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Project	Demo QA	Client	Helix Demo
Project No.	4567	Design Date	09/06/2017
Category	Demo Gas QA	Atmos. Press	14.7 psi
Network Type	Gas	Calc. Method	Modified Darcy
Description	Gas Flow Fluid Flow Handbook Example 9.3		

Fluid Flow Handbook, 2002, McGraw-Hill, Jamal Saleh, Pg 9.12, Example 9.3

Calculation Results	Publication	Helix delta-Q
Mass Flow rate	74225 lb/hr	82846 lb/hr Modified Darcy calculation.
Net Expansion Factor Y	0.656	0.733

Results are not the same, Helix calculates a different net expansion factor Y = 0.733, publication used 0.656.
Check calculations using the Crane 410 examples confirm the Helix Net Expansion factor calculation is correct for
sub-sonic and for sonic flow conditions - see Demo files marked Gas, Crane.

The additional networks show the effect of reducing the exit tank pressure.
At exit pressure of 44 psi flow is not yet sonic.
At exit pressure of 43 psi flow is sonic = choked. Note blue dot on diagram indicates chokd flow.
Even reducing the exit pressure to only 1 psi does not increase the mass flow rate beyond the value reached at sonic velocity.

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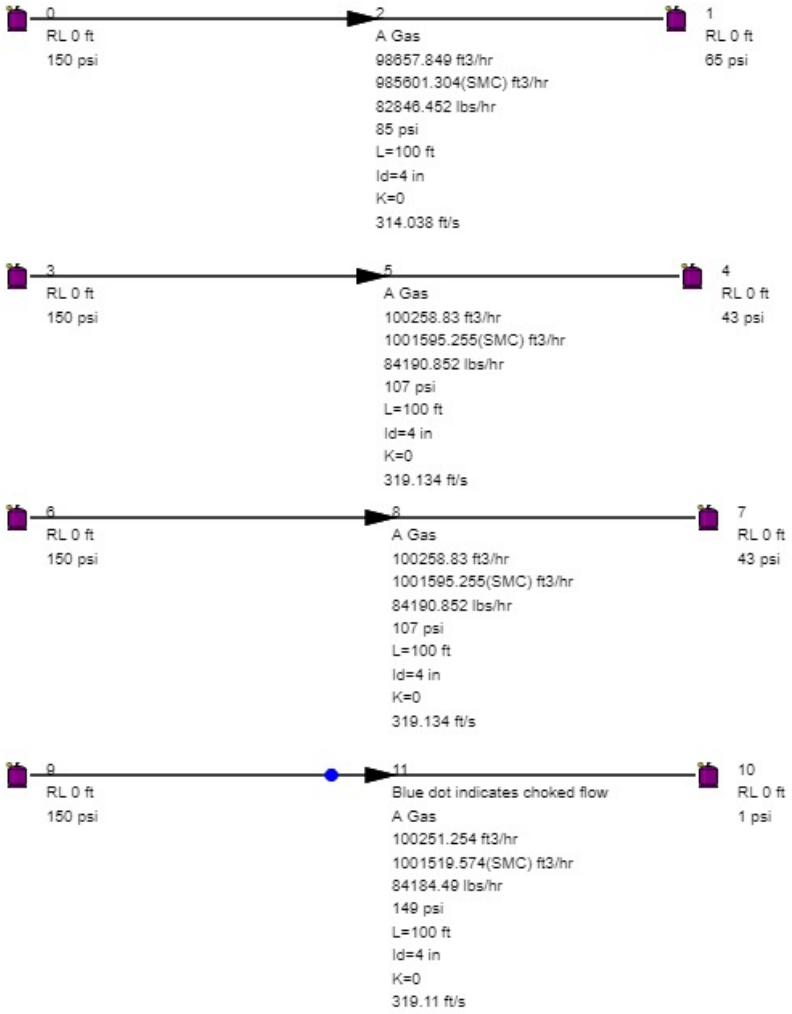
Project	Demo QA	Client	Helix Demo
Project No.	4567	Design Date	09/06/2017
Category	Demo Gas QA	Atmos. Press	14.7 psi
Description	Gas Flow Fluid Flow Handbook Example 9.3		



Gas Flow Fluid Flow Handbook Example 9.3

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Project	Demo QA	Client	Helix Demo
Project No.	4567	Design Date	09/06/2017
Category	Demo Gas QA	Atmos. Press	14.7 psi
Description	Gas Flow Fluid Flow Handbook Example 9.3		

