Helix Technologies Pty Ltd

Project	Helix QA	Client	Helix QA
Project No.	4567	Design Date	11/03/2017
Category	Demo Liquid QA	Atmos. Press	100.19 psi
Network Type	Liquid	Calc. Method	Darcy
Description	Gravity Flow Network		

Gravity Flow Network, ref. 'Hydraulics of Pipeline Systems', Bruce E. Larock et al. problem 12.4 pg 437-438
Two reservoirs feed a network with demand flows at junctions as shown in skectch above. Flow direction is unknown until the network is solved. The following is a comparison of published results with Helix deltaQ.

Calculation Comments	Published Value		Helix Calculation	
Pipe No	Pipe Flow Rate g/min	Head Loss ft	Pipe Flow Rate g/min	Head Loss ft
Pipe 1	1447	15.61	1446.69	15.618
Pipe 2	389	8.08	388.64	8.076
Pipe 3	61.2	0.19	61.36	0.192
Pipe 4	703	3.49	703.31	3.501
Pipe 5	11.7	0.02	11.95	0.017
Pipe 6	478	7.90	478.05	7.901

The velocities also match well as could be expected due to the close corre;ation on calculated flow rates and head loss

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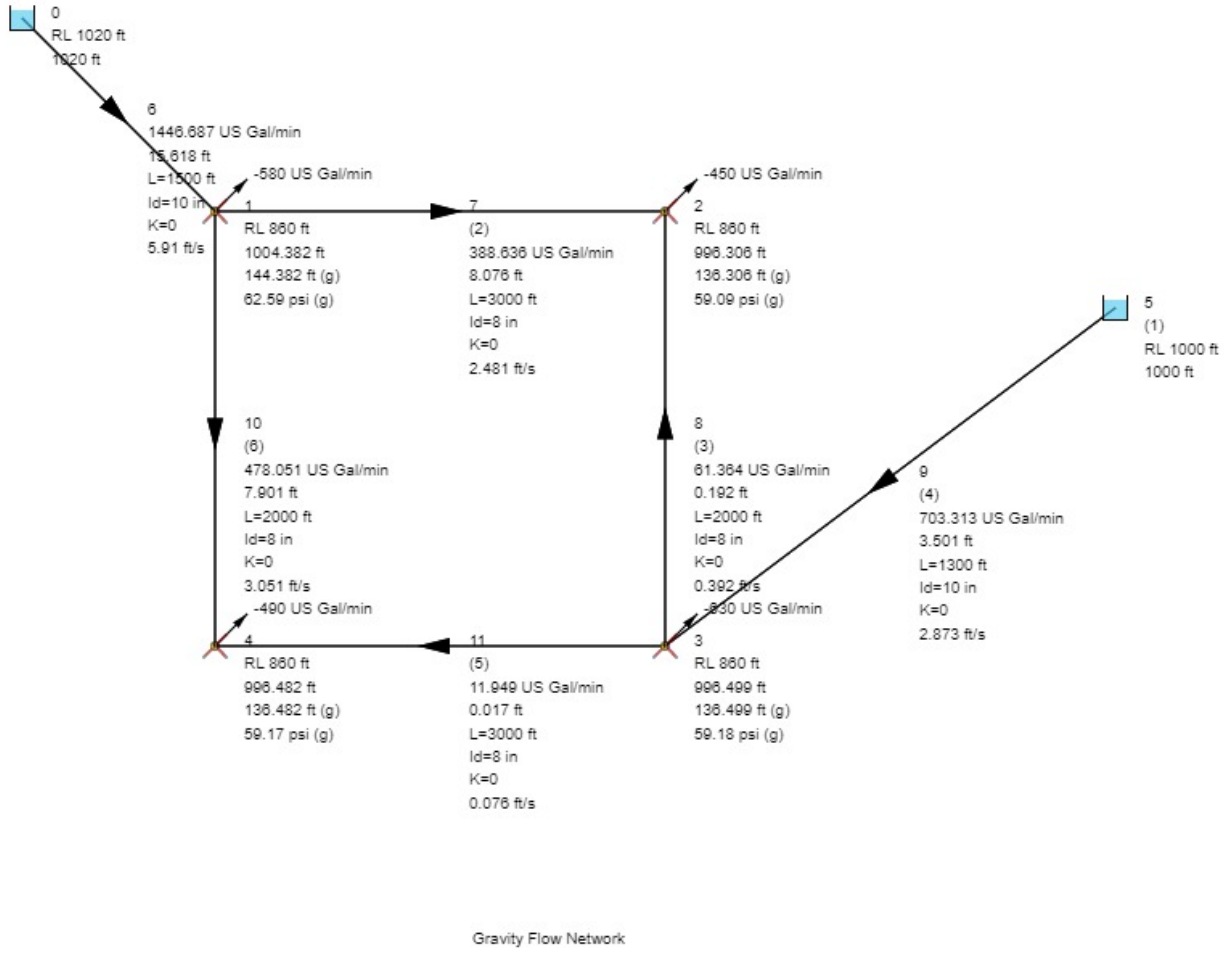
Category	Demo Liquid QA	Atmos. Press	100.19 psi
Description	Gravity Flow Network		



