

# Wastewater Treatment Lecture 8

## Pipe Network Analysis\_2<sup>nd</sup> Iteration

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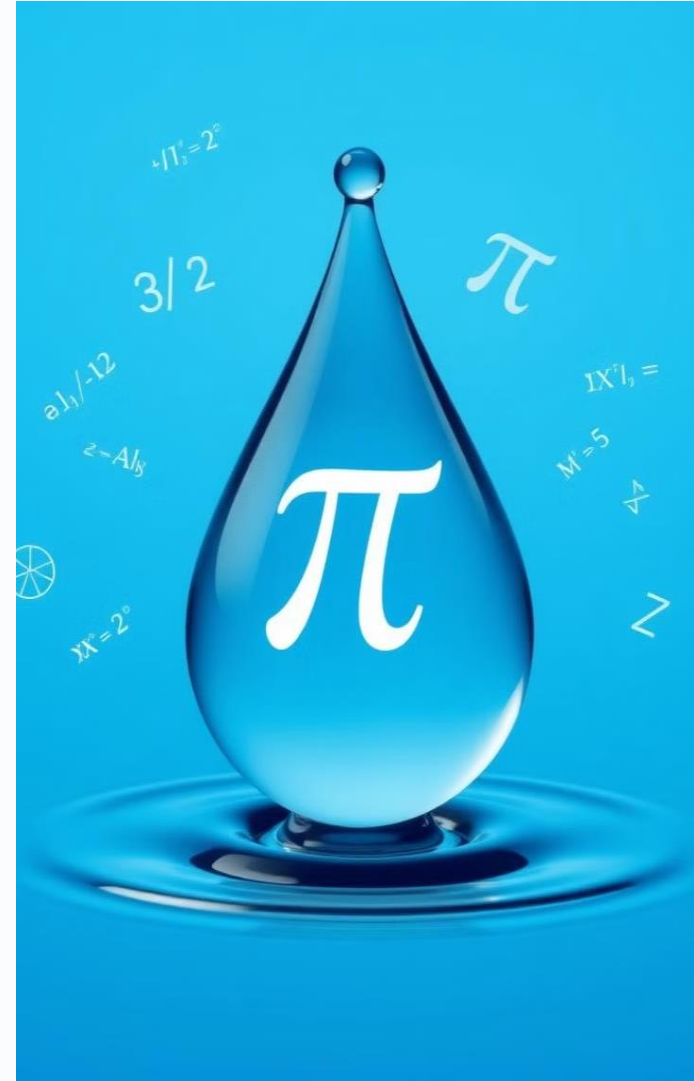


For Hazen Williams

$$\Delta = \frac{-\sum h_f}{1.85 * \sum \frac{h_f}{Q}}$$

After calculation  $\Delta$  correct  $Q_o$  and check  $\sum_{loop} h_f \approx 0$

$$Q = Q_o + \Delta$$



$$K = \frac{10.67 * L}{C^{1.85} * d^{4.87}}$$

$$HL (Pipe) = KQ^{1.85}$$

$$\Delta = \frac{-\sum h_f}{1.85 * \sum \frac{h_f}{Q}}$$

for pipe 2 in loop1

$$\Delta = \Delta_1 - \Delta_2$$

for pipe 2 in loop2

$$\Delta = \Delta_2 - \Delta_1$$

1- التدفق لازم يكون متر مكعب لكل ثانية

2- افرض قيم التدفق (Q) اذا كانو مش موجودات على الشبكة

3- حدد اتجاه التدفق والحلقات في الشبكة

4- اعمل جدول خاص بالمحاولة الأولى وضع القيم المطلوبة في الأعلى

5- احسب قيم الK

6- وضع قيم التدفق على الجدول ومراعاة إشارة التدفق (مع عقارب الساعة موجب)(عكس عقارب الساعة سالب)