Pipe No	2	From node to node	0 - 1
Description		Equipment No	
Gas	A Gas	Molecular Mass	31.82 kg/kmol
Ratio Cp/Cv	1.4	Viscosity	0.01786 cP
Temperature	21.1 C	Density	13.451 kg/m3
Gas SG to Air	1.099	Gas Specific Vol	0.074 m3/kg
Gas Constant R	261.294	Abs. Gas Temp.	0.074 deg K
Flow Condition	Free Flow	Net Exp.Factor Y	0.733
Pipe Description	Steel Pipes 4" AS1836 (ANSI B36.10)	Pipe Class	Sch 40
Nominal Diameter	4 in	Inside Diameter	4 in
Outside Diameter	4.5 in	Pipe Length	100 ft
Pipe Roughness	0.00218 in	Allowable Press.	150 psi
Orifice Plate Dia	-	Non Return Valve	No
Total Fittings k	0	Total Fittings kf	0
Flow Rate	98657.849 ft3/hr	Flow at SMC	985601.304 ft3/hr
Mass Flow Rate	82846.452 lbs/hr	Velocity	314.038 ft/s
Mach number	1		
Friction Loss	85 psi	Fitting Losses	0 psi
Orifice Losses	0 psi	Fixed Pressure Drop	0 psi
Total Pressure Drop	85 psi		
Entry Total Pressure	150 psi	Exit Total Pressure	65 psi
Reynolds No.	98533859.648	Friction Factor	0.017032 (Darcy f)

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Project	Demo QA	Client	Helix Demo
Project No.	4567	Design Date	09/06/2017
Category	Demo Gas QA	Atmos. Press	14.7 psi
Description	Gas Flow Fluid Flow Handbook Example 9.3		

Pipe No	5	From node to node	3 - 4
Description		Equipment No	
Gas	A Gas	Molecular Mass	31.82 kg/kmol
Ratio Cp/Cv	1.4	Viscosity	0.01786 cP
Temperature	21.1 C	Density	13.451 kg/m3
Gas SG to Air	1.099	Gas Specific Vol	0.074 m3/kg
Gas Constant R	261.294	Abs. Gas Temp.	0.074 deg K
Flow Condition	Free Flow	Net Exp.Factor Y	0.664
Pipe Description	Steel Pipes 4" AS1836 (ANSI B36.10)	Pipe Class	Sch 40
Nominal Diameter	4 in	Inside Diameter	4 in
Outside Diameter	4.5 in	Pipe Length	100 ft
Pipe Roughness	0.00218 in	Allowable Press.	150 psi
Orifice Plate Dia	-	Non Return Valve	No
Total Fittings k	0	Total Fittings kf	0
Flow Rate	100258.83 ft3/hr	Flow at SMC	1001595.255 ft3/hr
Mass Flow Rate	84190.852 lbs/hr	Velocity	319.134 ft/s
Mach number	1		
Friction Loss	107 psi	Fitting Losses	0 psi
Orifice Losses	0 psi	Fixed Pressure Drop	0 psi
Total Pressure Drop	107 psi		
Entry Total Pressure	150 psi	Exit Total Pressure	43 psi
Reynolds No.	100132828.397	Friction Factor	0.017032 (Darcy f)

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Project	Demo QA	Client	Helix Demo
Project No.	4567	Design Date	09/06/2017
Category	Demo Gas QA	Atmos. Press	14.7 psi
Description	Gas Flow Fluid Flow Handbook Example 9.3		

Pipe No	8	From node to node	6 - 7
Description		Equipment No	
Gas	A Gas	Molecular Mass	31.82 kg/kmol
Ratio Cp/Cv	1.4	Viscosity	0.01786 cP
Temperature	21.1 C	Density	13.451 kg/m3
Gas SG to Air	1.099	Gas Specific Vol	0.074 m3/kg
Gas Constant R	261.294	Abs. Gas Temp.	0.074 deg K
Flow Condition	Free Flow	Net Exp.Factor Y	0.664
Pipe Description	Steel Pipes 4" AS1836 (ANSI B36.10)	Pipe Class	Sch 40
Nominal Diameter	4 in	Inside Diameter	4 in
Outside Diameter	4.5 in	Pipe Length	100 ft
Pipe Roughness	0.00218 in	Allowable Press.	150 psi
Orifice Plate Dia	-	Non Return Valve	No
Total Fittings k	0	Total Fittings kf	0
Flow Rate	100258.83 ft3/hr	Flow at SMC	1001595.255 ft3/hr
Mass Flow Rate	84190.852 lbs/hr	Velocity	319.134 ft/s
Mach number	1		
Friction Loss	107 psi	Fitting Losses	0 psi
Orifice Losses	0 psi	Fixed Pressure Drop	0 psi
Total Pressure Drop	107 psi		
Entry Total Pressure	150 psi	Exit Total Pressure	43 psi
Reynolds No.	100132828.397	Friction Factor	0.017032 (Darcy f)

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Project	Demo QA	Client	Helix Demo
Project No.	4567	Design Date	09/06/2017
Category	Demo Gas QA	Atmos. Press	14.7 psi
Description	Gas Flow Fluid Flow Handbook Example 9.3		