Gravity Flow Network

Helix Technologies Pty Ltd

Project	Helix QA	Client	Helix QA
Project No.	4567	Design Date	11/03/2017
Category	Demo Liquid QA	Atmos. Press	100.19 psi
Description	Gravity Flow Network		

Pipe No	6	From node to node	0 - 1
Description		Equipment No	
Liquid	Water	Viscosity	1.31 cp
Temperature	10 C	Density	1000 kg/m3
Vapour Pressure	0.8 psi		
Pipe Description	Steel Pipes 8"	Pipe Class	Sch 40
Nominal Diameter	10 in	Inside Diameter	10 in
Outside Diameter	11 in	Pipe Length	1500 ft
Pipe Roughness	0.002 in	Allowable Press.	150 psi
Orifice Plate Dia	-	Non Return Valve	No
Total Fittings k	0	Total Fittings kf	0
Flow Rate	1446.687 US Gal/min	Velocity	5.91 ft/s
Friction Loss	15.618 ft	Fitting Losses	0 ft
Slurry Losses	0 ft	Orifice Losses	0 ft
Fixed Head Loss	0 ft	Booster Pump Head	0 ft
Total Head Loss	15.618 ft	Total Pressure Drop	6.771 psi
Entry Total Head	1020 ft	Exit Total Head	1004.382 ft
Entry Gauge Head	0 ft	Exit Gauge Head	144.382 ft
Reynolds No.	349254.249	Friction Factor	0.015982 (Darcy f)

Helix Technologies Pty Ltd

Project	Helix QA	Client	Helix QA
Project No.	4567	Design Date	11/03/2017
Category	Demo Liquid QA	Atmos. Press	100.19 psi
Description	Gravity Flow Network		

Pipe No	7	From node to node	1 - 2
Description	(2)	Equipment No	
Liquid	Water	Viscosity	1.31 cp
Temperature	10 C	Density	1000 kg/m3
Vapour Pressure	0.8 psi		
Pipe Description	Steel Pipes 8"	Pipe Class	Sch 40
Nominal Diameter	8 in	Inside Diameter	8 in
Outside Diameter	9 in	Pipe Length	3000 ft
Pipe Roughness	0.002 in	Allowable Press.	150 psi
Orifice Plate Dia	-	Non Return Valve	No
Total Fittings k	0	Total Fittings kf	0
Flow Rate	388.636 US Gal/min	Velocity	2.481 ft/s
Friction Loss	8.076 ft	Fitting Losses	0 ft
Slurry Losses	0 ft	Orifice Losses	0 ft
Fixed Head Loss	0 ft	Booster Pump Head	0 ft
Total Head Loss	8.076 ft	Total Pressure Drop	3.501 psi
Entry Total Head	1004.382 ft	Exit Total Head	996.306 ft
Entry Gauge Head	144.382 ft	Exit Gauge Head	136.306 ft
Reynolds No.	117278.973	Friction Factor	0.018764 (Darcy f)

Helix Technologies Pty Ltd

Project	Helix QA	Client	Helix QA
Project No.	4567	Design Date	11/03/2017
Category	Demo Liquid QA	Atmos. Press	100.19 psi
Description	Gravity Flow Network		

