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Online Chemical Engineering Information

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Content Based Chemical Engineering

FANNING - LIQUID FLOW / FIND FLOW - PSI KNOWN

BASIS: CRANE TECHNICAL PAPER 410 and MARKS' MECHANICAL ENGINEERS HANDBOOK. Friction factors for smooth (PVC, etc) and rough (Cast) pipe are included. PERRY'S CHEMICAL ENGINEERS HANDBOOK used for viscosities.

NOTE: Always begin a new case by retrieving the original file. Direct entry of data in cells that originally contain table lookups could cause functions to be lost, or incorrect calculations. I format cells requiring entry colored **RED**; calculated values are black.

1.) Enter identification at [B4]
2.) Enter the pipe ID at [C7], use [=], then go to pipe table, eg; [=F61] is the ID for 1 1/2" schd 40, or [=G61] metric (40 mm) or directly enter the size if it is not in table.
3.) Enter straight length at [C8]
4.) Enter pipe material at [C9], use [=], then go to material name in table (A56...A63) eg. [=A56] is Carbon Steel. **NOTE: Typing in a material type can LOCK the program up!**
5.) Enter inlet pressure at [B13]
6.) Enter outlet pressure at [B14]
7.) Enter elevation difference at [B15] (NOTE: Outlet - Inlet)
8.) Enter fluid name at [F7], use [=], then go to liquid table. eg. [=D125] is "WATER", or directly enter if not in table.
9.) Enter fluid temperature at [F8]
10.) If the liquid [F7], is in the liquid table, a representative specific gravity will show at [F9], otherwise directly enter it at [F9]. Check that the sp. gr. value is appropriate for the particular application.
11.) If the liquid [F7], is in the liquid table, the viscosity is automatically calculated at its temperature [F8], otherwise directly enter fluid viscosity at [F11]. **Note: no limits are built into viscosity calcs, eg. they will calculate a value for water at 12 deg F. and 450 deg F. If using the calculated viscosity, always check for reasonability, and change of state.**
12.) Enter the number of each type of valve & fitting just to their left. [A20]...[A27] & [D20]...[D27]
13.) Enter the reducer nomimal size,eg; "4/6" or "6/4" (dia1/dia2) at [F29] and [F30] to determine the beta coefficient. The size change 'k' will be calculated and included via [C33] and [C34]. For cases of NO increasers or reducers F29 & F30 should have a ' 0' to zero out C33 & C34.
14.) Enter the manufacturer's certified test value of K_R for the rupture disk in cell [F32], when available. When a disk is included, the calculated flow capacity in cell [E47] is decreased to compensate for the 10% capacity reduction required by the (ASME) Code. The new calculated flow capacity is shown in cell [E51].
15.) If a manufacturer's certified test value is not available use the (ASME Code) default value of 2.4.
16.) Misc items: for any item where `K' is not known but an equivalent length is, enter the value at [F33].
17.) Entrance and exit losses: normally 0.5 and 1.0, are entered at [C31] and [C32] as desired.
18.) Misc K: for any item where `K' is known, but not listed above. Enter value at [C35]. Note: to calculate `K' for control valve, or equivalent `K' for line size change, see [A66] thru [B90].
19.) Additional delta P if pressure drop is known can be added at [F35].
20.) Push the CALCULATE button at [H41] for the iterative calculation to take place and zeroing of the % error.
Flow `W' is calculated and shown at [E47]. Error flags will show at [C52] & [C53], check for conformance before printing out.

Print out using direct Excel commands. This application is provided by Chemical Engineers Resource Website, visit cheresources.com for additional selections.

Print out using direct EXCEL commands.

<<<<<<<< Psafety © January 2001, by Don Coffman >>>>>>>>

This Spreadsheet Requires MACROS to be ENABLED to ASSURE proper operation. See the Workbook Help Sheet for Additional Instructions on Use.

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Fanning - Liquid Flow / Find Flow - psi known

PIPE: Hazard #8; Seal Water Pump; C-975472

System			Fluid		
pipe ID :	1.61	in	fluid :	WATER	
length :	20	ft	temp :	100	°F
material :	Stainless Steel		sp. gr.:	0.992	
			density:	61.918	lb/ft³
			visc. :	0.679	µ, cps

Pressures

P1 - in :	25	psig	P1 - P2 :	25	psi, gauge pressure delta
P2 - out :	0	psig	P elev :	-7.74	psi, loss due to elevation
h2 - h1 :	-18	ft	ΔP :	32.74	psi, or 76.1 feet of head