7- نحسب قيم hf باستخدام المعادلة التالية

8- قيم ال hf تكون نفس إشارة قيم التدفق ونجمع قيم ال hf لكل حلقة لوحدها

9- قسمة قيم ال hf على التدفق Q وإيجاد مجموعهم

10- إيجاد قيمة تصحيح التدفق باستخدام العلاقة

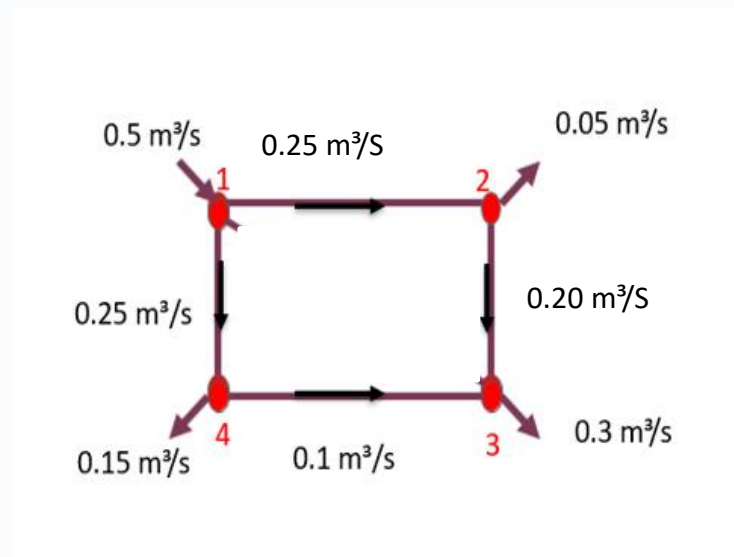
11- تصحيح التدفق للانابيب على الشبكة

12- الانبوب المشترك يأخذ تصحيح من الحلقتين المشترك بينهما الانبوب

# Example 1

Solve the following pipe network using Hazen William Method  $C_{hw}=100$

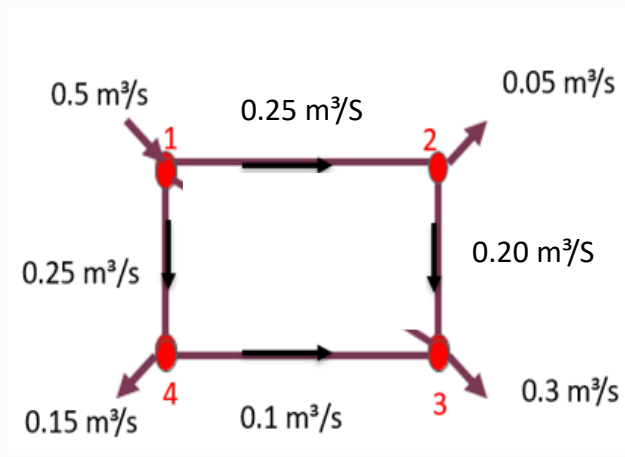
Pipe	Diameter (mm)	Length (m)
(1-2)	500	750
(2-3)	400	500
(3-4)	450	600
(4-1)	350	450







First Loop								
Pipe	L (m)	D (m)	k	Q (m <sup>3</sup> /sec)	hf	hf/Q	Δ	Q correct
1-2	750	0.5						
2-3	500	0.4						
3-4	600	0.45						
1-4	450	0.35						

First Loop								
Pipe	L (m)	D (m)	k	Q (m <sup>3</sup> /sec)	hf	hf/Q	Δ	Q correct
1-2	750	0.5	46.69192					
2-3	500	0.4	92.27887					
3-4	600	0.45	62.39801					
1-4	450	0.35	159.1349					

$$K = \frac{10.67 * L}{C^{1.85} * d^{4.87}}$$



First Loop								
Pipe	L (m)	D (m)	k	Q (m <sup>3</sup> /sec)	hf	hf/Q	Δ	Q correct
1-2	750	0.5	46.69192	0.25 				
2-3	500	0.4	92.27887	0.2 				
3-4	600	0.45	62.39801	-0.1 				
1-4	450	0.35	159.1349	-0.25 				

