Metric Conversion Factors

Temperature

To convert from	To	Use this formula
temperature Celsius, tC	temperature Fahrenheit, tF	tF = 1.8tC + 32
temperature Fahrenheit, tF	temperature Celsius, tC	tC = (tF - 32)/1.8
temperature Celsius, tC	temperature Kelvin, tK	tK = tC + 273.15
temperature Fahrenheit, tF	temperature Kelvin, tK	tK = (tF + 459.67)/1.8
temperature Kelvin, tK	temperature Celsius, tC	tC = tK - 273.15
temperature Kelvin, tK	temperature Fahrenheit, tF	tF = 1.8tK - 459.67
temperature Kelvin, tK	temperature Rankine, tR	tR = 9/5tK
temperature Rankine, tR	temperature Kelvin, tK	tK = 5/9tR

Volume

Multiply	By	To obtain
centimetre^3	0.06102376	inch^3
gallon (UK liquid)	0.004546092	metre^3 (m^3)
gallon (UK liquid)	4.546092	litre
gallon (US liquid)	0.003785412	metre^3 (m^3)
gallon (US liquid)	3.785412	litre
inch^3	16,387.06	millimetre^3 (mm^3)
inch^3	16.38706	centimetre^3 (cm^3)
inch^3	0.00001638706	metre^3 (m^3)
litre	0.001*	metre^3 (m^3)
litre	0.2199692	gallon (UK liquid)
litre	0.2641720	gallon (US liquid)
metre^3	219.9692	gallon (UK liquid)
metre^3	264.1720	gallon (US liquid)
metre^3	35.31466	foot^3
metre^3	1000.*	litre

Pressure and Stress

Multiply	By	To obtain
atmosphere	101,325	pascal (Pa)
atmosphere	14.6959	pound/inch^2
atmosphere	1.01325	bar
bar	100,000*	pascal (Pa)
bar	14.50377	pound/inch^2
bar	100,000*	newton/metre^2 (N/m^2)
Pascal	0.00001*	bar
Pascal	1.0*	newton/metre^2 (N/m^2)
Pascal	0.0001450377	pound/inch^2
pound/inch^2	0.06894757	bar
pound/inch^2	6,894.757	newton/metre^2 (N/m^2)
pound/inch^2	6,894.757	pascal (Pa)

Length

Multiply	By	To obtain
millimetre	0.003280840	foot
millimetre	0.0397008	inch
centimetre	0.03280840	foot
centimetre	0.3937008	inch
metre	39.37008	inch
metre	3.280840	foot
metre	1.093613	yard
metre	0.0006213712	mile (US statute)
inch	0.0254*	metre (m)
inch	2.54*	centimetre (cm)
inch	25.4*	millimetre (mm)
foot	0.3048*	metre (m)
foot	30.48*	centimetre (cm)
foot	304.8*	millimetre (mm)
yard	0.9144*	metre (m)
mile (US statute)	1,609.344*	metre (m)
mile (US statute)	1.609344*	kilometre (km)

Power

Multiply	By	To obtain
foot-pound/hour	0.0003766161	watt (W)
foot-pound/minute	0.02259697	watt (W)
horsepower (550 ft-lb/s)	0.7456999	kilowatt (kW)
horsepower (550 ft-lb/s)	745.6999	watt (W)
horsepower (electric)	746.*	watt (W)
horsepower (metric)	735.499	watt (W)
horsepower (UK)	745.70	watt (W)
kilowatt	1.341022	horsepower (550 ft-lb/s)
watt	2,655.224	foot-pound/hour
watt	44.25372	foot-pound/minute
watt	0.001341022	horsepower (550 ft-lb/s)
watt	0.001340483	horsepower (electric)
watt	0.001359621	horsepower (metric)
watt	0.001341022	horsepower (UK)
watt	3.412141	Btu (International Table)/hour

Mass

Multiply	By	To obtain
kilogram	35.27397	ounce
kilogram	2.204622	pound
kilogram	0.0009842064	ton (long) UK
kilogram	0.001102311	ton (short) US
kilogram	0.001*	tonne
ounce	28.34952	gram (g)
ounce	0.02834952	kilogram (kg)
pound	0.4535924	kilogram (kg)
ton long (2240 lb) UK	1,016.047	kilogram (kg)
ton short (2000 lb) US	907.1847	kilogram (kg)
tonne	1,000.*	kilogram (kg)

Flow

Multiply	By	To obtain
gallon (US liquid)/minute	0.00378541	metre^3/minute
gallon (US liquid)/minute	0.83267386	gallon (UK liquid)/minute
gallon (US liquid)/minute	3.785412	litre/minute
gallon (UK liquid)/minute	0.00454609	metre^3/minute
gallon (UK liquid)/minute	1.20095038	gallon (US liquid)/minute
gallon (UK liquid)/minute	4.546092	litre/minute
litre/minute	0.001	metre^3/minute
litre/minute	0.26417203	gallon (US liquid)/minute
litre/minute	0.21996915	gallon (UK liquid)/minute
metre^3/minute	1000	litre/minute
metre^3/minute	264.172037	gallon (US liquid)/minute
metre^3/minute	219.969151	gallon (UK liquid)/minute

