

## Helix Technologies Pty Ltd

Project	Helix QA	Client	Helix QA
Project No.	4567	Design Date	14/03/2017
Category	Demo Liquid Spray System	Atmos. Press	100.19 kPa
Network Type	Liquid	Calc. Method	Hazen
Description	Helix QA Spray System Example - Hazen Williams		

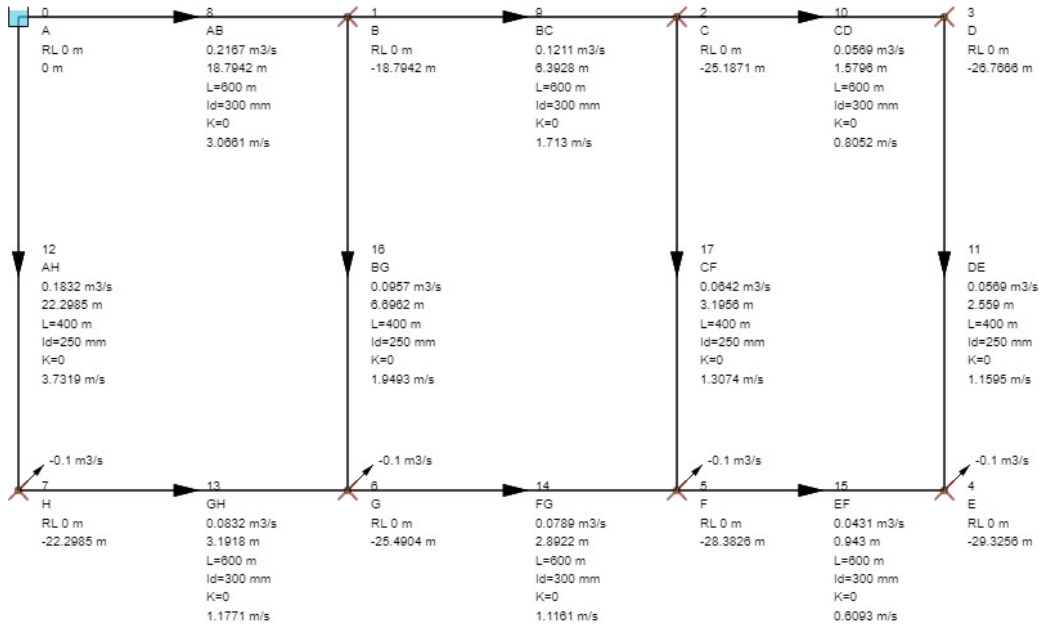
Spray Network Worked Example, ref. 2500 Solved Problems in Fluid Mechanics and Hydraulics, Jack B. Evett et.al. Example 13.5 on pg 322 to Fig 13.6 on pg 324. Assumed Water at 20 dg C. Solve using Hazen Williams with C=120 (Set the Pipe Roughness = 120 and Network Calc method to Hazen)

Calculated Results	Published Data	Helix Calculation
Pipe AB	0.215 m3/s 18.60m	0.2168 m3/s 18.792m
Pipe BG	0.095 m3/s 6.88m	0.0957 m3/s 6.696m
Pipe GH	0.085 m3/s 3.30m	0.0832 m3/s 3.1918m
Pipe HA	0.185 m3/s 22.40m	0.1832 m3/s 22.2985m
Pipe BC	0.120 m3/s 6.00m	0.1211 m3/s 6.3928m
Pipe CF	0.064 m3/s 3.00m	0.0642 m3/s 3.1956m
Pipe FG	0.080 m3/s 3.12m	0.0789 m3/s 2.8922m
Pipe GB	0.095 m3/s 6.88m	0.0957 m3/s 6.6962m
Pipe CD	0.056 m3/s 1.44m	0.0569 m3/s 1.5796m
Pipe DE	0.056 m3/s 2.36m	0.0569 m3/s 2.559m
Pipe EF	0.044 m3/s 1.02m	0.0431 m3/s 0.943m
Pipe FC	0.064 m3/s 3.00m	0.0642 m3/s 3.1956m

Helix results are after the minimum calculation iterations of 11, published results use the Hardy Cross method and only 3 iterations so it can be expected that the Helix results will be more accurate. Nevertheless, results are close and prove Helix Hazen Williams method works.