Pipe No	11	From node to node	9 - 10
Description	Blue dot indicates choked flow	Equipment No	
Gas	A Gas	Molecular Mass	31.82 kg/kmol
Ratio Cp/Cv	1.4	Viscosity	0.01786 cP
Temperature	21.1 C	Density	13.451 kg/m3
Gas SG to Air	1.099	Gas Specific Vol	0.074 m3/kg
Gas Constant R	261.294	Abs. Gas Temp.	0.074 deg K
Flow Condition	Choked Flow	Net Exp.Factor Y	0.661
Pipe Description	Steel Pipes 4" AS1836 (ANSI B36.10)	Pipe Class	Sch 40
Nominal Diameter	4 in	Inside Diameter	4 in
Outside Diameter	4.5 in	Pipe Length	100 ft
Pipe Roughness	0.00218 in	Allowable Press.	150 psi
Orifice Plate Dia	-	Non Return Valve	No
Total Fittings k	0	Total Fittings kf	0
Flow Rate	100251.254 ft3/hr	Flow at SMC	1001519.574 ft3/hr
Mass Flow Rate	84184.49 lbs/hr	Velocity	319.11 ft/s
Mach number	1		
Friction Loss	149 psi	Fitting Losses	0 psi
Orifice Losses	0 psi	Fixed Pressure Drop	0 psi
Total Pressure Drop	149 psi		
Entry Total Pressure	150 psi	Exit Total Pressure	1 psi
Reynolds No.	100125262.275	Friction Factor	0.017032 (Darcy f)

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Project	Demo QA	Client	Helix Demo
Project No.	4567	Design Date	09/06/2017
Category	Demo Gas QA	Atmos. Press	14.7 psi
Description	Gas Flow Fluid Flow Handbook Example 9.3		

Node No	0	Node Type	Tank
Description		Equipment No	
Rel. Level (RL)	0 ft	Pressure Input	150 psi
Ext Flow (+In/-Out)	-	Abs. Node Pressure	150 psi
Int.(Gauge) Head	0 psi		

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Project	Demo QA	Client	Helix Demo
Project No.	4567	Design Date	09/06/2017
Category	Demo Gas QA	Atmos. Press	14.7 psi
Description	Gas Flow Fluid Flow Handbook Example 9.3		

Node No	1	Node Type	Tank
Description		Equipment No	
Rel. Level (RL)	0 ft	Pressure Input	65 psi
Ext Flow (+In/-Out)	-	Abs. Node Pressure	65 psi
Int.(Gauge) Head	0 psi		

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Project	Demo QA	Client	Helix Demo
Project No.	4567	Design Date	09/06/2017
Category	Demo Gas QA	Atmos. Press	14.7 psi
Description	Gas Flow Fluid Flow Handbook Example 9.3		

Node No	3	Node Type	Tank
Description		Equipment No	
Rel. Level (RL)	0 ft	Pressure Input	150 psi
Ext Flow (+In/-Out)	-	Abs. Node Pressure	150 psi
Int.(Gauge) Head	0 psi		

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Project	Demo QA	Client	Helix Demo
Project No.	4567	Design Date	09/06/2017
Category	Demo Gas QA	Atmos. Press	14.7 psi
Description	Gas Flow Fluid Flow Handbook Example 9.3		

Node No	4	Node Type	Tank
Description		Equipment No	
Rel. Level (RL)	0 ft	Pressure Input	43 psi
Ext Flow (+In/-Out)	-	Abs. Node Pressure	43 psi
Int.(Gauge) Head	5.663 psi		

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Project	Demo QA	Client	Helix Demo
Project No.	4567	Design Date	09/06/2017
Category	Demo Gas QA	Atmos. Press	14.7 psi
Description	Gas Flow Fluid Flow Handbook Example 9.3		

Node No	6	Node Type	Tank
Description		Equipment No	
Rel. Level (RL)	0 ft	Pressure Input	150 psi
Ext Flow (+In/-Out)	-	Abs. Node Pressure	150 psi
Int.(Gauge) Head	0 psi		

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Project	Demo QA	Client	Helix Demo
Project No.	4567	Design Date	09/06/2017
Category	Demo Gas QA	Atmos. Press	14.7 psi
Description	Gas Flow Fluid Flow Handbook Example 9.3		

Node No	7	Node Type	Tank
Description		Equipment No	
Rel. Level (RL)	0 ft	Pressure Input	43 psi
Ext Flow (+In/-Out)	-	Abs. Node Pressure	43 psi
Int.(Gauge) Head	5.663 psi		

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Project	Demo QA	Client	Helix Demo
Project No.	4567	Design Date	09/06/2017
Category	Demo Gas QA	Atmos. Press	14.7 psi
Description	Gas Flow Fluid Flow Handbook Example 9.3		

Node No	9	Node Type	Tank
Description		Equipment No	
Rel. Level (RL)	0 ft	Pressure Input	150 psi
Ext Flow (+In/-Out)	-	Abs. Node Pressure	150 psi
Int.(Gauge) Head	0 psi		

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Project	Demo QA	Client	Helix Demo
Project No.	4567	Design Date	09/06/2017
Category	Demo Gas QA	Atmos. Press	14.7 psi
Description	Gas Flow Fluid Flow Handbook Example 9.3		

Node No	10	Node Type	Tank
Description		Equipment No	
Rel. Level (RL)	0 ft	Pressure Input	1 psi
Ext Flow (+In/-Out)	-	Abs. Node Pressure	1 psi
Int.(Gauge) Head	5.663 psi		