Fitting Losses ··· **fitting friction factor, *f*t** : 0.021

	valves	K		fittings	K
0	gate valve	0.000	1	thru `T'	0.410
0	globe valve	0.000	1	branch`T'	1.231
0	angle valve	0.000	0	scrwd 90°	0.000
1	ball valve	0.062	0	scrwd 45°	0.000
0	plug valve	0.000	0	short 90°	0.000
0	diaph valve	0.000	0	short 45°	0.000
0	b'fly valve	0.000	5	long 90°	1.436
1	swing check	1.026	0	long 45°	0.000

valves total :	1.088	**size change**		
fittings total :	3.078	reducer	0.000	dia.$_1$ / dia.$_2$
entrance :	0.500	increaser	0.000	dia.$_1$ / dia.$_2$
exit :	1.000			
reducer, K :	0.000	rupture disk :	0.0	K_R
increaser, K :	0.000	misc items equiv len :	0.0	feet
misc. K :	0.000	final length, l' :	20.0	feet
ΣK:	5.665	add'l equip. ΔP :	0	psig

assum *f* = 0.02082 calculated *f* = 0.02082 error *f* = 0.00%

12 ·f ·l'/d :	3.104	6.3 ·(W/dz) :	429797	Re
N :	8.769	velocity :	23.7	fps

Flow

$$W := \sqrt{\left[\frac{(\Delta P - elev_{loss})\cdot D\cdot d^4}{(2.79 + 10^{-7})\cdot\frac{12\cdot f\cdot l}{d} + \Sigma K}\right]} = 74{,}618 \text{ lb/hr, or } 150 \text{ gpm}$$

Fanning - Liquid Flow / Find Flow - psi known

PIPE: WATER SUPPLY PUMP TO STORAGE

System			Fluid		
pipe ID :	108.2	millimeter	fluid :	WATER	
length :	6.096	meter	temp :	37.7778	°C
material :	Stainless Steel		sp. gr.:	1.000	
			density:	1000	kg/m^3
			visc. :	0.0006794	z, Pa sec

Pressures

P1 - in :	1450	Pa	P1 - P2 :	1450	Pa, gauge pressure delta
P2 - out :	0	Pa	P elev :	0.00	Pa, loss due to elevation
h2 - h1 :	0	meter	ΔP :	1450.00	Pa, or 0.1 meter of head

Fitting Losses ··· **fitting friction factor, *f* t** : 0.017

	valves	K		fittings	K
0	gate valve	0.000	1	thru \`T'	0.333
0	globe valve	0.000	1	branch\`T'	1.000
0	angle valve	0.000	0	scrwd 90°	0.000
1	ball valve	0.050	0	scrwd 45°	0.000
0	plug valve	0.000	0	short 90°	0.000
0	diaph valve	0.000	0	short 45°	0.000
0	b'fly valve	0.000	5	long 90°	1.167
1	swing check	0.834	0	long 45°	0.000

valves total :	0.884	**size change**		
fittings total :	2.501	reducer	0.000	$dia._1 / dia._2$
entrance :	0.500	increaser	0.000	$dia._1 / dia._2$
exit :	1.000			
reducer, K :	0.000	rupture disk :	0.0	K_R
increaser, K :	0.000	misc items equiv len :	0.0	meter
misc. K :	0.000	final length, l' :	6.1	meter
ΣK:	4.884	add'l equip. ΔP :	0	Pa

assum *f* = 0.022388 calculated *f* = 0.022387 error *f* = 0.00%

f ·l/d :	1.261	1.27·(W/dz) :	109,302	Re
N :	6.146	velocity :	0.69	mps

Flow

$$W := \sqrt{\left[\frac{\left(\Delta P - elev_{loss}\right)\cdot D\cdot d^4}{\left(808\cdot 10^{-3}\right)\cdot\frac{f\cdot l}{d} + \Sigma K}\right]} = 6.32624081 \text{ kg/sec, or } 22.774467 \text{ m}^3\text{/hr}$$

material table	
material	**epsilon**
Carbon Steel	150
Cast Iron	850
CU tubing	5
glass	5
kynar	5
PVC	5
SS tubing	5
Stainless Steel	150

for control valve:

Cv = 25.6

$$K = \frac{891 d^4}{C_v^2}$$

K = 9.135

size change,

equivalent K:

convert diameter

d' = 1.610

with resistance of

K' = 3.80

in terms of

d = 1.610

ß = d'/d

= 1.000

$$K_1 = \frac{K}{\beta^4} = \underline{3.80}$$

orifice equivalent length:

Ko = 0.60

A = 1.00

$$l := \frac{0.05 d^5}{K_o^2 \cdot A^2 \cdot f}$$

l = 73.6 eq. feet

PIPE			
nominal	inside diameter		
diameter	schd 10S	schd 40	schd 80
1/2	0.674	0.622	0.546
3/4	0.884	0.824	0.742
1	1.097	1.049	0.957
1 1/4	1.422	1.380	1.278
1 1/2	1.682	1.610	1.500
2	2.157	2.067	1.939
2 1/2	2.635	2.469	2.323
3	3.260	3.068	2.900
3 1/2	3.760	3.548	3.364
4	4.260	4.026	3.826
6	6.357	6.065	5.761
8	8.329	7.981	7.625
10	10.420	10.020	9.562
12	12.390	11.938	11.374
14	13.624	13.124	12.500
16	15.624	15.000	14.312
18	17.624	16.867	16.124
20	19.564	18.812	17.938
24	23.500	22.624	21.562

