



About this document

This document contains screenshots of software available from Cheresources.com. You can find this title in our online store at:

<http://www.cheresources.com/cheplusstore/catalogue.php>

Clicking the above link should activate your default browser and launch the site.

We recommend using our search feature to find the title.

If you haven't visited our site before, you can find the main page at:

<http://www.cheresources.com>

Thanks for visiting our site,

Chris Haslego
President
Cheresources, Inc.

© COPYRIGHT, 2005. CHERESOURCES, INC.

1422 Goswick Ridge Road
Midlothian VA 23114

Fax: 561-658-6489
Email: support@cheresources.com

***Content Based
Chemical Engineering***

FANNING - LIQUID FLOW / FIND PRESSURE - FLOW 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: [=F62] is the ID for 1 1/2" schd 40, or [=G62] metric (40 mm) or directly enter the size if it is not in table.
- 3.) Enter straight pipe length at [C8].
- 4.) Enter the pipe material at [C9], use [=], then go to material name in the table (A57..A64) eg. [=A57] is Carbon Steel. **NOTE: Typing in a material type LOCKS the program up!**
- 5.) Enter the inlet elevation at [C10].
- 6.) Enter the outlet elevation at [C11].
- 7.) Enter fluid name at [F7], use [=], then go to liquid table.eg. [=D126] is "WATER", or enter the liquid name directly if not included in the LOOKUP table.
- 8.) Enter the fluid temperature at [F8].
- 9.) If the liquid [F7], is in the liquid table, a representative specific gravity will show at [F9], otherwise directly enter the value at [F9]. Check that the specific gravity value is appropriate for the particular application.
- 10.) If the liquid [F7], is in the liquid table, the viscosity will be automatically calculated at its temperature [F8], otherwise directly enter the fluid viscosity at [F11]. **Note: no limits are built into the viscosity calculations, eg. they will calculate a value for water at 12 deg F. and at 450 deg F. If using the calculated viscosity, always check for reasonability, and the change of state.**
- 11.) Enter the target mass flowrate at [C13]. The flow will show in volumetric rate at [E13].
- 12.) Enter the number of each type of valve & fitting just to their left @ [A20]...[A27] and @ [D20]...[D27].
- 13.) Enter the reducer nominal 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 & F20 should have a ' 0' to zero out C33 & C34.
- 14.) In the case of a Rupture Disk enter the manufacturer's certified test value of K_R value in cell [F32]. When the manufacturer's certified test value is not available use the (ASME Code) default value of 2.4. If a disk is included, the flow rate input in cell [C13] is increased to compensate for the 10% capacity reduction required by the (ASME) Code. The new target flow rate is shown in cell [C15].
- 15.) Entrance and exit losses: normally 0.5 and 1.0, enter at [C31] and [C32] as desired.
- 16.) 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 [B74].
- 17.) Additional delta P if pressure drop is known can be added at [F35].
- 18.) The program is automated via embedded macros. With the mouse click on the (CALCULATE) button to iterate thru the answer. **NOTE: In Excel 2000 set the program up as follows: under TOOLS|OPTIONS|CALCULATION set the iteration "MAXIMUM CHANGE" to 0.0001! This assures a iteration to < 1% error within the macro.**
- 20.) Total 'delta P' is calculated and shown at [C53].

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

Print out using direct EXCEL commands.

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

The originator of these spreadsheet(s) specifically excludes all warranties, expressed or implied, as to the accuracy of the data and other information set forth and assumes NO liability for any losses or damage resulting from the use of the materials or application of the data.

Consistent with GOOD ENGINEERING PRACTICE, the burden rests with the USER of these spreadsheets to review ALL calculations, and assumptions. The USER IS FULLY RESPONSIBLE for the results or decisions based on calculations.

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

dmcoffman@aol.com

Fanning - Liquid Flow / Find Pressure - Flow Known

PIPE: OIL SUPPLY PUMP TO STORAGE

System			Fluid		
pipe ID :	1.610	in	fluid :	OIL, VEGETABLE HARDENED	
length :	20	ft	temp. :	90.0	°F
material :	Carbon Steel		sp. gr. :	0.920	
elev in :	15	ft	density :	57.41	lb/ft ³
elev out :	3	ft	visc. :	53.820	μ ,cps
W : 50000 lb/hr =			109 gpm		