First Loop								
Pipe	L (m)	D (m)	k	Q (m <sup>3</sup> /sec)	hf	hf/Q	Δ	Q correct
1-2	750	0.5	46.69192	0.25	3.592781			
2-3	500	0.4	92.27887	0.2	4.699025			
3-4	600	0.45	62.39801	-0.1	-0.8814			
1-4	450	0.35	159.1349	-0.25	-12.2449			
				Σ	-4.83447			

$$HL (Pipe) = KQ^{1.85}$$

First Loop								
Pipe	L (m)	D (m)	k	Q (m <sup>3</sup> /sec)	hf	hf/Q	Δ	Q correct
1-2	750	0.5	46.69192	0.25	3.592781	14.37113		
2-3	500	0.4	92.27887	0.2	4.699025	23.49513		
3-4	600	0.45	62.39801	-0.1	-0.8814	8.813953		
1-4	450	0.35	159.1349	-0.25	-12.2449	48.97952		
				Σ	-4.83447	95.65973		

First Loop								
Pipe	L (m)	D (m)	k	Q (m <sup>3</sup> /sec)	hf	hf/Q	Δ	Q correct
1-2	750	0.5	46.69192	0.25	3.592781	14.37113	0.027318	
2-3	500	0.4	92.27887	0.2	4.699025	23.49513	0.027318	
3-4	600	0.45	62.39801	-0.1	-0.8814	8.813953	0.027318	
1-4	450	0.35	159.1349	-0.25	-12.2449	48.97952	0.027318	
					-4.83447	95.65973		
		Δ1	0.027318					

$$\Delta = \frac{-\sum h_f}{1.85 * \sum \frac{h_f}{Q}}$$

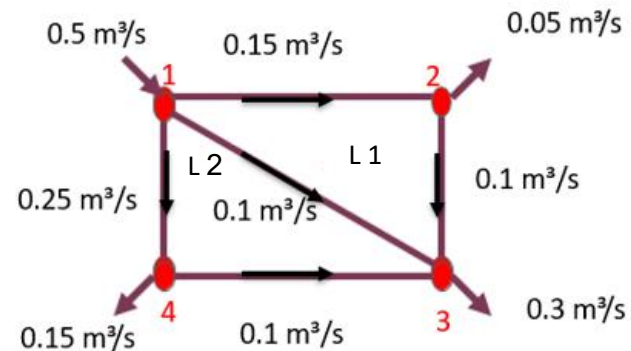
First Loop								
Pipe	L (m)	D (m)	k	Q (m <sup>3</sup> /sec)	hf	hf/Q	Δ	Q correct
1-2	750	0.5	46.69192	0.25	3.592781	14.37113	0.027318	0.277318
2-3	500	0.4	92.27887	0.2	4.699025	23.49513	0.027318	0.227318
3-4	600	0.45	62.39801	-0.1	-0.8814	8.813953	0.027318	-0.07268
1-4	450	0.35	159.1349	-0.25	-12.2449	48.97952	0.027318	-0.22268
					-4.83447	95.65973		
		Δ1	0.027318					

