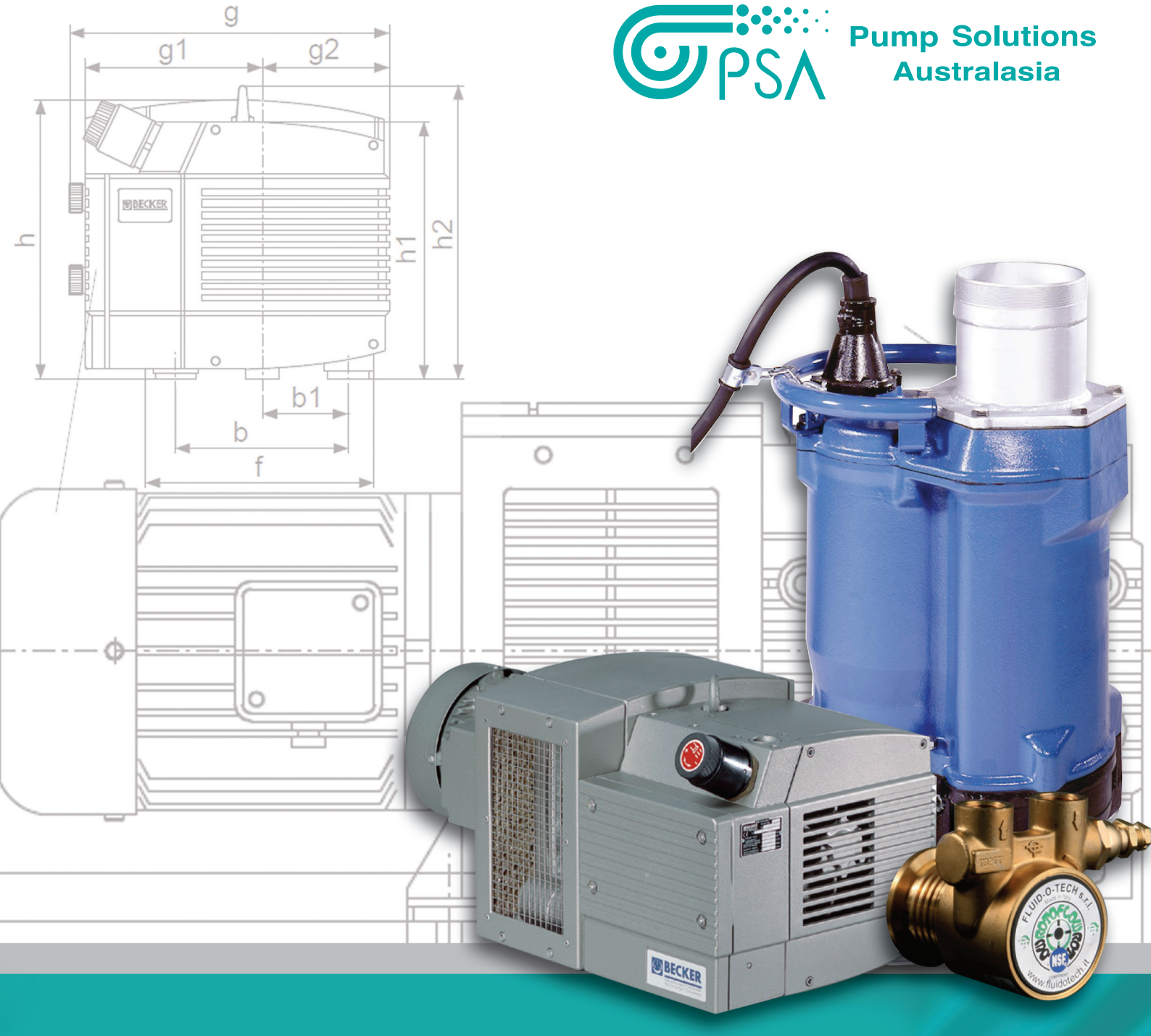
Pump Solutions Australasia




# SPECIFICATIONS & FORMULAE

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## PUMPING FORMULA FOR WATER AT 20°C

| | |
|---|---|
| Volumetric flow from mass flow and density | Vol. Flow (L/s) = 1.002 x Mass Flow (kg/s) |
| Pump input power from pump performance | $\text{Power (kW)} = \frac{\text{Volumetric Flow (l/s) x Head (m)}}{\text{102.2 x efflciency (decimal)}}$ |
| Motor input energy per volume of liquid pumped | $\text{Energy/Volume} = \frac{\text{Head (m)}}{\text{368.0 x motor efflciency (dec) x pump efflciency (dec)}}$ |
| Flow velocity in pipes | $\text{Flow velocity (m/s)} = \frac{\text{1273 x Flow (L/s)}}{\text{(pipe diameter in mm)}^2}$ |
| Through any area normal to the direction of flow: | $\text{Flow velocity (m/s)} = \frac{\text{1000 x Flow (L/s)}}{\text{area (mm}^2\text{)}}$ |

