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Content Based
Chemical Engineering

Piping Pressure Drop Template -- For Liquids or Gases
Version 2.19a

by Stephen M. Hall, PE

All cells are locked except user-defined data; unlock sheet from Tools menu (no password required)
VIEW-COMMENTS to see some additional explanations.

DATA INPUT

Project Data

Prepared by	S. Hall	Client	Sample
Date	15-Mar-2003	W.O.	10314
● English ○ SI		Unit	Process
		Area	Tank Farm

Line ID

Line Number: Liquid Example

General Pipeline Data

Service: Raw Material Transfer
Pipe Material Specification: A << 150 lb Carbon Steel
Insulation: None
Ambient Temp (deg F): 80.00

Process Data

Fluid Name		Toluene	● Liquid
Molecular Weight	(Entry Ignored>>>)	92.13	○ Gas
Actual Flow	(gallons/minute)	100.00	
Maximum Flow	(gallons/minute)	100.00	
Flowing Temperature	(deg F)	70.00	
Nominal Pressure	(psia)	14.70	
Specific Gravity		0.87	(<<< Entry Ignored)
Absolute Viscosity	(centipoise)	0.779	(<<< Entry Ignored)

Optional Pulldown List of Fluids: Toluene

Conversion from scfm to pph

Desired scfm:	150
Molecular weight:	92.13
Actual Flow (lb/h):	**2,310**

Size Selection Criteria

○ Economic ○ Specific Diameter ○ Target Velocity

3

Conversion from acfm to pph

Desired acfm:	150
Molecular weight:	92.13
Pressure (psia):	14.7
Temperature (deg F):	70
Actual Flow (lb/h):	**2,144**

Physical Layout

Length of pipeline (feet): 1000

90 deg Ell	0	Globe Valve	0
Long Rad. Ell	0	Gate Valve	0
45 deg Ell	0	Ball Valve (reduced p	0
180 deg Bend	0	Butterfly Valve	0
TEE-Line Flow	0	Plug Valve	0
TEE-Branch Flow	0	Angle Valve	0
Bell Mouth Inlet	0	Swing Check Valve	0
Square Mouth Inlet	0	Re-Entrant Pipe	0

Report Selection

● Results Summary	○ LIQFLOW
○ Datasheet Style	○ EquivLength
○ Instructions	○ OPTLIQ

PIPELINE SIZING CALCULATION

REV	PREPARED BY	DATE	APPROVAL
0	S. Hall	15-Mar-2003	
1			
2			

CLIENT	*LINE NO.*	
Sample	**Liquid Example**	
W.O.	*REQUISITION NO.*	*SPECIFICATION NO.*
10314		18103
UNIT *AREA*	*PROCURED BY*	*INSTALLED BY*
Process Tank Farm		

General

Fluid Service			***Raw Material Transfer***
Pipe Specification			***A: 150 lb Carbon Steel***
Surface Roughness	(feet)		***0.00015***
Insulation			***None***
Ambient Temperature	(deg F)		***80***

Process Data

Fluid Pumped			***Toluene (liquid)***
Design Flow Rate	(gallons/minute)		***100***
Maximum Flow Rate	(gallons/minute)		***100***
Flowing Temperature	(deg F)		***70***
Nominal Pressure	(psia)		***14.7***
Specific Gravity			***0.867*** *(= 54.10 lb/cu.ft.)*
Viscosity	(centipoise)		***0.583587***

Basis for Sizing: Optimum Economic Diameter

	Nom.		O.D.	Wall	I.D.	Reynolds	Friction	Pressure Drop/100 equiv ft			Velocity
	Size	Sched	(in.)	(in.)	(in.)	Number	Factor	(psi)	(ft water)	(ft liq)	(ft/sec)
	2	80	2.375	0.218	1.939	2.42E+05	0.0207	*8.81*	20.36	23.48	10.87
===>	***3***	40	3.500	0.216	3.068	1.53E+05	0.0199	***0.85***	***1.97***	2.27	***4.34***
	4	40	4.500	0.237	4.026	1.17E+05	0.0198	*0.22*	0.51	0.58	2.52