Pipe No	8	From node to node	2 - 3
Description	(3)	Equipment No	
Liquid	Water	Viscosity	1.31 cp
Temperature	10 C	Density	1000 kg/m3
Vapour Pressure	0.8 psi		
Pipe Description	Steel Pipes 8"	Pipe Class	Sch 40
Nominal Diameter	8 in	Inside Diameter	8 in
Outside Diameter	9 in	Pipe Length	2000 ft
Pipe Roughness	0.002 in	Allowable Press.	150 psi
Orifice Plate Dia	-	Non Return Valve	No
Total Fittings k	0	Total Fittings kf	0
Flow Rate	61.364 US Gal/min	Velocity	0.392 ft/s
Friction Loss	0.192 ft	Fitting Losses	0 ft
Slurry Losses	0 ft	Orifice Losses	0 ft
Fixed Head Loss	0 ft	Booster Pump Head	0 ft
Total Head Loss	0.192 ft	Total Pressure Drop	0.083 psi
Entry Total Head	996.499 ft	Exit Total Head	996.306 ft
Entry Gauge Head	136.306 ft	Exit Gauge Head	136.114 ft
Reynolds No.	18517.827	Friction Factor	0.026898 (Darcy f)

Helix Technologies Pty Ltd

Project	Helix QA	Client	Helix QA
Project No.	4567	Design Date	11/03/2017
Category	Demo Liquid QA	Atmos. Press	100.19 psi
Description	Gravity Flow Network		

Pipe No	9	From node to node	3 - 5
Description	(4)	Equipment No	
Liquid	Water	Viscosity	1.31 cp
Temperature	10 C	Density	1000 kg/m3
Vapour Pressure	0.8 psi		
Pipe Description	Steel Pipes 8"	Pipe Class	Sch 40
Nominal Diameter	10 in	Inside Diameter	10 in
Outside Diameter	11 in	Pipe Length	1300 ft
Pipe Roughness	0.002 in	Allowable Press.	150 psi
Orifice Plate Dia	-	Non Return Valve	No
Total Fittings k	0	Total Fittings kf	0
Flow Rate	703.313 US Gal/min	Velocity	2.873 ft/s
Friction Loss	3.501 ft	Fitting Losses	0 ft
Slurry Losses	0 ft	Orifice Losses	0 ft
Fixed Head Loss	0 ft	Booster Pump Head	0 ft
Total Head Loss	3.501 ft	Total Pressure Drop	1.518 psi
Entry Total Head	1000 ft	Exit Total Head	996.499 ft
Entry Gauge Head	136.499 ft	Exit Gauge Head	-7.003 ft
Reynolds No.	169791.299	Friction Factor	0.017493 (Darcy f)

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Project	Helix QA	Client	Helix QA
Project No.	4567	Design Date	11/03/2017
Category	Demo Liquid QA	Atmos. Press	100.19 psi
Description	Gravity Flow Network		

Pipe No	10	From node to node	1 - 4
Description	(6)	Equipment No	
Liquid	Water	Viscosity	1.31 cp
Temperature	10 C	Density	1000 kg/m3
Vapour Pressure	0.8 psi		
Pipe Description	Steel Pipes 8"	Pipe Class	Sch 40
Nominal Diameter	8 in	Inside Diameter	8 in
Outside Diameter	9 in	Pipe Length	2000 ft
Pipe Roughness	0.002 in	Allowable Press.	150 psi
Orifice Plate Dia	-	Non Return Valve	No
Total Fittings k	0	Total Fittings kf	0
Flow Rate	478.051 US Gal/min	Velocity	3.051 ft/s
Friction Loss	7.901 ft	Fitting Losses	0 ft
Slurry Losses	0 ft	Orifice Losses	0 ft
Fixed Head Loss	0 ft	Booster Pump Head	0 ft
Total Head Loss	7.901 ft	Total Pressure Drop	3.425 psi
Entry Total Head	1004.382 ft	Exit Total Head	996.482 ft
Entry Gauge Head	144.382 ft	Exit Gauge Head	136.482 ft
Reynolds No.	144261.852	Friction Factor	0.018197 (Darcy f)

Helix Technologies Pty Ltd

Project	Helix QA	Client	Helix QA
Project No.	4567	Design Date	11/03/2017
Category	Demo Liquid QA	Atmos. Press	100.19 psi
Description	Gravity Flow Network		