Helix Technologies Pty Ltd

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Helix QA Spray System Example - Hazen Williams

**Helix Technologies Pty Ltd**

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Project No.	4567	Design Date	14/03/2017
Category	Demo Liquid Spray System	Atmos. Press	100.19 kPa
Description	Helix QA Spray System Example - Hazen Williams		
Pipe No	8	From node to node	0 - 1
Description	AB	Equipment No	
Liquid	Water	Viscosity	1.002 cp
Temperature	20 C	Density	998.204 kg/m3
Vapour Pressure	2.34 kPa		
Pipe Description	Steel Pipes 12" AS1836 (ANSI B36.10)	Pipe Class	Sch 40
Nominal Diameter	300 mm	Inside Diameter	300 mm
Outside Diameter	320 mm	Pipe Length	600 m
Pipe Roughness	120 mm	Allowable Press.	2000 kPa
Orifice Plate Dia	-	Non Return Valve	No
Total Fittings k	0	Total Fittings kf	0
Flow Rate	0.2167 m3/s	Velocity	3.0661 m/s
Friction Loss	18.7942 m	Fitting Losses	0 m
Slurry Losses	0 m	Orifice Losses	0 m
Fixed Head Loss	0 m	Booster Pump Head	0 m
Total Head Loss	18.7942 m	Total Pressure Drop	183.9772 kPa
Entry Total Head	0 m	Exit Total Head	-18.7942 m
Entry Gauge Head	0 m	Exit Gauge Head	-18.7942 m
Reynolds No.	916345.7333	Friction Factor	0.0195969 (Darcy f)

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Category	Demo Liquid Spray System	Atmos. Press	100.19 kPa
Description	Helix QA Spray System Example - Hazen Williams		
Pipe No	9	From node to node	1 - 2
Description	BC	Equipment No	
Liquid	Water	Viscosity	1.002 cp
Temperature	20 C	Density	998.204 kg/m3
Vapour Pressure	2.34 kPa		
Pipe Description	Steel Pipes 12" AS1836 (ANSI B36.10)	Pipe Class	Sch 40
Nominal Diameter	300 mm	Inside Diameter	300 mm
Outside Diameter	320 mm	Pipe Length	600 m
Pipe Roughness	120 mm	Allowable Press.	2000 kPa
Orifice Plate Dia	-	Non Return Valve	No
Total Fittings k	0	Total Fittings kf	0
Flow Rate	0.1211 m3/s	Velocity	1.713 m/s
Friction Loss	6.3928 m	Fitting Losses	0 m
Slurry Losses	0 m	Orifice Losses	0 m
Fixed Head Loss	0 m	Booster Pump Head	0 m
Total Head Loss	6.3928 m	Total Pressure Drop	62.5798 kPa
Entry Total Head	-18.7942 m	Exit Total Head	-25.1871 m
Entry Gauge Head	-18.7942 m	Exit Gauge Head	-25.1871 m
Reynolds No.	511943.6234	Friction Factor	0.0213621 (Darcy f)

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Project No.	4567	Design Date	14/03/2017
Category	Demo Liquid Spray System	Atmos. Press	100.19 kPa
Description	Helix QA Spray System Example - Hazen Williams		
Pipe No	10	From node to node	2 - 3
Description	CD	Equipment No	
Liquid	Water	Viscosity	1.002 cp
Temperature	20 C	Density	998.204 kg/m3
Vapour Pressure	2.34 kPa		
Pipe Description	Steel Pipes 12" AS1836 (ANSI B36.10)	Pipe Class	Sch 40
Nominal Diameter	300 mm	Inside Diameter	300 mm
Outside Diameter	320 mm	Pipe Length	600 m
Pipe Roughness	120 mm	Allowable Press.	2000 kPa
Orifice Plate Dia	-	Non Return Valve	No
Total Fittings k	0	Total Fittings kf	0
Flow Rate	0.0569 m3/s	Velocity	0.8052 m/s
Friction Loss	1.5796 m	Fitting Losses	0 m
Slurry Losses	0 m	Orifice Losses	0 m
Fixed Head Loss	0 m	Booster Pump Head	0 m
Total Head Loss	1.5796 m	Total Pressure Drop	15.4627 kPa
Entry Total Head	-25.1871 m	Exit Total Head	-26.7666 m
Entry Gauge Head	-25.1871 m	Exit Gauge Head	-26.7666 m
Reynolds No.	240659.7492	Friction Factor	0.0238897 (Darcy f)