**NOTE:** Coefficients are based on:
1. Density of water at 20°C of 998.2042 kg/m³
2. Gravitational acceleration of 9.8 m/s²

Head of liquid from pressure and density
1. Head (m) = 0.1022 x Pressure (kPa)
2. Head (ft) = 0.3354 x Pressure (kPa)

## FORMULAE AND EQUIVALENTS

### Pumping power formula

*Centrifugal Pumps*

$$\text{Power req.} = \frac{\text{Flow (L/s) x Head (m) x SG}}{\text{102.2 x Efficiency (dec)}}$$

$$\text{Slurry Flow (m}^3\text{/hr)} = \frac{\text{Solids (Tonne/hr)}}{\text{Slurry SG x \% Solids (dec)}}$$

$$\text{Slurry SG} = \frac{\text{Solids SG}}{\text{\% Solids (dec) + \% Water (dec) x Solids SG}}$$

### Pressure and Vacuum Equivalents

1 atmosphere = 29.92 in Hg = 760mm Hg = 14.7psi
1mm Hg = 1 Torr = (3.937 x $10^2$) in Hg = 1000µ Hg = 1.333
1 bar = $10^3$ millibars = $10^6$ microbars = 750.06mm Hg
1 microbar = 0.75micron
1 inch Hg = 25.4mm Hg
x in. Hg vacuum = (29.92 - x) in Hg absolute
y mm Hg vacuum = (760 - y) mm Hg absolute
z PSIG = (z + 14.7) PSIA
w PSIA = (w - 14.7) PSIG

### Circle formulas

Area = $\pi r^2$
Circumference = $2\pi r$
Volume of cylinder = $\pi D^2 H \times 0.25$
Volume of sphere = $0.166 \times D^2$
where: = 3.14
r = radius
D = diameter
H = height

### Weight

Pounds to kilolgrams = lbs ÷ 2.2
Kilograms to pounds = kg x 2.2
Gallons to pounds = gallons x 10
litres to kilograms = litres x 1

### Affinity laws

How changes in pump speed affect pump flow, head and input: $Q = Q_1 \times N/N_1$
$H = H_1 \times (N/N_1)^2$
$P = P_1 \times (N/N_1)^3$

where: N = New speed, $N_1$ = Old speed, Q = Flow @ N, $Q_1$ = Flow @ $N_1$, H = Head @ N, $H_1$ = Head @ $N_1$, P = I/P power @ N, $P_1$ = I/P power @ $N_1$

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# SPECIFICATIONS & FORMULAE

## FORMULAE AND EQUIVALENTS cont.

### Net positive suction head

Flooded suction: $NPSH_A = ha - hv + hi$
Suction lift: $NPSH_A = ha - hv - hs - hi$

ha = the available atmospheric pressure in metres of liquid on the surface of the supply liquid
hv = the vapour pressure of the liquid being pumped expressed in metres of head. For water (20°C) at sea level, this is 10.2m
hs = the height in metres of the supply liquid surface level with respect to the pump inlet
hi = suction line friction losses expressed in metres of head

These calculations yield the available net positive suction head for a given system ($NPSH_A$). This must be compared to the required net positive suction head ($NPSH_R$) at the duty point as calculated by the pump manufacturer. $NPSH_A$ must exceed $NPSH_R$ by a safety margin of at least 0.5m.

### Nozzle flow rates

| Pressure | | Nozzle diameter (mm) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| kPa | psi | 2 | 4 | 6 | 8 | 10 | 12 | 16 | 20 | 25 |
| 200 | 29 | 0.06 | 0.25 | 0.56 | 1.01 | 1.57 | 2.26 | 4.02 | 6.29 | 9.82 |
| 300 | 43 | 0.08 | 0.31 | 0.69 | 1.23 | 1.93 | 2.77 | 4.93 | 7.70 | 12.03 |
| 400 | 58 | 0.09 | 0.36 | 0.89 | 1.42 | 2.22 | 3.20 | 5.69 | 8.89 | 13.89 |
| 500 | 73 | 0.10 | 0.40 | 0.89 | 1.59 | 2.48 | 3.58 | 6.36 | 9.94 | 15.53 |
| 600 | 87 | 0.11 | 0.43 | 0.98 | 1.74 | 2.72 | 3.92 | 6.97 | 10.89 | 17.02 |
| 700 | 102 | 0.12 | 0.47 | 1.06 | 1.88 | 2.94 | 4.23 | 7.53 | 11.76 | 18.38 |
| 800 | 116 | 0.12 | 0.50 | 1.13 | 2.01 | 3.14 | 4.53 | 8.05 | 12.58 | 19.65 |
| 900 | 131 | 0.13 | 0.53 | 1.20 | 2.13 | 3.33 | 4.80 | 8.54 | 13.34 | 20.84 |
| 1000 | 145 | 0.14 | 0.56 | 1.20 | 2.25 | 3.52 | 5.06 | 9.00 | 14.06 | 21.97 |