Viscosity

Multiply	By	To obtain
centipoise	0.001*	pascal-second (Pa.s)
centistoke	0.000001*	metre^2/second (m^2/s)
metre^2/second	1,000,000.*	centistoke
metre^2/second	10,000.*	stoke
pascal-second	1,000.*	centipoise
pascal-second	10.*	poise
poise	0.1*	pascal-second (Pa.s)
stoke	0.0001*	metre^2/second (m^2 /s)

** Where an asterisk is shown, the figure is exact*

Hydraulic Equations

Hydraulic Motor or Engine Torque

Imperial

$$T = \frac{5252 \times HP}{rpm}$$

T = Torque in pound foot (lb-ft)
HP = Horsepower
rpm = Engine speed in revolutions per minute

EXAMPLE: What is the torque of an engine that develops 40 HP at 2500 rpm?

$$T = \frac{5252 \times 40}{2500} = 84 \text{ lb-ft}$$

Metric

$$T = \frac{9.545 \times P}{rpm}$$

T = Torque in newton metre (Nm)
P = Power in watts (W)
rpm = Engine speed in revolutions per minute

EXAMPLE: What is the torque of an engine that develops 30,000 W at 2500 rpm?

$$T = \frac{9.545 \times 30{,}000}{2500} = 114.54 \text{ Nm}$$

Hydraulic Motor Torque Required

Imperial

$$ST = \frac{VW \times u \times r}{R}$$

VW = Vehicle weight over driving tyres (lbs)
u = Coefficient of friction of tyres on average road surface, generally 0.6
r = Rolling radius of loaded driving tyre in inches
R = Overall gear reduction in both axle and transmission

Metric

$$ST = \frac{VW \times u \times r}{R \times 101.97}$$

VW = Vehicle weight over driving tyres (kg)
u = Coefficient of friction of tyres on average road surface, generally 0.6
r = Rolling radius of loaded driving tyre in millimetres
R = Overall gear reduction in both axle and transmission

WEBTEC
WEBTEC Products Limited

Manufacturers of Hydraulic Components and Test Equipment for Mobile, Industrial and Agricultural Machinery

Nuffield Road, St. Ives, Cambridgeshire, PE27 3LZ, UK
Tel: +44(0)1480 397400
Fax: +44(0)1480 466555
E-mail: sales@webtec.co.uk
www.webtec.co.uk

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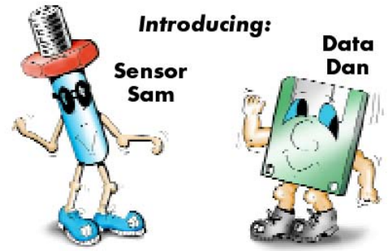
Metric Conversion Factors & Useful Hydraulic Equations



Hydraulic Motor Speed from Ground Speed

Imperial

$$rpm = \frac{168 \times R \times S}{r}$$

168 = Factor
rpm = Revolutions per minute of engine
r = Rolling radius of loaded drive tyre in inches
R = Overall gear reduction including both axle and transmission
S = Vehicle speed in miles per hour

EXAMPLE: Find the motor speed where the overall gear reduction is 10, vehicle speed is 15 mph and rolling radius of driving tyre is 15 inches