Physical Layout

90 deg Ell	-	TEE-Line Flow	-	Globe Valve	-	Plug Valve	-
Long Rad. Ell	-	TEE-Brnch Flow	-	Gate Valve	-	Angle Valve	-
45 deg Ell	-	Bell Mouth Inlet	-	Ball Valve (red. port)	-	Swing Check Valve	-
180 deg Bend	-	Sq. Mouth Inlet	-	Butterfly Valve	-	Re-Entrant Pipe	-

Straight Feet of Pipe (measured through centerline of fittings): ***1000*** feet

Heat Loss

	Nom.		Pipe is Uninsulated					
	Size	units	Bare	0.5 in	1 in	1-1/2 in	2 in	3 in
	2	Btu/hr-ft	(7)	n/a	n/a	n/a	n/a	n/a
===>	3	Btu/hr-ft	(11)	n/a	n/a	n/a	n/a	n/a
	4	Btu/hr-ft	(13)	n/a	n/a	n/a	n/a	n/a

Summary of Results

	Nom.	Eq Lgth	Pressure Drop			Heat Loss (Gain), But/hr					
	Size	(ft)	(psi)	(ft water)	(ft liq)	Bare	0.5 in	1 in	1-1/2 in	2 in	3 in
	2	1,000	88.13	*203.58*	234.8	(7,363)	n/a	n/a	n/a	n/a	n/a
===>	3	1,000	8.54	*19.73*	22.7	(11,336)	n/a	n/a	n/a	n/a	n/a
	4	1,000	2.19	*5.06*	5.8	(13,417)	n/a	n/a	n/a	n/a	n/a

EFFECT OF FLOW VARIATION

REV	PREPARED BY	DATE	APPROVAL
0	S. Hall	15-Mar-2003	
1			
2			

CLIENT **Sample**

LINE NO. **Liquid Example**

W.O. 10314

REQUISITION NO.

SPECIFICATION NO. 18103

UNIT Process *AREA* Tank Farm

PROCURED BY

INSTALLED BY

1	**General**		
2	Fluid Service		***Raw Material Transfer***
3	Pipe Specification		***A: 150 lb Carbon Steel***
4	Surface Roughness	(feet)	***0.00015***
5	Insulation		***None***
6	Ambient Temperature	(deg F)	***80***
7			
8	**Process Data**		
9	Fluid Pumped		***Toluene (liquid)***
10	Design Flow Rate	(gallons/minute)	***100***
11	Maximum Flow Rate	(gallons/minute)	***100***
12	Flowing Temperature	(deg F)	***70***
13	Nominal Pressure	(psia)	***14.7***
14	Specific Gravity		***0.867*** *(= 54.10 lb/cu.ft.)*
15	Viscosity	(centipoise)	***0.58359***
16			

17	**Smaller Pipe Size**		**2** in.	Flow	Reynolds	Friction	DeltaP/100 equiv ft		Velocity
18	Schedule		80	(gpm)	Number	Factor	(psi)	(ft water)	(ft/sec)
19	Outside Diameter	(in.)	2.375	10	24,192	0.0270	0.11	0.26	1.09
20	Wall Thickness	(in.)	0.218	20	48,384	0.0241	0.41	0.95	2.17
21	Inside Diameter	(in.)	1.939	30	72,576	0.0229	0.87	2.02	3.26
22				40	96,768	0.0222	1.51	3.48	4.35
23				50	120,960	0.0217	2.31	5.33	5.43
24				60	145,152	0.0214	3.27	7.56	6.52
25				70	169,344	0.0211	4.40	10.17	7.61
26				80	193,536	0.0210	5.70	13.17	8.69
27				90	217,727	0.0208	7.16	16.54	9.78
28				100	241,919	0.0207	8.79	20.30	10.87

