

Appendix C – Helpful Pump Data

PRESSURE

Feet of Water x 0.433	= PSI
(PSI x 2.31) / Sp. Gr.	= Feet of Water
(Fl. Head x Sp. Gr.) / 2.31	= PSI
PSI x 6.9	= kPa
ATM x 14.7	= PSI
ATM x 33.9	= Feet of Water
ATM x 760	= mm Hg
kg / cm ² x 14.22	= PSI
Meters of Water x 1.42	= PSI
Bar x 14.5	= PSI
Inches of Hg x 0.491	= PSI

CENTRIFUGAL PUMPS

Liquid HP =	$\frac{\text{GPM} \times \text{Fl. of Head} \times \text{Sp. Gr.}}{3960}$
Brake HP =	$\frac{\text{GPM} \times \text{TDH} \times \text{Sp. Gr.}}{3960 \times \text{Pump Efficiency}}$
Efficiency Overall HP =	$\frac{\text{BPH}}{\text{Motor Efficiency}}$
Estimated effects of viscosity on Centrifugal Pumps	
SSU FLOW	HEAD EFFICIENCY
35 100%	100%
500 95%	98%
1000 92%	97%
3000 80%	94%
	60%

PARTICLE SIZE COMPARISON

Mesh	Inch	Micron
3250	0.0002	6
1600	0.0005	14
750	0.0010	25
325	0.0016	40
250	0.0024	62
200	0.0029	74
180	0.0033	85
150	0.0041	100
120	0.0046	118
100	0.0055	149
80	0.0070	179
50	0.0117	300
40	0.0150	385
30	0.0200	513
24	0.0280	718
20	0.0340	872
18	0.0390	1000
16	0.0450	1154
14	0.0510	1308
12	0.0600	1538
10	0.0750	1923
8	0.0970	2488
6	0.1320	3385
4	0.1590	4077
2	0.2030	5205
1 Micron = 10 ⁻⁶ Meters		
1 Micron = 3.9 x 10 ⁻⁵ Inch		

PIPING

Velocity in Feet per Second	=	$\frac{\text{GPM} \times 0.321}{\text{Pipe Area in Square Inches}}$
Rule of Thumb:		Typically it is best to keep pipe velocities around 10 ft/second for good results.
Suction Piping:		Typically it is best to have piping in one plane from source tank and have a straight run at least 10 times the pipe's diameter leading into the pump suction.
Pipe Size:		Doubling the diameter of the pipe increases its capacity four times.

RULES OF THUMB FOR MOTORS

A Motor develops 1.5 ft-lbs per HP @ 3600 RPM	
A Motor develops 3.0 ft-lbs per HP @ 1800 RPM	
A Motor develops 4.5 ft-lbs per HP @ 1200 RPM	
A 3-Phase motor draws 1.00 Amp per HP @ 575 Volts	
A 3-Phase motor draws 1.25 Amp per HP @ 460 Volts	
A 3-Phase motor draws 2.50 Amp per HP @ 230 Volts	
HP = $\frac{\text{Torque (ft-lbs)} \times \text{RPM}}{5252}$	Torque (in-lbs) = $\frac{\text{HP} \times 63,000}{\text{RPM}}$

VISCOSITY

Conversions:	= Centistokes x 4.55
SSU*	= Centistokes x 0.132
Degrees Engler*	= Centistokes x 4.05
Sec. Redwood 1*	= 100 Centistokes
1 Stoke	= 100 Centipoises
1 Poise	= Centipoise / Sp. Gr.
Centistokes	= Centipoise / Sp. Gr.
*Where Centistokes are greater than 50	
Definitions:	
Newtonian fluids are unaffected by shear. (e.g. Water, mineral oil)	
Non-Newtonian fluids are affected by shear. (5 types)	
Bingham-Plastic fluids do not have an exact shear yield point which once exceeded, viscosity decreases. (e.g. Tomato Catsup)	
Pseudo-Plastic fluids do not have an exact yield point, but instead viscosity decreases as the magnitude of shear rate increases. (e.g. Many emulsions)	
Dilutant fluids' viscosity increases as the magnitude of the shear rate increases. (e.g. Printing ink, candy compounds)	
Thixotropic fluids decrease in viscosity both in relation to the shear magnitude and the period of time subjected to shear. Their viscosity might also depend on a previous shear condition. (e.g. Drilling mud, starches, pain)	
Rheoplectic fluids increase in viscosity both in relation to the shear magnitude and the period of time subjected to shear. (e.g. Some greases)	

AFFINITY LAWS FOR CENTRIFUGAL PUMPS

These formulas can be used to estimate capacity, head and BHP for a pump speed or impeller diameter when a curve is not readily available.

- Flow is directly proportional to the ratio of impeller speed:
 $GPM_2 = (GPM_1 \times RPM_2) / RPM_1$
- Head is directly proportional to the square of the ratio of impeller speed:
 $HEAD_2 = HEAD_1 \times (RPM_2 / RPM_1)^2$
- The HP is directly proportional to the cube of the ratio of impeller speed:
 $BHP_2 = BHP_1 \times (RPM_2 / RPM_1)^3$
- Flow is directly proportional to the ratio of impeller diameter:
 $FLOW_2 = FLOW_1 \times (Impeller Diameter_2 / Impeller Diameter_1)$
- Head is directly proportional to the square of the ratio of impeller diameter:
 $HEAD_2 = HEAD_1 \times (Impeller Diameter_2 / Impeller Diameter_1)^2$
- The HP is directly proportional to the cube of the ratio of impeller diameter:
 $BHP_2 = BHP_1 \times (Impeller Diameter_2 / Impeller Diameter_1)^3$

ATMOSPHERIC PRESSURE

Altitude in Feet	Pressure in PSIA
0	14.70
100	14.64
300	14.54
500	14.43
700	14.33
1,000	14.17
1,500	13.92
2,000	13.66
3,000	13.17
4,000	12.69
5,000	12.23
7,000	11.34
10,000	10.11
15,000	8.29
20,000	6.76
25,000	5.45
30,000	4.36
40,000	2.72
50,000	1.68
60,000	1.04