$$Q = Q_o + \Delta$$

# Example 1

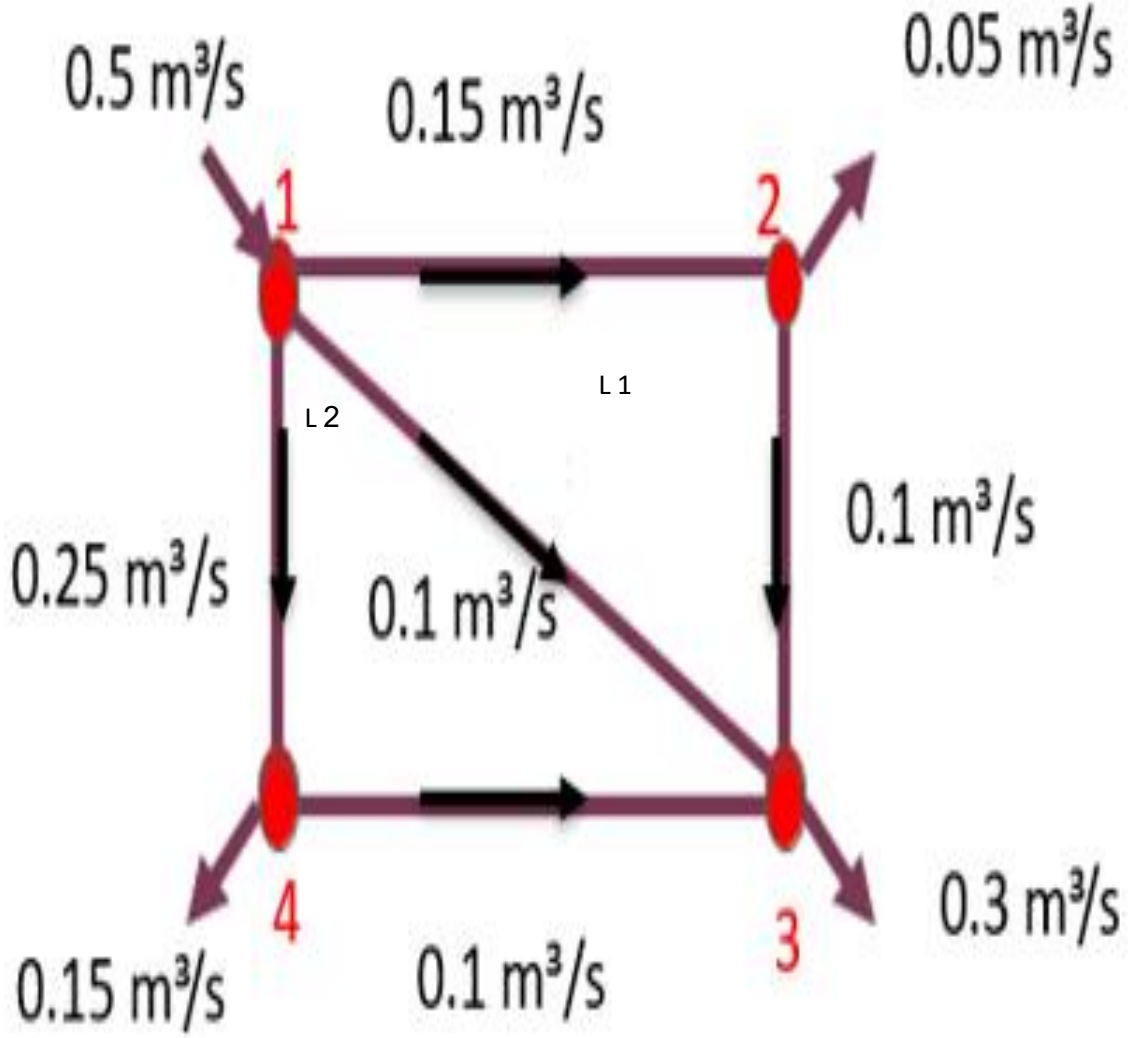
Solve the following pipe network using Hazen William Method  $C_{hw}=100$

	Diameter (mm)	Length (m)
(1-2)	500	750
(2-3)	400	500
(3-4)	450	600
(4-1)	350	450
(1-3)	450	600



First Loop

Pipe	L (m)	D (m)	k	Q (m <sup>3</sup> /sec)	hf	hf/Q	Δ	Q correct









f/Q	Δ	Q correct

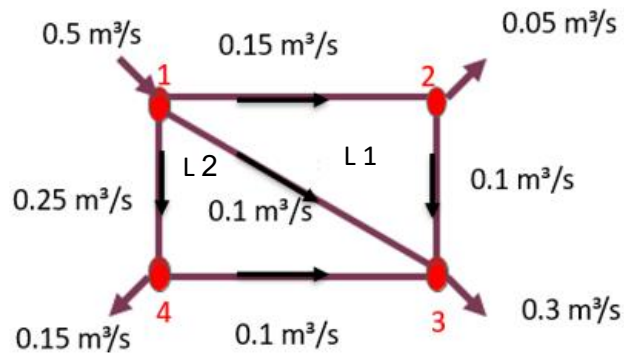
First Loop								
Pipe	L (m)	D (m)	k	Q (m3/sec)	hf	hf/Q	Δ	Q correct
1-2	750	0.5	46.69192					
2-3	500	0.4	92.27887					
3-1	600	0.45	62.39801					

