Helix Technologies Pty Ltd

Project	Helix QA	Client	Helix QA
Project No.	4567	Design Date	16/03/2017
Category	Demo Air QA	Atmos. Press	14.7 psi
Network Type	Gas	Calc. Method	Isothermal
Description	Isothermal Air Flow in smooth pipe		

Piping Calculations Manual, 2005, McGraw-Hill, E. Shashi Menon, P.E., Page 265, Example 5.8

Air flows at 50 ft/s through a 2-in inside diameter pipe at 80 deg F at an initial pressure of 100 psig. If the pipe is horizontal and 1000 ft long, calculate the pressure drop considering isothermal flow. Use a friction factor f =0.02.
In the Helix program there are two ways to solve this problem. There is also an Isothermal or Modified Darcy method of calculation for gas networks. Use the Isothermal method in this example but you can compare the results with the Modified Darcy method as well.

Method 1. Build the network with two Tanks (known pressure nodes). Set the Calculation Method to Isothermal and Gas Calc Method to Mass Flow under Network Settings and Fluid as Gas. Set the first node pressure to 100 psig + 14.7 psi atmospheric = 114.7 psi absolute. (The Helix program works in absolute node pressures). Now enter the correct fluid (Air at 26.6 degrees~80 F). Enter the 2" id pipe 1000ft long with no fittings i.e k = 0. Set the absolute roughness to say 0.002" as a normal steel pipe. Set the outlet tank pressure to say 10% less than inlet pressure i.e 103 psi. Solve. The flow rate is 0.83ft3/s and velocity is 38 ft/s. This is less than the required 50 ft/s velocity. Lower the outlet node pressure to say 90 psi and solve. Velocity is now 53.8 ft/s which is a bit high so increase pressure at outlet node and re-solve until velocity is 50ft/s at 94.4psi outlet pressure. Check calculated friction factor f, it is = 0.01973 at an outlet pressure of 94.55 psi. This means the pipe friction can be adjusted up slightly and outlet pressure adjusted down accordingly to keep the velocity at 50ft/s.

Method 2. Build the network with one Tank and one Nozzle. (Tank is known pressure node and Nozzle is known flow node). Set the Calculation Method to Isothermal and Gas Calc Method to Mass Flow under Network Settings and Fluid as Gas. Set the Tank node pressure to 100 psig + 14.7 psi atmospheric = 114.7 psi absolute. (The Helix program works in absolute node pressures). Now enter the correct fluid (Air at 26.6 degrees~80 F). Enter the 2" id pipe 1000ft long with no fittings. Set the absolute roughness to say 0.002" as a normal steel pipe. Set the outlet Nozzle flow to say -1 ft3/s. Solve. The velocity is 45.84 ft/s which is lower than required 50 ft/s so increase the flow by trial and error until you find -1.091 ft3/s gives the required velocity of 50 ft/s. The Calculated outlet pressure at the nozzle is 94.54 psi.

Published result is 94.18 psia and Helix calculation is 94.5 psia so there is close correlation. A closer match can be obtained by adjusting pipe roughness until calculated Darcy friction factor f = 0.02.

This example illustrates the Helix known pressure nodes method where the flow rate is calculated vs the known flow system where the pressure drop is calculated.

Change the Gas Calculation method to Modified Darcy in the Network Details settings and recalculate and compare the results with the Isothermal method. Results are close.

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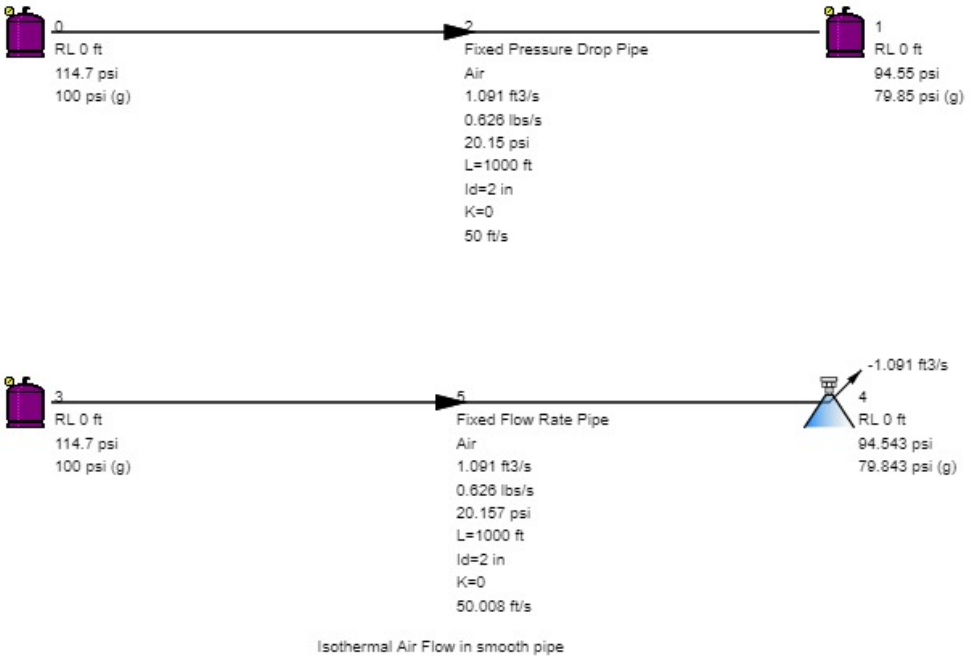