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Project No.	4567	Design Date	14/03/2017
Category	Demo Liquid Spray System	Atmos. Press	100.19 kPa
Description	Helix QA Spray System Example - Hazen Williams		
Pipe No	11	From node to node	3 - 4
Description	DE	Equipment No	
Liquid	Water	Viscosity	1.002 cp
Temperature	20 C	Density	998.204 kg/m3
Vapour Pressure	2.34 kPa		
Pipe Description	Steel Pipes 10" AS1836 (ANSI B36.10)	Pipe Class	Sch 40
Nominal Diameter	250 mm	Inside Diameter	250 mm
Outside Diameter	270 mm	Pipe Length	400 m
Pipe Roughness	120 mm	Allowable Press.	2000 kPa
Orifice Plate Dia	-	Non Return Valve	No
Total Fittings k	0	Total Fittings kf	0
Flow Rate	0.0569 m3/s	Velocity	1.1595 m/s
Friction Loss	2.559 m	Fitting Losses	0 m
Slurry Losses	0 m	Orifice Losses	0 m
Fixed Head Loss	0 m	Booster Pump Head	0 m
Total Head Loss	2.559 m	Total Pressure Drop	25.0499 kPa
Entry Total Head	-26.7666 m	Exit Total Head	-29.3256 m
Entry Gauge Head	-26.7666 m	Exit Gauge Head	-29.3256 m
Reynolds No.	288780.6519	Friction Factor	0.0233302 (Darcy f)

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Project No.	4567	Design Date	14/03/2017
Category	Demo Liquid Spray System	Atmos. Press	100.19 kPa
Description	Helix QA Spray System Example - Hazen Williams		
Pipe No	12	From node to node	0 - 7
Description	AH	Equipment No	
Liquid	Water	Viscosity	1.002 cp
Temperature	20 C	Density	998.204 kg/m3
Vapour Pressure	2.34 kPa		
Pipe Description	Steel Pipes 10" AS1836 (ANSI B36.10)	Pipe Class	Sch 40
Nominal Diameter	250 mm	Inside Diameter	250 mm
Outside Diameter	270 mm	Pipe Length	400 m
Pipe Roughness	120 mm	Allowable Press.	2000 kPa
Orifice Plate Dia	-	Non Return Valve	No
Total Fittings k	0	Total Fittings kf	0
Flow Rate	0.1832 m3/s	Velocity	3.7319 m/s
Friction Loss	22.2985 m	Fitting Losses	0 m
Slurry Losses	0 m	Orifice Losses	0 m
Fixed Head Loss	0 m	Booster Pump Head	0 m
Total Head Loss	22.2985 m	Total Pressure Drop	218.2811 kPa
Entry Total Head	0 m	Exit Total Head	-22.2985 m
Entry Gauge Head	0 m	Exit Gauge Head	-22.2985 m
Reynolds No.	929440.0553	Friction Factor	0.0196205 (Darcy f)

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Project No.	4567	Design Date	14/03/2017
Category	Demo Liquid Spray System	Atmos. Press	100.19 kPa
Description	Helix QA Spray System Example - Hazen Williams		
Pipe No	13	From node to node	7 - 6
Description	GH	Equipment No	
Liquid	Water	Viscosity	1.002 cp
Temperature	20 C	Density	998.204 kg/m3
Vapour Pressure	2.34 kPa		
Pipe Description	Steel Pipes 12" AS1836 (ANSI B36.10)	Pipe Class	Sch 40
Nominal Diameter	300 mm	Inside Diameter	300 mm
Outside Diameter	320 mm	Pipe Length	600 m
Pipe Roughness	120 mm	Allowable Press.	2000 kPa
Orifice Plate Dia	-	Non Return Valve	No
Total Fittings k	0	Total Fittings kf	0
Flow Rate	0.0832 m3/s	Velocity	1.1771 m/s
Friction Loss	3.1918 m	Fitting Losses	0 m
Slurry Losses	0 m	Orifice Losses	0 m
Fixed Head Loss	0 m	Booster Pump Head	0 m
Total Head Loss	3.1918 m	Total Pressure Drop	31.2451 kPa
Entry Total Head	-22.2985 m	Exit Total Head	-25.4904 m
Entry Gauge Head	-22.2985 m	Exit Gauge Head	-25.4904 m
Reynolds No.	351790.305	Friction Factor	0.0225831 (Darcy f)