29	**Selected Pipe Size**		**3** in.	Flow	Reynolds	Friction	DeltaP/100 equiv ft		Velocity
30	Schedule		40	(gpm)	Number	Factor	(psi)	(ft water)	(ft/sec)
31	Outside Diameter	(in.)	3.500	10	15,289	0.0289	0.01	0.03	0.43
32	Wall Thickness	(in.)	0.216	20	30,579	0.0250	0.04	0.10	0.87
33	Inside Diameter	(in.)	3.068	30	45,868	0.0233	0.09	0.21	1.30
34				40	61,158	0.0222	0.15	0.35	1.74
35				50	76,447	0.0215	0.23	0.53	2.17
36				60	91,737	0.0210	0.32	0.75	2.60
37				70	107,026	0.0206	0.43	1.00	3.04
38				80	122,316	0.0203	0.56	1.29	3.47
39				90	137,605	0.0201	0.70	1.61	3.91
40				100	152,895	0.0199	0.85	1.97	4.34

41	**Next Larger Pipe Size**		**4** in.	Flow	Reynolds	Friction	DeltaP/100 equiv ft		Velocity
42	Schedule		40	(gpm)	Number	Factor	(psi)	(ft water)	(ft/sec)
43	Outside Diameter	(in.)	4.500	10	11,651	0.0306	0.00	0.01	0.25
44	Wall Thickness	(in.)	0.237	20	23,303	0.0260	0.01	0.03	0.50
45	Inside Diameter	(in.)	4.026	30	34,954	0.0240	0.02	0.05	0.76
46				40	46,605	0.0227	0.04	0.09	1.01
47				50	58,257	0.0219	0.06	0.14	1.26
48				60	69,908	0.0213	0.08	0.19	1.51
49				70	81,559	0.0208	0.11	0.26	1.76
50				80	93,210	0.0204	0.14	0.33	2.02
51				90	104,862	0.0201	0.18	0.41	2.27
52				100	116,513	0.0198	0.22	0.50	2.52

EQUIVALENT LENGTH OF PIPE

REV	PREPARED BY	DATE	APPROVAL
0	S. Hall	15-Mar-2003	
1			
2			

CLIENT	*LINE NO.*	
Sample	**Liquid Example**	
W.O.	*REQUISITION NO.*	*SPECIFICATION NO.*
10314		18103
UNIT *AREA*	*PROCURED BY*	*INSTALLED BY*
Process Tank Farm		

1	**General**	
2	Fluid Service	***Raw Material Transfer***
3	Pipe Specification	***A: 150 lb Carbon Steel***
4		
5		
6		
7		

Pipe Size	2 **inch**		3 **inch**		4 **inch**	
Fittings	Qty	Equiv. Ft.	Qty	Equiv. Ft.	Qty	Equiv. Ft.
90 deg Ell	0	0.0	0	0.0	0	0.0
Long Rad. Ell	0	0.0	0	0.0	0	0.0
45 deg Ell	0	0.0	0	0.0	0	0.0
TEE-Line Flow	0	0.0	0	0.0	0	0.0
TEE-Branch Flow	0	0.0	0	0.0	0	0.0
180 deg Bend	0	0.0	0	0.0	0	0.0
Globe Valve	0	0.0	0	0.0	0	0.0
Gate Valve	0	0.0	0	0.0	0	0.0
Ball Valve (red. port)	0	0.0	0	0.0	0	0.0
Butterfly Valve	0	0.0	0	0.0	0	0.0
Plug Valve	0	0.0	0	0.0	0	0.0
Angle Valve	0	0.0	0	0.0	0	0.0
Swing Check Valve	0	0.0	0	0.0	0	0.0
Bell Mouth Inlet	0	0.0	0	0.0	0	0.0
Square Mouth Inlet	0	0.0	0	0.0	0	0.0
Re-Entrant Pipe	0	0.0	0	0.0	0	0.0
Straight Pipe		1,000		1,000		1,000
Total Equiv Feet		1000		1000		1000

Equivalent lengths are calculated using a table of values.
If the fitting/size combination does not appear in the table, the "K Value" method is used.
"K Value" data are from the Hydraulic Institute, Pipe Friction Manual, regressed.