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Pipe No	2	From node to node	0 - 1
Description	Fixed Pressure Drop Pipe	Equipment No	
Gas	Air	Molecular Mass	28.96 kg/kmol
Ratio Cp/Cv	1.4	Viscosity	0.02 cP
Temperature	26.67 C	Density	9.187 kg/m3
Gas SG to Air	1	Gas Specific Vol	0.109 m3/kg
Gas Constant R	287.099	Abs. Gas Temp.	0.109 deg K
Flow Condition	Free Flow	Net Exp.Factor Y	1
Pipe Description	Steel Pipes 2" AS1836 (ANSI B36.10)	Pipe Class	Sch 40
Nominal Diameter	2 in	Inside Diameter	2 in
Outside Diameter	2.5 in	Pipe Length	1000 ft
Pipe Roughness	0.002 in	Allowable Press.	999 psi
Orifice Plate Dia	-	Non Return Valve	No
Total Fittings k	0	Total Fittings kf	0
Flow Rate	1.091 ft3/s	Flow at SMC	8.178 ft3/s
Mass Flow Rate	0.626 lbs/s	Velocity	50 ft/s
Mach number	0.532		
Friction Loss	20.15 psi	Fitting Losses	0 psi
Orifice Losses	0 psi	Fixed Pressure Drop	0 psi
Total Pressure Drop	20.15 psi		
Entry Total Pressure	114.7 psi	Exit Total Pressure	94.55 psi
Reynolds No.	3267403.042	Friction Factor	0.019732 (Darcy f)

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Pipe No	5	From node to node	3 - 4
Description	Fixed Flow Rate Pipe	Equipment No	
Gas	Air	Molecular Mass	28.96 kg/kmol
Ratio Cp/Cv	1.4	Viscosity	0.02 cP
Temperature	26.67 C	Density	9.187 kg/m3
Gas SG to Air	1	Gas Specific Vol	0.109 m3/kg
Gas Constant R	287.099	Abs. Gas Temp.	0.109 deg K
Flow Condition	Free Flow	Net Exp.Factor Y	1
Pipe Description	Steel Pipes 2" AS1836 (ANSI B36.10)	Pipe Class	Sch 40
Nominal Diameter	2 in	Inside Diameter	2 in
Outside Diameter	2.5 in	Pipe Length	1000 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	1.091 ft3/s	Flow at SMC	8.179 ft3/s
Mass Flow Rate	0.626 lbs/s	Velocity	50.008 ft/s
Mach number	0.532		
Friction Loss	20.157 psi	Fitting Losses	0 psi
Orifice Losses	0 psi	Fixed Pressure Drop	0 psi
Total Pressure Drop	20.157 psi		
Entry Total Pressure	114.7 psi	Exit Total Pressure	94.543 psi
Reynolds No.	3267878.834	Friction Factor	0.019732 (Darcy f)

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Node No	0	Node Type	Tank
Description		Equipment No	
Rel. Level (RL)	0 ft	Pressure Input	114.7 psi
Ext Flow (+In/-Out)	-	Abs. Node Pressure	114.7 psi
Int.(Gauge) Head	2594582.113 psi		

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Node No	1	Node Type	Tank
Description		Equipment No	
Rel. Level (RL)	0 ft	Pressure Input	94.55 psi
Ext Flow (+In/-Out)	-	Abs. Node Pressure	94.55 psi
Int.(Gauge) Head	2128597.88 psi		

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Node No	3	Node Type	Tank
Description		Equipment No	
Rel. Level (RL)	0 ft	Pressure Input	114.7 psi
Ext Flow (+In/-Out)	-	Abs. Node Pressure	114.7 psi
Int.(Gauge) Head	2594582.113 psi		

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Node No	4	Node Type	Nozzle
Description		Equipment No	
Rel. Level (RL)	0 ft	Pressure Input	0 psi
Ext Flow (+In/-Out)	-1.091 ft3/s	Abs. Node Pressure	94.543 psi
Int.(Gauge) Head	2138630.008 psi		