COPPER TUBING			
nominal	inside diameter		
diameter	Type K	Type L	Type M
1/8	0.186	0.200	0.200
1/4	0.311	0.315	0.325
3/8	0.402	0.430	0.450
1/2	0.527	0.545	0.569
5/8	0.652	0.666	0.690
3/4	0.745	0.785	0.811
1	0.995	1.025	1.055
1 1/4	1.245	1.265	1.291
1 1/2	1.481	1.505	1.571
2	1.959	1.985	2.009
2 1/2	2.435	2.465	2.495
3	2.907	2.945	2.981
3 1/2	3.385	3.425	3.459
4	3.857	3.905	3.935
5	4.805	4.875	4.907
6	5.741	5.845	5.881
8	7.583	7.725	7.785

Sanitary Tubing			
Nominal Size	Inside Diameter	Wall Thickness	Outside Diameter
1/4	0.180	0.035	0.25
3/8	0.305	0.035	0.38
1/2	0.370	0.065	0.50
3/4	0.620	0.065	0.75
1	0.870	0.065	1.00
1 1/2	1.370	0.065	1.50
2	1.870	0.065	2.00
2 1/2	2.370	0.065	2.50
3	2.834	0.083	3.00
4	3.834	0.083	4.00
6	5.782	0.109	6.00
8	7.782	0.109	8.00

liquid	visc (cp)	spec. grav.
ACETIC ACID 100%	0.986	1.050
ACETIC ACID 70%	1.820	1.010
ACETONE	0.267	0.789
AMMONIA 26%	0.814	0.905
AMMONIA 100%	0.082	0.682
BENZENE	0.514	0.844
BLACK LIQUOR 50%	67.828	1.250
BLACK LIQUOR 63%	1186.796	1.330
BLACK LIQUOR 68%	6319.631	1.360
BRINE, CALCIUM CHLORIDE 25%	1.328	1.230
BRINE, SODIUM CHLORIDE 25%	1.301	1.190
CARBON DIOXIDE	0.063	1.102
CAUSTIC 20%	2.679	1.223
CAUSTIC 50%	39.945	1.530
CHLORINE LIQUID	0.317	1.467
CONDENSATE	0.680	0.996
DOWTHERM A	2.930	0.995
ETHANOL 100%	0.762	0.789
ETHANOL 40%	1.418	0.935
ETHANOL 95%	0.905	0.804
ETHYL CHLORIDE	0.234	0.923
ETHYLENE GLYCOL	11.374	1.110
FREON, R11	0.389	1.410
FREON, R12	0.245	1.170
FREON, R22	0.208	1.440
FUEL OIL #2	2.799	0.876
FUEL OIL #6	185.462	0.993
GASOLINE	0.511	0.751
GLYCEROL, 100%	376.300	1.260
HYDROCHLORIC 31.5%	1.556	1.159
ISOPROPYL ALCOHOL	1.257	0.785
KEROSENE	1.491	0.811
LUBE OIL MOBIL 634	420.342	0.884
METHANOL 100%	0.453	0.796
METHANOL 40%	1.556	0.937
METHANOL 90%	0.586	0.824
METHYL CHLORIDE	0.229	0.998
MULTITHERM PG-1	23.148	0.875
NITRIC ACID 60%	1.729	1.370
NITRIC ACID 95%	0.872	1.500
OIL, VEGETABLE HARDENED	45.541	0.920
OIL, VEGETABLE UNHARDENED	34.966	0.880
SULPHUR DIOXIDE	0.294	1.434
SULPHURIC 110%, FUMING	27.430	1.840
SULPHURIC ACID 60%	4.419	1.500
SULPHURIC ACID 98%	13.918	1.830
TOLUENE	0.493	0.862
TURPENTINE	1.041	0.864
WATER	0.679	0.992

Pipe Friction Data - Crane TP-410		
Nominal Size	Friction Factor, ƒt	Next Pipe Size
0.200	0.0373	0.300
0.300	0.0327	0.400
0.400	0.0300	0.500
0.500	0.0281	0.750
0.750	0.0250	1.000
1.000	0.0231	1.500
1.500	0.0208	2.000
2.000	0.0194	2.500
2.500	0.0184	3.000
3.000	0.0177	3.500
3.500	0.0170	4.000
4.000	0.0165	5.000
5.000	0.0157	6.000
6.000	0.0151	8.000
8.000	0.0142	10.000
10.000	0.0136	12.000
12.000	0.0131	14.000
14.000	0.0127	16.000
16.000	0.0124	20.000
20.000	0.0119	24.000
24.000	0.0115	36.000
36.000	0.0107	48.000
48.000	0.0101	60.000

Factor, ƒt Interpolation

1.50	0.0208
1.610	0.0205
2.00	0.0194