Helix Technologies Pty Ltd

Project	Quality Assurance	Client	ABC Metals ..
Project No.	4567	Design Date	09/03/2017
Category	Demo QA Slurry	Atmos. Press	100.19 kPa
Network Type	Liquid	Calc. Method	Darcy
Description	Warman Slurry Manual pg 18 example		

Warman Slurry Manual (pg 18 in hardcopy, pg 32 in 2009 edition) example check values

Check Description	Warman	Helix deltaQ
Flow rate m3/hr	176.2	176.2
Total Head loss m	25.4	25.31 (0.43 + 5.88 + 19m static)
SG of Mixture Sm	1.23	1.23
Conc. by Volume Cv	13.9%	13.92%
Durand Co-eff Fl	1.04	1.03
Settling Limiting Vel	2.3 m/s	2.28 m/s
Solids Transport	65 tph	65.0 tph
NPSH available		9.08 m

Results correlate well, some small rounding differences are present.
Warman example does not state exact pipe roughness, Helix model assumes 0.06 to gibe a frction factor = 0.017 as used by Warman.
Back calculate the K value for equivalent length of 16.75m used for bends. hfittings = KV^2/2g and hf = f L/D V^2/2g = 0.017 * 16.75 / 0.15 * 2.77^2 / 2 * 9.81 = 0.7424m for fitting losses = KV^/2g therefore K = hf /V^2 * 2g = 0.7424 / 2.77 / 2.77 * 2 * 9.81 = 1.898 divide by 5 bends = 0.38 per bend.
Add exit k value losses and sudden enlargement of 1 + 0.41 = total K value of 3.45, see pipe details.
Total head loss Helix = 0.43 + 5.88 = 6.31m + 19m static = 25.31m

Click on the delivery pipe and then on the Graph tab to view the system and slurry settlement curve.

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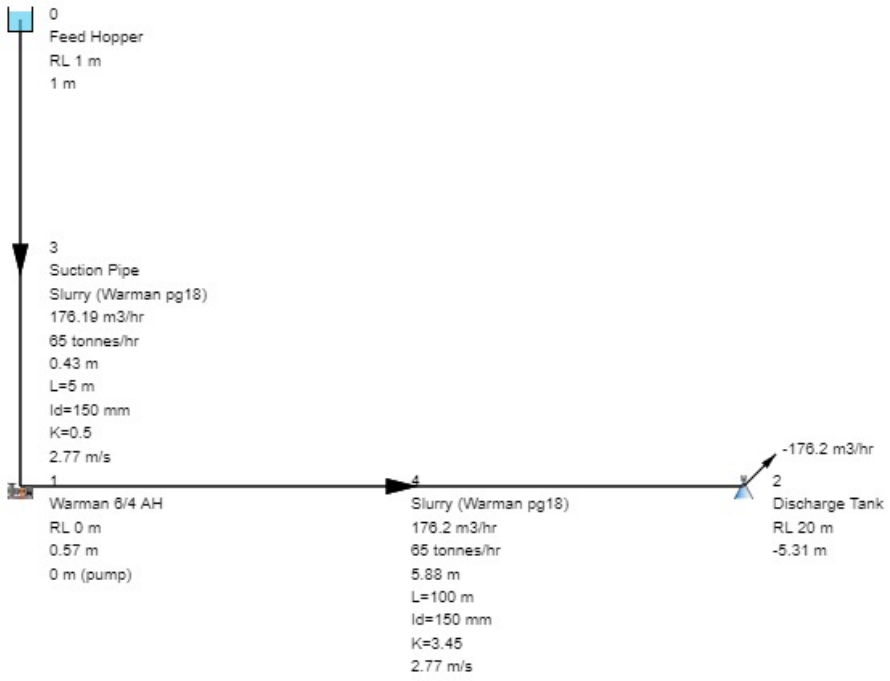

Warman Slurry Manual pg 18 example

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Category	Demo QA Slurry	Atmos. Press	100.19 kPa
Description	Warman Slurry Manual pg 18 example		