SELECTED PIPE DIAMETER

REV	PREPARED BY	DATE	APPROVAL	CLIENT	LINE NO.	
				Sample	**Liquid Example**	
0	S. Hall	15-Mar-2003		W.O. 10314	REQUISITION NO.	SPECIFICATION NO. 18103
1				UNIT Process	AREA Tank Farm	PROCURED BY / INSTALLED BY
2						

	General		
Fluid Service		***Raw Material Transfer***	
Pipe Specification		***A: 150 lb Carbon Steel***	
Surface Roughness	(feet)	***0.00015***	
Insulation		***None***	
Ambient Temperature	(deg F)	***80***	
	Process Data		
Fluid Pumped		***Toluene (liquid)***	
Design Flow Rate	(gallons/minute)	***100***	
Maximum Flow Rate	(gallons/minute)	***100***	
Flowing Temperature	(deg F)	***70***	
Nominal Pressure	(psia)	***14.7***	
Specific Gravity		***0.867***	*(= 54.10 lb/cu.ft.)*
Viscosity	(centipoise)	***0.58359***	
	Economic Data		
Purchase cost of new pipe, 1 inch diameter, $/ft			$1.75
Ratio of costs for fittings & installation to purch. cost of pipe			5
Factor relating pipe cost to diameter (exponential)			1.30
Frictional loss due to fittings and bends, % of straight pipe			35%
Operation, hours/yr			8,000
Cost of electricity, $/kwhr			$0.15
Efficiency of motor and pump, %			60%
Annual fixed charges for maintenance, % of pipe cost			20%
	Basis for Sizing: Optimum Economic Diameter		
Optimum diameter calculated using Peters & Timmerhaus formula			2.59
Closest pipe size from specified material class			3

	Smaller Size	Selected Size	Next Larger Size
Actual Size (inch nominal size)	2	3	4
(inch actual inside diame)	1.939	3.068	4.026
Velocity (feet/second)	10.87	4.34	2.52
Reynolds No.	241,919	152,895	116,513
Friction Factor	0.0207	0.0199	0.0198
Pressure Drop (psi/100 equiv ft	8.813	0.854	0.219

Calculated Costs, $ per year per foot of installed piping:

	2	3	4
Pumping Cost (power)	$11.02	$1.20	$0.32
Initial Piping (capital expenditure)	$25.85	$43.80	$63.66
Annual Piping (maintenance)	$5.17	$8.76	$12.73
Total	$16.19	$9.96	$13.05

Reference: Peters & Timmerhaus
Plant Design and Economics for Chemical Engineers

Insulation Material Data

Table may be modified or supplemented. If adding new insulation material, insert new row prior to end of table (at row 15 for instance), add new materia

Insulation Material	Min. Thickness (in)	Thermal Conductivity Coefficients					Maximum Temperature (ºF)	Minimum Temperature (ºF)	Thermal Conductivity, K [Btu*in/ (h*ft²*ºF)]
		m	*p*	*s*	*t*	*u*			
Calcium Silicate	1	0.369	1.58E-04	3.92E-07	9.40E-11	0.00E+00	1000	250	0.383
Cellular glass	1	0.289	5.14E-04	4.36E-07	2.27E-10	2.76E-13	900	-450	0.330
Elastometric foam	0.5						200	-40	0.290
Fiberglass	1	0.195	4.25E-04	0.00E+00	0.00E+00	0.00E+00	850	42	0.227
Mineral Wool	1	0.228	3.72E-04	6.00E-07	0.00E+00	0.00E+00	1200	42	0.259
Perlite, expanded	1	0.388	4.73E-04	3.06E-07	-8.00E-11	0.00E+00	1000	250	0.425
Phenolic foam	1	0.116667	6.67E-04				300	75	0.167
Polystyrene foam	1						165	-65	0.230
Polyurethane/ Polyisocyanurate foams	1	0.174	-1.55E-04	-3.39E-07	8.38E-09	1.82E-11	250	-200	0.165