..... Fitting Losses ... fitting friction factor, *f* : 0.021

valves			K			fittings			K		
1	gate valve	0.164	0	thru `T'	0.000	0	branch `T'	0.000	0	scrwd 90°	0.000
0	globe valve	0.000	0	scrwd 45°	0.000	0	short 90°	0.000	0	short 45°	0.000
0	angle valve	0.000	0	long 90°	0.000	0	long 45°	0.000	0		
0	ball valve	0.000	0	long 45°	0.000						
0	plug valve	0.000									
0	diaph valve	0.000									
0	b'fly valve	0.000									
0	swing check	0.000									
valves total :			0.164		 size change					
fittings total :			0.000			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 :	345.0	feet			
misc. K :			0.000			final length, l' :	365.0	feet			
<hr style="width: 100%;"/>			<hr style="width: 100%;"/>			add'l equip. ΔP :	0	psig			
ΣK :			1.664								

6.3 · (W/dz) : 3635 Re velocity: 17.1 fps

assumf = 0.042135 calculatedf = 0.042135 errorf = 0.00%

N: 116.293 12 · f · l/d : 114.629

..... friction

$$\Delta P := \left[\left(\frac{12 \cdot f \cdot l}{d} + \Sigma K \right) \cdot \left(\frac{2.79 \cdot 10^{-7} \cdot W^2}{D \cdot d^4} \right) + \text{Elev}_{\text{loss}} \right]$$

ΔP : 210.3 psi, or 528.02 feet of OIL, VEGETABLE HARDENED
 P elev : -4.8 psi, loss due to elevation
 ΔP : 205.51 psi, loss including elevation

Fanning - Liquid Flow / Find Pressure - Flow Known

PIPE: WATER SUPPLY PUMP TO STORAGE

..... System Fluid
pipe ID : 40.940 millimeter	fluid : WATER
length : 6.096 meter	temp. : 37.7778 °C
material : Stainless	sp. gr. : 1.000
elev in : 5.4864 meter	density : 1000 kg/m ³
elev out : 0 meter	visc. : 0.0006794 z, Pa sec

W : 9.4379817 kg/sec, or 33.97673414 m³/hr

..... Fitting Losses ... fitting friction factor, *f* : 0.021

..... valves K fittings K
0 gate valve 0.000	1 thru `T' 0.416
0 globe valve 0.000	1 branch `T' 1.249
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° 1.457
1 swing check 1.041	0 long 45° 0.000
..... size change	
valves total : 1.103	reducer 0.000 dia. ₁ / dia. ₂
fittings total : 3.122	increaser 0.000 dia. ₁ / dia. ₂
entrance : 0.500	
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 : 5.725	add'l equip. ΔP : 0 Pa

1.27·(W/dz) : 430,964 Re velocity: 7.2 fps

assumf = 0.020814 calculatedf = 0.020814 errorf = 0.00%

N : 8.824 f·l/d : 3.099

..... friction

$$\Delta P = \left(\frac{f \cdot l}{d} + \Sigma K \right) \cdot \left(\frac{808 \cdot 10^{-3} \cdot W^2}{D \cdot d^4} \right) + \text{elev loss}$$

ΔP : 226071.2 Pa, or 23.1 meter of WATER

P elev : -53803.0 Pa, loss due to elevation

ΔP : 172268.22 psi, loss including elevation

material table		PIPE				COPPER TUBING			Sanitary Tubing				
matl	epsilon	inside diameter			inside diameter			Nominal	Inside	Wall	Outside		
Carbon Steel	150	diameter	schd 10S	schd 40	schd 80	diameter	Type K	Type L	Type M	Size	Diameter	Thickness	Diameter
Cast Iron	850	1/2	0.674	0.622	0.546	1/8	0.186	0.200	0.200	1/4	0.180	0.035	0.25
CU tubing	5	3/4	0.884	0.824	0.742	1/4	0.311	0.315	0.325	3/8	0.305	0.035	0.38
glass	5	1	1.097	1.049	0.957	3/8	0.402	0.430	0.450	1/2	0.370	0.065	0.50
kynar	5	1 1/4	1.422	1.380	1.278	1/2	0.527	0.545	0.569	3/4	0.620	0.065	0.75
PVC	5	1 1/2	1.682	1.610	1.500	5/8	0.652	0.666	0.690	1	0.870	0.065	1.00
SS tubing	5	2	2.157	2.067	1.939	3/4	0.745	0.785	0.811	1 1/2	1.370	0.065	1.50
Stainless	150	2 1/2	2.635	2.469	2.323	1	0.995	1.025	1.055	2	1.870	0.065	2.00
		3	3.260	3.068	2.900	1 1/4	1.245	1.265	1.291	2 1/2	2.370	0.065	2.50
		3 1/2	3.760	3.548	3.364	1 1/2	1.481	1.505	1.571	3	2.834	0.083	3.00
		4	4.260	4.026	3.826	2	1.959	1.985	2.009	4	3.834	0.083	4.00
		6	6.357	6.065	5.761	2 1/2	2.435	2.465	2.495	6	5.782	0.109	6.00
		8	8.329	7.981	7.625	3	2.907	2.945	2.981	8	7.782	0.109	8.00
		10	10.420	10.020	9.562	3 1/2	3.385	3.425	3.459				
		12	12.390	11.938	11.374	4	3.857	3.905	3.935				
		14	13.624	13.124	12.500	5	4.805	4.875	4.907				
		16	15.624	15.000	14.312	6	5.741	5.845	5.881				
		18	17.624	16.867	16.124	8	7.583	7.725	7.785				
		20	19.564	18.812	17.938								
		24	23.500	22.624	21.562								