## Helix Technologies Pty Ltd

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Category	Demo Liquid Spray System	Atmos. Press	100.19 kPa
Description	Helix QA Spray System Example - Hazen Williams		
Pipe No	14	From node to node	6 - 5
Description	FG	Equipment No	
Liquid	Water	Viscosity	1.002 cp
Temperature	20 C	Density	998.204 kg/m3
Vapour Pressure	2.34 kPa		
Pipe Description	Steel Pipes 12" AS1836 (ANSI B36.10)	Pipe Class	Sch 40
Nominal Diameter	300 mm	Inside Diameter	300 mm
Outside Diameter	320 mm	Pipe Length	600 m
Pipe Roughness	120 mm	Allowable Press.	2000 kPa
Orifice Plate Dia	-	Non Return Valve	No
Total Fittings k	0	Total Fittings kf	0
Flow Rate	0.0789 m3/s	Velocity	1.1161 m/s
Friction Loss	2.8922 m	Fitting Losses	0 m
Slurry Losses	0 m	Orifice Losses	0 m
Fixed Head Loss	0 m	Booster Pump Head	0 m
Total Head Loss	2.8922 m	Total Pressure Drop	28.3123 kPa
Entry Total Head	-25.4904 m	Exit Total Head	-28.3826 m
Entry Gauge Head	-25.4904 m	Exit Gauge Head	-28.3826 m
Reynolds No.	333566.8583	Friction Factor	0.0227617 (Darcy f)

## Helix Technologies Pty Ltd

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Category	Demo Liquid Spray System	Atmos. Press	100.19 kPa
Description	Helix QA Spray System Example - Hazen Williams		
Pipe No	15	From node to node	5 - 4
Description	EF	Equipment No	
Liquid	Water	Viscosity	1.002 cp
Temperature	20 C	Density	998.204 kg/m3
Vapour Pressure	2.34 kPa		
Pipe Description	Steel Pipes 12" AS1836 (ANSI B36.10)	Pipe Class	Sch 40
Nominal Diameter	300 mm	Inside Diameter	300 mm
Outside Diameter	320 mm	Pipe Length	600 m
Pipe Roughness	120 mm	Allowable Press.	2000 kPa
Orifice Plate Dia	-	Non Return Valve	No
Total Fittings k	0	Total Fittings kf	0
Flow Rate	0.0431 m3/s	Velocity	0.6093 m/s
Friction Loss	0.943 m	Fitting Losses	0 m
Slurry Losses	0 m	Orifice Losses	0 m
Fixed Head Loss	0 m	Booster Pump Head	0 m
Total Head Loss	0.943 m	Total Pressure Drop	9.2311 kPa
Entry Total Head	-28.3826 m	Exit Total Head	-29.3256 m
Entry Gauge Head	-28.3826 m	Exit Gauge Head	-29.3256 m
Reynolds No.	182083.3529	Friction Factor	0.0248975 (Darcy f)

## Helix Technologies Pty Ltd

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Category	Demo Liquid Spray System	Atmos. Press	100.19 kPa
Description	Helix QA Spray System Example - Hazen Williams		
Pipe No	16	From node to node	1 - 6
Description	BG	Equipment No	
Liquid	Water	Viscosity	1.002 cp
Temperature	20 C	Density	998.204 kg/m3
Vapour Pressure	2.34 kPa		
Pipe Description	Steel Pipes 10" AS1836 (ANSI B36.10)	Pipe Class	Sch 40
Nominal Diameter	250 mm	Inside Diameter	250 mm
Outside Diameter	270 mm	Pipe Length	400 m
Pipe Roughness	120 mm	Allowable Press.	2000 kPa
Orifice Plate Dia	-	Non Return Valve	No
Total Fittings k	0	Total Fittings kf	0
Flow Rate	0.0957 m3/s	Velocity	1.9493 m/s
Friction Loss	6.6962 m	Fitting Losses	0 m
Slurry Losses	0 m	Orifice Losses	0 m
Fixed Head Loss	0 m	Booster Pump Head	0 m
Total Head Loss	6.6962 m	Total Pressure Drop	65.5489 kPa
Entry Total Head	-18.7942 m	Exit Total Head	-25.4904 m
Entry Gauge Head	-18.7942 m	Exit Gauge Head	-25.4904 m
Reynolds No.	485471.4577	Friction Factor	0.0216022 (Darcy f)