Intermediate Calculations		
Wind Factor	0	
2*pi*(Ti-Ts)	-62.83185307	
K factor, per inch	0.02160625	
Average temperature (fluid to ambient	75	deg F

Insulation Material Data

Table may be modified or supplemented. If adding new insulation material, insert new row prior to end of table (at row 15 for instance), add new materia

Insulation Material	Min. Thickness (in)	Thermal Conductivity Coefficients					Maximum Temperature (ºF)	Minimum Temperature (ºF)	Thermal Conductivity, K [Btu*in/ (h*ft²*ºF)]
		m	*p*	*s*	*t*	*u*			
Calcium Silicate	1	0.369	1.58E-04	3.92E-07	9.40E-11	0.00E+00	1000	250	0.383
Cellular glass	1	0.289	5.14E-04	4.36E-07	2.27E-10	2.76E-13	900	-450	0.330
Elastometric foam	0.5						200	-40	0.290
Fiberglass	1	0.195	4.25E-04	0.00E+00	0.00E+00	0.00E+00	850	42	0.227
Mineral Wool	1	0.228	3.72E-04	6.00E-07	0.00E+00	0.00E+00	1200	42	0.259
Perlite, expanded	1	0.388	4.73E-04	3.06E-07	-8.00E-11	0.00E+00	1000	250	0.425
Phenolic foam	1	0.116667	6.67E-04				300	75	0.167
Polystyrene foam	1						165	-65	0.230
Polyurethane/ Polyisocyanurate foams	1	0.174	-1.55E-04	-3.39E-07	8.38E-09	1.82E-11	250	-200	0.165

Intermediate Calculations		
Wind Factor	0	
2*pi*(Ti-Ts)	-62.83185307	
K factor, per inch	0.02160625	
Average temperature (fluid to ambient	75	deg F

Standard Specifications

Modify this table to incorporate project- or company-specific pipe specification designations. Keep it in alphabetical order by Spec.
The column "Size Table" refers to the Pipe Specification Lookup Table section located below. Add additional columns if necessary, or edit the existing on

							Cost Factors			
Spec Code	Description	Min Temp deg F	Max Temp deg F	Max Press psig	Roughness ft	Purchase $/ft (1 inch)	Ratio Fittings	Exponent	Size Table
A	150 lb Carbon Steel	-10	450	150	0.00015	$1.75	5	1.3	2
A3	125 lb Carbon Steel	-10	450	125	0.00015	$1.75	5	1.3	2
B	300 lb Carbon Steel	-20	750	300	0.00015	$1.75	5	1.3	2
C	316L SS Pipe	-100	500	145	0.0001	$4.50	8	0.89	8
CU	Copper Pipe	-100	250	110	0.000005	$4.50	8	0.89	6
D1	316L SS Sanitary Tubin	-100	450	150	0.000001	$4.50	8	0.89	15
D2	316L SS Zephyrweld Tu	-100	450	150	0.000005	$4.50	8	0.89	14
F1	Teflon-Lined Pipe	-20	500	170	0.000005	$4.50	8	0.89	9
F2	PVDF-Lined Pipe, Heav	-20	275	150	0.000005	$4.50	8	0.89	10
F3	PVDF-Lined Pipe, Thick	-20	275	150	0.000005	$4.50	8	0.89	11
F4	Polypropylene-Line Pipe	0	225	150	0.000005	$4.50	8	0.89	12
G	FRP Pipe, Epoxy Lining	0	225	150	0.000005	$4.50	8	0.89	13
GL	Glass-lined Steel	-20	450	150	0.000005	$4.50	8	0.89	7
H1	CPVC Pipe	0	180	100	0.000005	$0.75	18	0.91	16
H2	Polypropylene Pipe, SDI	0	200	150	0.000005	$4.50	8	0.89	17
K	Type K Copper Water T	-100	250	110	0.000015	$4.50	8	0.89	3
L	Type L Copper Water Tu	-100	250	110	0.000015	$4.50	8	0.89	4
M	Type M Copper Water T	-100	250	110	0.000015	$4.50	8	0.89	5