### Units of flow rate

| Convert from ↓ / Convert to → | | Imp gall/min | US gall/min | m³/hr | L/s | L/m |
|---|---|---|---|---|---|---|
| | | Multiply by | | | | |
| Imp gall/min | (g/m) | 1 | 1.2 | 0.273 | 0.076 | 4.546 |
| US gall/min | (g/m) | 0.833 | 1 | 0.227 | 0.063 | 3.787 |
| Cubic Metres/hr | (m³/hr) | 3.666 | 4.4 | 1 | 0.278 | 16.66 |
| Litres/second | (L/s) | 13.19 | 15.85 | 3.6 | 1 | 60 |
| Litres/min | (L/m) | 0.219 | 0.264 | 0.06 | 0.016 | 1 |

### Units of volume

| Convert from ↓ / Convert to → | | Litre | Kilolitre | Cubic Metre | Imp Gallon | US Gallon |
|---|---|---|---|---|---|---|
| | | Multiply by | | | | |
| Litre | (L) | 1 | 0.001 | 0.001 | 0.220 | 0.264 |
| Kilolitre | (kL) | 1000 | 1 | 1 | 220 | 264 |
| Cubic Metre | (m³) | 1000 | 1 | 1 | 220 | 264 |
| Imp Gallon | (gall) | 4.546 | 0.00454 | 0.00454 | 1 | 1.201 |
| US Gallon | (gall) | 3.785 | 0.0038 | 0.0038 | 0.833 | 1 |

### Units of pressure

| Convert from ↓ / Convert to → | | kPa | m | bar | psi | ft | At |
|---|---|---|---|---|---|---|---|
| | | Multiply by | | | | | |
| Kilopascal | (kPa) | 1 | 0.102 | 0.01 | 0.145 | 0.335 | - |
| metre head | (m) | 9.804 | 1 | 0.095 | 1.42 | 3.28 | 0.098 |
| Bar | (bar) | 100 | 10.2 | 1 | 14.5 | 33.45 | 1 |
| Pounds/sq in | (psi) | 6.895 | 0.704 | 0.069 | 1 | 2.307 | 0.069 |
| feet of water | (ft) | 2.98 | 0.3048 | 0.03 | 0.4335 | 1 | 0.03 |
| Atmosphere | (At) | 100 | 10.33 | 1 | 14.7 | 33.9 | 1 |

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### Units of length

| Convert from ↓ / Convert to → | | mm | cm | m | km | in | ft | mile |
|---|---|---|---|---|---|---|---|---|
| | | Multiply by | | | | | | |
| Millimetre | (mm) | 1 | 0.1 | 0.001 | - | 0.0394 | 0.0033 | - |
| Centimetre | (cm) | 10 | 1 | 0.01 | - | 0.394 | 0.0326 | - |
| Metre | (m) | 1000 | 100 | 1 | 0.001 | 39.37 | 3.281 | 0.000621 |
| Kilometre | (km) | - | - | 1000 | 1 | - | 3281 | 0.521 |
| Inch | (in) | 25.4 | 2.54 | 0.0254 | - | 1 | 0.083 | - |
| Feet | (ft) | 304.8 | 30.48 | 0.305 | - | 12 | 1 | - |
| Mile | (mile) | - | - | 1610 | 1.61 | - | 5280 | 1 |

# SPECIFICATIONS & FORMULAE

## CONVERSION UNITS

| Quantity | Various units | | Pumping units (SI) | | |
|---|---|---|---|---|---|
| | Name | Symbol | Name | Symbol | Conversion factors |
| Length and head of liquid | Foot | ft | Metre | m | 0.3048 |
| Area | Acre<br>Hectare | ac<br>ha | Square metre | $m^2$ | 4047<br>10,000 |
| Volume | Imperial gallon<br>Cubic foot | gal<br>$ft^3$ | Litre | L | 4.546<br>28.32 |
| Power | Horsepower<br>Foot pound-force per second<br>Kilogram-force metre per second | hp<br>ft.lbsf/s<br>kgf.m/s | Kilowatt | kW | 0.7457<br>0.0014<br>0.0098 |
| Density | Pound per cubic foot<br>Pound per imperial gallon<br>Pound per US gallon | $lb/ft^3$<br>lb/gal<br>lb/US gal | Kilogram per cubic metre | $kg/m^3$ | 16.02<br>99.78<br>119.8 |
| Concentration | Part per million | ppm | Milligram per litre | mg/L | 1.000 |
| Dynamic viscosity | Centipoise | cP | Millipascal second | mPa.s | 1.000 |
| Kinematic viscosity | Saybolt second universal<br>Centistoke | ssu<br>cSt | Square millimetre per second | $mm^2/s$ | 0.2165*<br>1.000 |
| Torque | Foot pounds | ft.lbs | Newton meters | Nm | 1.355 |
| Temperature | Centigrade<br>Farenheit | °C<br>°F | Farenheit<br>Centigrade | °F<br>°C | °C x1.8 + 32<br>(°F-32) x 0.55 |

* Approximate conversion factor for use above 250 SSU

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