## Helix Technologies Pty Ltd

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Category	Demo Liquid Spray System	Atmos. Press	100.19 kPa
Description	Helix QA Spray System Example - Hazen Williams		
Pipe No	17	From node to node	2 - 5
Description	CF	Equipment No	
Liquid	Water	Viscosity	1.002 cp
Temperature	20 C	Density	998.204 kg/m3
Vapour Pressure	2.34 kPa		
Pipe Description	Steel Pipes 10" AS1836 (ANSI B36.10)	Pipe Class	Sch 40
Nominal Diameter	250 mm	Inside Diameter	250 mm
Outside Diameter	270 mm	Pipe Length	400 m
Pipe Roughness	120 mm	Allowable Press.	2000 kPa
Orifice Plate Dia	-	Non Return Valve	No
Total Fittings k	0	Total Fittings kf	0
Flow Rate	0.0642 m3/s	Velocity	1.3074 m/s
Friction Loss	3.1956 m	Fitting Losses	0 m
Slurry Losses	0 m	Orifice Losses	0 m
Fixed Head Loss	0 m	Booster Pump Head	0 m
Total Head Loss	3.1956 m	Total Pressure Drop	31.2815 kPa
Entry Total Head	-25.1871 m	Exit Total Head	-28.3826 m
Entry Gauge Head	-25.1871 m	Exit Gauge Head	-28.3826 m
Reynolds No.	325605.3236	Friction Factor	0.0229191 (Darcy f)

## Helix Technologies Pty Ltd

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Category	Demo Liquid Spray System	Atmos. Press	100.19 kPa
Description	Helix QA Spray System Example - Hazen Williams		
Node No	0	Node Type	Tank
Description	A	Equipment No	
Rel. Level (RL)	0 m	Pressure Input	0 kPa
Nozzle K value	-	Ext Flow (+In/-Out)	-
Int.(Gauge) Head	-	Int.(Gauge) Pressure	-
Total Node Head	0 m		

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Description	Helix QA Spray System Example - Hazen Williams		

Node No	1	Node Type	Junction
Description	B	Equipment No	
Rel. Level (RL)	0 m	Pressure Input	0 kPa
Nozzle K value	-	Ext Flow (+In/-Out)	0 m3/s
Int.(Gauge) Head	-18.7942 m	Int.(Gauge) Pressure	-183.9772 kPa
Total Node Head	-18.7942 m		

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Node No	2	Node Type	Junction
Description	C	Equipment No	
Rel. Level (RL)	0 m	Pressure Input	0 kPa
Nozzle K value	-	Ext Flow (+In/-Out)	0 m3/s
Int.(Gauge) Head	-25.1871 m	Int.(Gauge) Pressure	-246.557 kPa
Total Node Head	-25.1871 m		

## Helix Technologies Pty Ltd

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Node No	3	Node Type	Junction
Description	D	Equipment No	
Rel. Level (RL)	0 m	Pressure Input	0 kPa
Nozzle K value	-	Ext Flow (+In/-Out)	0 m3/s
Int.(Gauge) Head	-26.7666 m	Int.(Gauge) Pressure	-262.0197 kPa
Total Node Head	-26.7666 m		



## Helix Technologies Pty Ltd

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Description	Helix QA Spray System Example - Hazen Williams		
Node No	4	Node Type	Junction
Description	E	Equipment No	
Rel. Level (RL)	0 m	Pressure Input	0 kPa
Nozzle K value	-	Ext Flow (+In/-Out)	-0.1 m3/s
Int.(Gauge) Head	-29.3256 m	Int.(Gauge) Pressure	-287.0696 kPa
Total Node Head	-29.3256 m		

## Helix Technologies Pty Ltd

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Category	Demo Liquid Spray System	Atmos. Press	100.19 kPa
Description	Helix QA Spray System Example - Hazen Williams		

Node No	5	Node Type	Junction
Description	F	Equipment No	
Rel. Level (RL)	0 m	Pressure Input	0 kPa
Nozzle K value	-	Ext Flow (+In/-Out)	-0.1 m3/s
Int.(Gauge) Head	-28.3826 m	Int.(Gauge) Pressure	-277.8385 kPa
Total Node Head	-28.3826 m		

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Project	Helix QA	Client	Helix QA
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Category	Demo Liquid Spray System	Atmos. Press	100.19 kPa
Description	Helix QA Spray System Example - Hazen Williams		

Node No	6	Node Type	Junction
Description	G	Equipment No	
Rel. Level (RL)	0 m	Pressure Input	0 kPa
Nozzle K value	-	Ext Flow (+In/-Out)	-0.1 m3/s
Int.(Gauge) Head	-25.4904 m	Int.(Gauge) Pressure	-249.5262 kPa
Total Node Head	-25.4904 m		

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Category	Demo Liquid Spray System	Atmos. Press	100.19 kPa
Description	Helix QA Spray System Example - Hazen Williams		

Node No	7	Node Type	Junction
Description	H	Equipment No	
Rel. Level (RL)	0 m	Pressure Input	0 kPa
Nozzle K value	-	Ext Flow (+In/-Out)	-0.1 m3/s
Int.(Gauge) Head	-22.2985 m	Int.(Gauge) Pressure	-218.2811 kPa
Total Node Head	-22.2985 m		