Pipe No	3	From node to node	0 - 1
Description	Suction Pipe	Equipment No	
Slurry Type	Settling Slurry		
Slurry Description	Slurry (Warman pg18)	Slurry Reference	Example
SG Carrier Liquid Sl	1	Liquid Viscosity	1 cP
SG of Dry Solids	2.65	SG of Mixture	1.23
Conc. by Mass Cw	30 % w/w	Concentration by Vol	1.23 % v/v
Solids Flow Rate	65 tonnes/hr	Particle Size d50	0.21 mm
Grading	Widely Graded		
Durand co-eff. Fl	1.03	Settling Velocity Vl	2.28 m/s
Settling Flow Rate	144.75 m3/hr		
Pump Wear Factor Pw	0.89	Pump Head Ratio HR	0.93
Pipe Description	Steel 6" Rubber lined	Pipe Class	Sch 40
Nominal Diameter	150 mm	Inside Diameter	150 mm
Outside Diameter	168.3 mm	Pipe Length	5 m
Pipe Roughness	0.06 mm	Allowable Press.	8130 kPa
Orifice Plate Dia	-	Non Return Valve	No

Pipe Fitting Description	Qty	K value	Kft value
Entrance - flush 1/2	1	0.5	0

Total Fittings k	0.5	Total Fittings kf	0
Flow Rate	176.19 m3/hr	Velocity	2.77 m/s
Friction Loss	0.23 m	Fitting Losses	0.2 m
Slurry Losses	0.01 m	Orifice Losses	0 m
Fixed Head Loss	0 m	Booster Pump Head	0 m
Total Head Loss	0.43 m	Total Pressure Drop	5.14 kPa
Entry Total Head	1 m	Exit Total Head	0.57 m
Entry Gauge Head	0 m	Exit Gauge Head	0.57 m
Reynolds No.	510866.76	Friction Factor	0.01699 (Darcy f)

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Category	Demo QA Slurry	Atmos. Press	100.19 kPa
Description	Warman Slurry Manual pg 18 example		

Pipe No	4	From node to node	1 - 2
Description		Equipment No	
Slurry Type	Settling Slurry		
Slurry Description	Slurry (Warman pg18)	Slurry Reference	Example
SG Carrier Liquid Sl	1	Liquid Viscosity	1 cP
SG of Dry Solids	2.65	SG of Mixture	1.23
Conc. by Mass Cw	30 % w/w	Concentration by Vol	1.23 % v/v
Solids Flow Rate	65 tonnes/hr	Particle Size d50	0.21 mm
Grading	Widely Graded		
Durand co-eff. Fl	1.03	Settling Velocity Vl	2.28 m/s
Settling Flow Rate	144.75 m3/hr		
Pump Wear Factor Pw	0.89	Pump Head Ratio HR	0.93
Pipe Description	Steel 6" Rubber lined	Pipe Class	Sch 40
Nominal Diameter	150 mm	Inside Diameter	150 mm
Outside Diameter	168.3 mm	Pipe Length	100 m
Pipe Roughness	0.06 mm	Allowable Press.	8130 kPa
Orifice Plate Dia	-	Non Return Valve	No

Pipe Fitting Description	Qty	K value	Kft value
Sudden Enlargement - 1:2	1	0.55	30
Exit - Sharp edged	1	1	0
Bend - 90 degree elbow r/d = 16	5	0.38	42

Total Fittings k	3.45	Total Fittings kf	0
Flow Rate	176.2 m3/hr	Velocity	2.77 m/s
Friction Loss	4.53 m	Fitting Losses	1.35 m
Slurry Losses	0.1 m	Orifice Losses	0 m
Fixed Head Loss	0 m	Booster Pump Head	0 m
Total Head Loss	5.88 m	Total Pressure Drop	70.95 kPa
Entry Total Head	0.57 m	Exit Total Head	-5.31 m
Entry Gauge Head	0.57 m	Exit Gauge Head	-25.31 m
Reynolds No.	510882.3	Friction Factor	0.01699 (Darcy f)

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Category	Demo QA Slurry	Atmos. Press	100.19 kPa
Description	Warman Slurry Manual pg 18 example		

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

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Node No	1	Node Type	Pump
Description	Warman 6/4 AH	Equipment No	PP-01
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	0.57 m		
Pump Head	0 m	Pump Flow Rate	176.19 m3/hr
Pump / Fan Efficiency	66 %	Pump Absorbed Power	0 kW
Casing Pressure	6.92 kPa		
Pump NPSH required	2.7 m	Pump NPSH available	9.08 m

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Description	Warman Slurry Manual pg 18 example		

Node No	2	Node Type	Nozzle
Description	Discharge Tank	Equipment No	TK-01
Rel. Level (RL)	20 m	Pressure Input	0 kPa
Nozzle K value	0	Ext Flow (+In/-Out)	-176.2 m3/hr
Int.(Gauge) Head	-25.31 m	Int.(Gauge) Pressure	-305.21 kPa
Total Node Head	-5.31 m		