Pipe No	11	From node to node	4 - 3
Description	(5)	Equipment No	
Liquid	Water	Viscosity	1.31 cp
Temperature	10 C	Density	1000 kg/m3
Vapour Pressure	0.8 psi		
Pipe Description	Steel Pipes 8"	Pipe Class	Sch 40
Nominal Diameter	8 in	Inside Diameter	8 in
Outside Diameter	9 in	Pipe Length	3000 ft
Pipe Roughness	0.002 in	Allowable Press.	150 psi
Orifice Plate Dia	-	Non Return Valve	No
Total Fittings k	0	Total Fittings kf	0
Flow Rate	11.949 US Gal/min	Velocity	0.076 ft/s
Friction Loss	0.017 ft	Fitting Losses	0 ft
Slurry Losses	0 ft	Orifice Losses	0 ft
Fixed Head Loss	0 ft	Booster Pump Head	0 ft
Total Head Loss	0.017 ft	Total Pressure Drop	0.007 psi
Entry Total Head	996.499 ft	Exit Total Head	996.482 ft
Entry Gauge Head	136.482 ft	Exit Gauge Head	136.465 ft
Reynolds No.	3605.775	Friction Factor	0.041401 (Darcy f)

Helix Technologies Pty Ltd

Project	Helix QA	Client	Helix QA
Project No.	4567	Design Date	11/03/2017
Category	Demo Liquid QA	Atmos. Press	100.19 psi
Description	Gravity Flow Network		

Node No	0	Node Type	Tank
Description		Equipment No	
Rel. Level (RL)	1020 ft	Pressure Input	0 psi
Nozzle K value	-	Ext Flow (+In/-Out)	-
Int.(Gauge) Head	-	Int.(Gauge) Pressure	-
Total Node Head	1020 ft		

Helix Technologies Pty Ltd

Project	Helix QA	Client	Helix QA
Project No.	4567	Design Date	11/03/2017
Category	Demo Liquid QA	Atmos. Press	100.19 psi
Description	Gravity Flow Network		

Node No	1	Node Type	Junction
Description		Equipment No	
Rel. Level (RL)	860 ft	Pressure Input	0 psi
Nozzle K value	-	Ext Flow (+In/-Out)	-580 US Gal/min
Int.(Gauge) Head	144.382 ft	Int.(Gauge) Pressure	62.59 psi
Total Node Head	1004.382 ft		

Helix Technologies Pty Ltd

Project	Helix QA	Client	Helix QA
Project No.	4567	Design Date	11/03/2017
Category	Demo Liquid QA	Atmos. Press	100.19 psi
Description	Gravity Flow Network		

Node No	2	Node Type	Junction
Description		Equipment No	
Rel. Level (RL)	860 ft	Pressure Input	0 psi
Nozzle K value	-	Ext Flow (+In/-Out)	-450 US Gal/min
Int.(Gauge) Head	136.306 ft	Int.(Gauge) Pressure	59.09 psi
Total Node Head	996.306 ft		

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Project	Helix QA	Client	Helix QA
Project No.	4567	Design Date	11/03/2017
Category	Demo Liquid QA	Atmos. Press	100.19 psi
Description	Gravity Flow Network		

Node No	3	Node Type	Junction
Description		Equipment No	
Rel. Level (RL)	860 ft	Pressure Input	0 psi
Nozzle K value	-	Ext Flow (+In/-Out)	-630 US Gal/min
Int.(Gauge) Head	136.499 ft	Int.(Gauge) Pressure	59.18 psi
Total Node Head	996.499 ft		

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Project	Helix QA	Client	Helix QA
Project No.	4567	Design Date	11/03/2017
Category	Demo Liquid QA	Atmos. Press	100.19 psi
Description	Gravity Flow Network		

Node No	4	Node Type	Junction
Description		Equipment No	
Rel. Level (RL)	860 ft	Pressure Input	0 psi
Nozzle K value	-	Ext Flow (+In/-Out)	-490 US Gal/min
Int.(Gauge) Head	136.482 ft	Int.(Gauge) Pressure	59.17 psi
Total Node Head	996.482 ft		

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Project	Helix QA	Client	Helix QA
Project No.	4567	Design Date	11/03/2017
Category	Demo Liquid QA	Atmos. Press	100.19 psi
Description	Gravity Flow Network		

Node No	5	Node Type	Tank
Description	(1)	Equipment No	
Rel. Level (RL)	1000 ft	Pressure Input	0 psi
Nozzle K value	-	Ext Flow (+In/-Out)	-
Int.(Gauge) Head	-	Int.(Gauge) Pressure	-
Total Node Head	1000 ft		