Second Loop								
Pipe	L (m)	D (m)	k	Q (m3/sec)	hf	hf/Q	Δ	Q correct
1-4	450	0.35	159.1349					
4-3	600	0.45	62.39801					
3-1	600	0.45	62.39801					

$$K = \frac{10.67 * L}{C^{1.85} * d^{4.87}}$$

First Loop								
Pipe	L (m)	D (m)	k	Q (m <sup>3</sup> /sec)	hf	hf/Q	Δ	Q correct
1-2	750	0.5	46.69192	0.15				
2-3	500	0.4	92.27887	0.1				
3-1	600	0.45	62.39801	-0.1				

Second Loop								
Pipe	L (m)	D (m)	k	Q (m <sup>3</sup> /sec)	hf	hf/Q	Δ	Q correct
1-4	450	0.35	159.1349	-0.25				
4-3	600	0.45	62.39801	-0.1				
3-1	600	0.45	62.39801	0.1				



First Loop								
Pipe	L (m)	D (m)	k	Q (m3/sec)	hf	hf/Q	Δ	Q correct
1-2	750	0.5	46.69192	0.15	1.396402			
2-3	500	0.4	92.27887	0.1	1.303474			
3-1	600	0.45	62.39801	-0.1	-0.8814			

1.818481

Second Loop								
Pipe	L (m)	D (m)	k	Q (m3/sec)	hf	hf/Q	Δ	Q correct
1-4	450	0.35	159.1349	-0.25	-12.2449			
4-3	600	0.45	62.39801	-0.1	-0.8814			
3-1	600	0.45	62.39801	0.1	0.881395			
					-12.2449			

$$HL (Pipe) = KQ^{1.85}$$

First Loop								
Pipe	L (m)	D (m)	k	Q (m3/sec)	hf	hf/Q	$\Delta$	Q correct
1-2	750	0.5	46.69192	0.15	1.396402	9.309349		
2-3	500	0.4	92.27887	0.1	1.303474	13.03474		
3-1	600	0.45	62.39801	-0.1	-0.8814	8.813953		
					1.818481	31.15804		

Second Loop								
Pipe	L (m)	D (m)	k	Q (m3/sec)	hf	hf/Q	$\Delta$	Q correct
1-4	450	0.35	159.1349	-0.25	-12.2449	48.97952		
4-3	600	0.45	62.39801	-0.1	-0.8814	8.813953		
3-1	600	0.45	62.39801	0.1	0.881395	8.813953		
					-12.2449	66.60743		

First Loop								
Pipe	L (m)	D (m)	k	Q (m3/sec)	hf	hf/Q	$\Delta$	Q correct
1-2	750	0.5	46.69192	0.15	1.396402	9.309349	-0.03155	
2-3	500	0.4	92.27887	0.1	1.303474	13.03474	-0.03155	
3-1	600	0.45	62.39801	-0.1	-0.8814	8.813953	-0.13092	
					1.818481	31.15804		

$\Delta 1$	-0.03155
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Second Loop								
Pipe	L (m)	D (m)	k	Q (m3/sec)	hf	hf/Q	$\Delta$	Q correct
1-4	450	0.35	159.1349	-0.25	-12.2449	48.97952	0.099371	
4-3	600	0.45	62.39801	-0.1	-0.8814	8.813953	0.099371	
3-1	600	0.45	62.39801	0.1	0.881395	8.813953	0.130919	
					-12.2449	66.60743		

$\Delta 2$	0.099371
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$$\Delta = \frac{-\sum h_f}{1.85 * \sum \frac{h_f}{Q}}$$

For pipe 2 in loop1

$$\Delta = \Delta_1 - \Delta_2$$

For pipe 2 in loop2

$$\Delta = \Delta_2 - \Delta_1$$

First Loop									
Pipe	L (m)	D (m)	k	Q (m3/sec)	hf	hf/Q	$\Delta$	Q correct	
1-2	750	0.5	46.69192	0.15	1.396402	9.309349	-0.03155	0.118452	
2-3	500	0.4	92.27887	0.1	1.303474	13.03474	-0.03155	0.068452	
3-1	600	0.45	62.39801	-0.1	-0.8814	8.813953	-0.13092	-0.23092	
					1.818481	31.15804			
			$\Delta 1$	-0.03155				$\Delta L1- P2$	-0.13092

