\sum h_{fi} = 0$, then the solution is correct in that loop.

- 3.1. if $\sum h_{fi} \neq 0$, then add the following correction δq to the discharges of all pipes in that loop.

$$\delta q = -\frac{\sum h_{fi}}{2 \sum \frac{h_{fi}}{q_i}} \quad (\text{sum over all pipes of the loop})$$

- 3.3. Return to the step 2. Stop if $\sum h_{fi} = 0$ in all loops