for control valve:

$$C_v = 25.6$$

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

$$K = 9.135$$

size change, equiv. K

convert diameter

$$d = 2.067$$

with resistance of

$$K' = 3.800$$

in terms of

$$d = 1.610$$

$$\beta = d/d'$$

$$= 0.779$$

$$K_1 = \frac{K}{\beta^4} = 1.40$$

orifice equivalent length

$$K_o = 0.600$$

$$A = 1.000$$

$$l = \frac{0.051 \cdot d^5}{K_o^2 \cdot A^2 \cdot f}$$

$$l = 36.4 \text{ ft}$$

liquid	visc (cp)	spec. grav	Pipe Friction Data - Crane TP-410		
			Nominal Size	Friction Factor, ft	Next Pipe Size
ACETIC ACID 100%	1.069	1.050			
ACETIC ACID 70%	2.041	1.010			
ACETONE	0.282	0.789	0.200	0.0373	0.300
AMMONIA 26%	0.897	0.905	0.300	0.0327	0.400
AMMONIA 100%	0.088	0.682	0.400	0.0300	0.500
BENZENE	0.555	0.844	0.500	0.0281	0.750
BLACK LIQUOR 50%	83.000	1.250	0.750	0.0250	1.000
BLACK LIQUOR 63%	1690.265	1.330	1.000	0.0231	1.500
BLACK LIQUOR 68%	9365.820	1.360	1.500	0.0208	2.000
BRINE, CALCIUM CHLORIDE 25%	1.584	1.230	2.000	0.0194	2.500
BRINE, SODIUM CHLORIDE 25%	1.551	1.190	2.500	0.0184	3.000
CARBON DIOXIDE	0.067	1.102	3.000	0.0177	3.500
CAUSTIC 20%	3.097	1.223	3.500	0.0170	4.000
CAUSTIC 50%	53.638	1.530	4.000	0.0165	5.000
CHLORINE LIQUID	0.325	1.467	5.000	0.0157	6.000
CONDENSATE	0.766	0.996	6.000	0.0151	8.000
DOWTHERM A	3.236	0.995	8.000	0.0142	10.000
ETHANOL 100%	0.852	0.789	10.000	0.0136	12.000
ETHANOL 40%	1.683	0.935	12.000	0.0131	14.000
ETHANOL 95%	1.011	0.804	14.000	0.0127	16.000
ETHYL CHLORIDE	0.246	0.923	16.000	0.0124	20.000
ETHYLENE GLYCOL	13.709	1.110	20.000	0.0119	24.000
FREON, R11	0.409	1.410	24.000	0.0115	36.000
FREON, R12	0.252	1.170	36.000	0.0107	48.000
FREON, R22	0.213	1.440	48.000	0.0101	60.000
FUEL OIL #2	3.273	0.876			
FUEL OIL #6	234.849	0.993			
GASOLINE	0.543	0.751			
GLYCEROL, 100%	546.460	1.260			
HYDROCHLORIC 31.5%	1.661	1.159			
ISOPROPYL ALCOHOL	1.442	0.785			
KEROSENE	1.645	0.811			
LUBE OIL MOBIL 634	544.429	0.884			
METHANOL 100%	0.489	0.796			
METHANOL 40%	1.661	0.937			
METHANOL 90%	0.632	0.824			
METHYL CHLORIDE	0.235	0.998			
MULTITHERM PG-1	27.188	0.875			
NITRIC ACID 60%	1.911	1.370			
NITRIC ACID 95%	0.937	1.500			
OIL, VEGETABLE HARDENED	53.820	0.920			
OIL, VEGETABLE UNHARDENED	40.850	0.880			
SULPHUR DIOXIDE	0.308	1.434			
SULPHURIC 110%, FUMING	32.259	1.840			
SULPHURIC ACID 60%	4.922	1.500			
SULPHURIC ACID 98%	16.425	1.830			
TOLUENE	0.523	0.862			
TURPENTINE	1.134	0.864			
WATER	0.760	0.994			

Factor, ft Interpolation

$$1.50 \quad 0.0208$$

$$1.610 \quad 0.02052$$

$$2.00 \quad 0.0194$$