Second Loop									
Pipe	L (m)	D (m)	k	Q (m3/sec)	hf	hf/Q	$\Delta$	Q correct	
1-4	450	0.35	159.1349	-0.25	-12.2449	48.97952	0.099371	-0.15063	
4-3	600	0.45	62.39801	-0.1	-0.8814	8.813953	0.099371	-0.00063	
3-1	600	0.45	62.39801	0.1	0.881395	8.813953	0.130919	0.230919	
					-12.2449	66.60743			
			$\Delta 2$	0.099371				$\Delta L2- P2$	0.13092

$$Q = Q_o + \Delta$$

# Second Iteration

## 2<sup>nd</sup> Iteration

First Loop								
Pipe	L (m)	D (m)	k	Q (m <sup>3</sup> /sec)	hf	hf/Q	$\Delta$	Q correct
1-2	750	0.5	46.69192	0.1184524				
2-3	500	0.4	92.27887	0.0684524				
3-1	600	0.45	62.39801	-0.230919				

Second Loop								
Pipe	L (m)	D (m)	k	Q (m <sup>3</sup> /sec)	hf	hf/Q	$\Delta$	Q correct
1-4	450	0.35	159.1349	-0.150629				
4-3	600	0.45	62.39801	-0.000629				
3-1	600	0.45	62.39801	0.2309188				

## 2<sup>nd</sup> Iteration

First Loop								
Pipe	L (m)	D (m)	k	Q (m <sup>3</sup> /sec)	hf	hf/Q	Δ	Q correct
1-2	750	0.5	46.69192	0.1184524	0.902189	7.616473		
2-3	500	0.4	92.27887	0.0684524	0.646503	9.444575		
3-1	600	0.45	62.39801	-0.230919	-4.14544	17.95193		

-2.59674    35.01297

Second Loop								
Pipe	L (m)	D (m)	k	Q (m <sup>3</sup> /sec)	hf	hf/Q	Δ	Q correct
1-4	450	0.35	159.1349	-0.150629	-4.79618	31.84106		
4-3	600	0.45	62.39801	-0.000629	-7.5E-05	0.118565		
3-1	600	0.45	62.39801	0.2309188	4.145436	17.95193		
					-0.65082	49.91156		

## 2<sup>nd</sup> Iteration

First Loop								
Pipe	L (m)	D (m)	k	Q (m <sup>3</sup> /sec)	hf	hf/Q	Δ	Q correct
1-2	750	0.5	46.69192	0.1184524	0.902189	7.616473		
2-3	500	0.4	92.27887	0.0684524	0.646503	9.444575		
3-1	600	0.45	62.39801	-0.230919	-4.14544	17.95193		

-2.59674    35.01297

Second Loop								
Pipe	L (m)	D (m)	k	Q (m <sup>3</sup> /sec)	hf	hf/Q	Δ	Q correct
1-4	450	0.35	159.1349	-0.150629	-4.79618	31.84106		
4-3	600	0.45	62.39801	-0.000629	-7.5E-05	0.118565		
3-1	600	0.45	62.39801	0.2309188	4.145436	17.95193		
					-0.65082	49.91156		

## 2<sup>nd</sup> Iteration

First Loop								
Pipe	L (m)	D (m)	k	Q (m <sup>3</sup> /sec)	hf	hf/Q	Δ	Q correct
1-2	750	0.5	46.69192	0.1184524	0.902189	7.616473	0.040089	0.158542
2-3	500	0.4	92.27887	0.0684524	0.646503	9.444575	0.040089	0.108542
3-1	600	0.45	62.39801	-0.230919	-4.14544	17.95193	0.033041	-0.19788
					-2.59674	35.01297		

Δ 1	0.040089
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Δ L1- P2 0.033041

Second Loop								
Pipe	L (m)	D (m)	k	Q (m <sup>3</sup> /sec)	hf	hf/Q	Δ	Q correct
1-4	450	0.35	159.1349	-0.150629	-4.79618	31.84106	0.007048	-0.14358
4-3	600	0.45	62.39801	-0.000629	-7.5E-05	0.118565	0.007048	0.006419
3-1	600	0.45	62.39801	0.2309188	4.145436	17.95193	-0.03304	0.197878
					-0.65082	49.91156		

Δ 2	0.007048
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Δ L2- P2 -0.03304