

Helix Technologies Pty Ltd

Project	Demo QA	Client	Helix Demo
Project No.	4567	Design Date	10/06/2017
Category	Demo Slurry Bingham	Atmos. Press	100.19 kPa
Network Type	Liquid	Calc. Method	Darcy
Description	Bingham Slurry Worked Example 5-4 Slurry Systems Handbook		

Slurry Systems Handbook, Baha Abulnaga, McGraw Hill Example 5.4 pg 5.10
 A Bingham slurry clay suspension with a mixture density of 1440 kg/m³ flows in 63mm ID pipe.
 Velocity of flow is 2.5m/s, Yield stress of slurry is 20Pa and co-efficient of rigidity is 32.8 mPa-s =
 0.0328 Pa-s.

Calculation Results	Publication	Helix Delta-Q
Reynolds Number Re	6914.6	6910
Hedstrom No	106 249	106 179
Darcy Friction factor f	0.024	0.033084
Pressure Drop per unit length	1714 Pa/m	2362 Pa/m

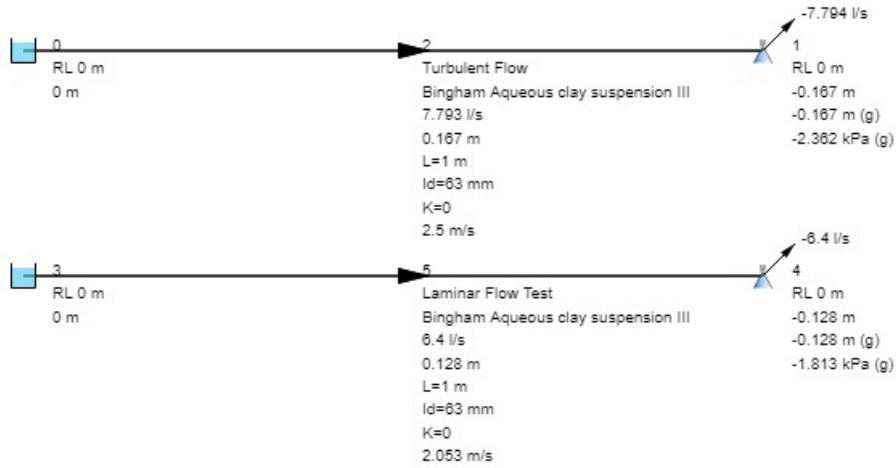
Helix delta-Q head loss and pressure drop is higher, it is based on the Weir / Warman method shown on page S5-3 of the Weir / Warman Slurry Pumping manual, 2002.

Helix Technologies prefers the Warman method as the Slurry Systems Handbook publication's Darby method actually shows a pressure drop when the flow transitions from laminar to turbulent.

Refer to the second pipe in this example, it is the same slurry and pipe but at a velocity of 2.053m/s, the flow is in the laminar regime. The pressure drop is 1813, close to the Darby method value but at a significantly lower flow velocity.

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Description	Bingham Slurry Worked Example 5-4 Slurry Systems Handbook		
Pipe No	2	From node to node	0 - 1
Description	Turbulent Flow	Equipment No	
Slurry Type	Bingham Plastic		
Slurry Description	Bingham Aqueous clay suspension III		
Slurry Reference	Slurry Systems Handbook		
SG Carrier Liquid Sl	1	Liquid Viscosity	1 cP
SG of Dry Solids	2.65	SG of Mixture	1.439
Conc. by Mass Cw	49 % w/w	Concentration by Vol	26.609 % v/v
Solids Flow Rate	5.495 kg/s	Particle Size d50	0.001 mm
Yield Stress To	20 Pa	Co-eff of Rigidity n	0.0328 Pa-s
Yield Stress Tw 8V/D	30.413 Pa	Shear Rate 8V/D	317.469 -s
Hedstrom No.	106179	Pressure Drop / m	2361.754 Pa/m
Critical Velocity Vc	2.261 m/s	Critical Flow Rate	7.047 l/s
Reynolds No at Vc	6954.514		
Pump Wear Factor Pw	1	Pump Head Ratio HR	0.999
Pipe Description	Polyethylene PE100 AS4130	Pipe Class	PN12.5
Nominal Diameter	75 mm	Inside Diameter	63 mm
Outside Diameter	75 mm	Pipe Length	1 m
Pipe Roughness	0 mm	Allowable Press.	1250 kPa
Orifice Plate Dia	-	Non Return Valve	No
Total Fittings k	0	Total Fittings kf	0
Flow Rate	7.793 l/s	Velocity	2.5 m/s
Friction Loss	0.167 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	0.167 m	Total Pressure Drop	2.362 kPa
Entry Total Head	0 m	Exit Total Head	-0.167 m
Entry Gauge Head	0 m	Exit Gauge Head	-0.167 m
Reynolds No.	6910.233	Friction Factor	0.033085 (Darcy f)

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Pipe No	5	From node to node	3 - 4
Description	Laminar Flow Test	Equipment No	
Slurry Type	Bingham Plastic		
Slurry Description	Bingham Aqueous clay suspension III		
Slurry Reference	Slurry Systems Handbook		
SG Carrier Liquid Sl	1	Liquid Viscosity	1 cP
SG of Dry Solids	2.65	SG of Mixture	1.439
Conc. by Mass Cw	49 % w/w	Concentration by Vol	26.609 % v/v
Solids Flow Rate	4.513 kg/s	Particle Size d50	0.001 mm
Yield Stress To	20 Pa	Co-eff of Rigidity n	0.0328 Pa-s
Yield Stress Tw 8V/D	28.551 Pa	Shear Rate 8V/D	260.706 -s
Hedstrom No.	106179	Pressure Drop / m	1812.771 Pa/m
Critical Velocity Vc	2.261 m/s	Critical Flow Rate	7.047 l/s
Reynolds No at Vc	6954.514		
Pump Wear Factor Pw	1	Pump Head Ratio HR	0.999
Pipe Description	Polyethylene PE100 AS4130	Pipe Class	PN12.5
Nominal Diameter	75 mm	Inside Diameter	63 mm
Outside Diameter	75 mm	Pipe Length	1 m
Pipe Roughness	0 mm	Allowable Press.	1250 kPa
Orifice Plate Dia	-	Non Return Valve	No
Total Fittings k	0	Total Fittings kf	0
Flow Rate	6.4 l/s	Velocity	2.053 m/s
Friction Loss	0.128 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	0.128 m	Total Pressure Drop	1.813 kPa
Entry Total Head	0 m	Exit Total Head	-0.128 m
Entry Gauge Head	0 m	Exit Gauge Head	-0.128 m
Reynolds No.	5674.684	Friction Factor	0.037656 (Darcy f)

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Node No	0	Node Type	Tank
Description		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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Node No	1	Node Type	Nozzle
Description		Equipment No	
Rel. Level (RL)	0 m	Pressure Input	0 kPa
Nozzle K value	0	Ext Flow (+In/-Out)	-7.794 l/s
Int.(Gauge) Head	-0.167 m	Int.(Gauge) Pressure	-2.362 kPa
Total Node Head	-0.167 m		

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Node No	3	Node Type	Tank
Description		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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Node No	4	Node Type	Nozzle
Description		Equipment No	
Rel. Level (RL)	0 m	Pressure Input	0 kPa
Nozzle K value	0	Ext Flow (+In/-Out)	-6.4 l/s
Int.(Gauge) Head	-0.128 m	Int.(Gauge) Pressure	-1.813 kPa
Total Node Head	-0.128 m		