$$rpm = \frac{168 \times 10 \times 15}{15} = 1680 \text{ rpm}$$

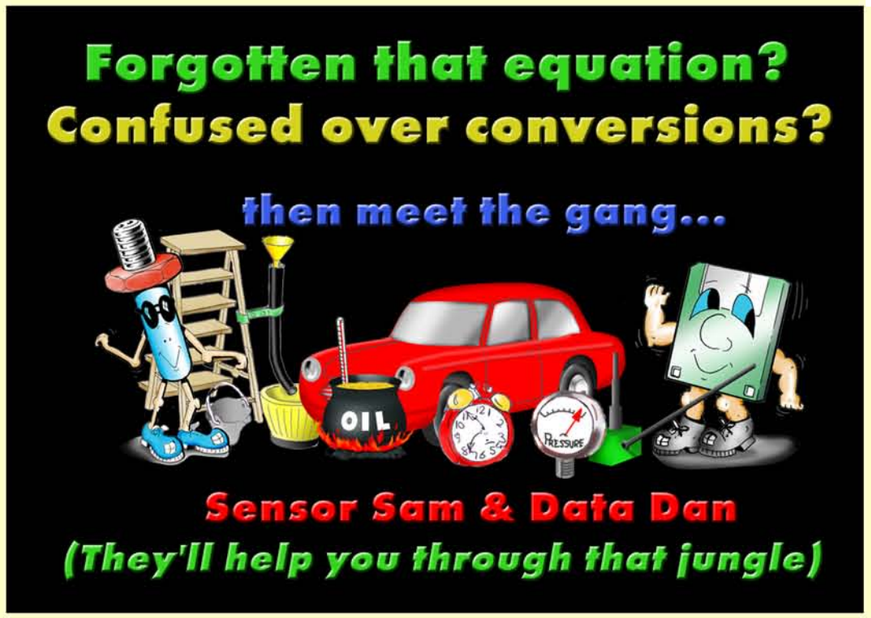
Metric

$$rpm = \frac{2651.51 \times R \times S}{r}$$

2651.51 = Factor
rpm = Revolutions per minute of engine
r = Rolling radius of loaded drive tyre in millimetres
R = Overall gear reduction including both axle and transmission
S = Vehicle speed in kilometres per hour

EXAMPLE: Find the motor speed where the overall gear reduction is 10, vehicle speed is 20 kph and rolling radius of driving tyre is 400 millimetres

$$rpm = \frac{2651.51 \times 10 \times 20}{400} = 1325.75 \text{ rpm}$$



Overall Gear Reduction

Imperial

$$R = \frac{rpm \times r}{168 \times S}$$

168 = Factor
rpm = Revolutions per minute of engine
r = Rolling radius of loaded driving tyre in inches
R = Overall gear reduction including both axle and transmission
S = Vehicle speed in miles per hour

EXAMPLE: Find out overall gear reduction of a vehicle where the motor speed is 1680 rpm, the rolling radius of loaded driving tyre is 15 inches and the mph is 15.

$$R = \frac{1680 \times 15}{168 \times 15} = 10 \text{ to } 1$$

Metric

$$R = \frac{rpm \times r}{2651.51 \times S}$$

2651.51 = Factor
rpm = Revolutions per minute of engine
r = Rolling radius of loaded driving tyre in millimetres
R = Overall gear reduction including both axle and transmission
S = Vehicle speed in kilometres per hour

EXAMPLE: Find out overall gear reduction of a vehicle where the motor speed is 1680 rpm, the rolling radius of loaded driving tyre is 381mm and the kph is 24.

$$R = \frac{1680 \times 381}{2651.51 \times 24} = 10 \text{ to } 1$$

Ground Speed from Motor Speed

Imperial

$$S = \frac{rpm \times r}{168 \times R}$$

168 = Factor
rpm = Revolutions per minute of the motor
r = Rolling radius of loaded driving tyre in inches
R = Overall gear reduction including both axle and transmission
S = Vehicle speed in miles per hour

EXAMPLE: Find the mph of a vehicle where the motor speed is 1680 rpm, the rolling radius of loaded driving tyre is 15 inches and the overall gear reduction is 10

$$S = \frac{1680 \times 15}{168 \times 10} = 15 \text{ mph}$$

Metric

$$S = \frac{rpm \times r}{2651.51 \times R}$$

2651.51 = Factor
rpm = Revolutions per minute of the motor
r = Rolling radius of loaded driving tyre in millimetres
R = Overall gear reduction including both axle and transmission
S = Vehicle speed in kilometres per hour

EXAMPLE: Find the kph of a vehicle where the motor speed is 1326 rpm, the rolling radius of loaded driving tyre is 400 millimetres and the overall gear reduction is 10

$$S = \frac{1326 \times 400}{2651.51 \times 10} = 20 \text{ kph}$$

Axle Torque

Imperial

$$Ta = T \times Rta \times Ra$$

Ta = Axle torque (lb-in)
Ra = Axle gear reduction
Rta = Gear reduction through auxiliary transmission if used
= Motor torque (lb-in)

EXAMPLE: What is the rear axle torque in high gear on a vehicle having 1000 lb-in motor torque, an auxiliary ratio of 4:1, and an axle ratio of 20:1

$$Ta = 1000 \times 4 \times 20 = 80{,}000 \text{ lb-in}$$

Metric

$$Ta = T \times Rta \times Ra$$

Ta = Axle torque (Nm)
Ra = Axle gear reduction
Rta = Gear reduction through auxiliary transmission if used
= Motor torque (Nm)

EXAMPLE: What is the rear axle torque in high gear on a vehicle having 100 Nm in motor torque, an auxiliary ratio of 5:1, and an axle ratio of 20:1

$$Ta = 100 \times 5 \times 20 = 10{,}000 \text{ Nm}$$

Hydraulic Pump Formulae

Actual Pump delivery (lpm) = Volumetric efficiency (max. of 1) x Displacement per revolution (lpm) x Pump speed (rpm)

$$\text{Volumetric efficiency} = \frac{\text{Actual Pump delivery}}{\text{Theoretical Pump delivery}}$$

$$\text{Hydraulic power (kW)} = \frac{\text{Pump delivery (lpm)} \times \text{Max. pressure (bar)}}{600}$$

$$\text{Torque efficiency} = \frac{\text{Overall efficiency (max. of 1)}}{\text{Volumetric efficiency (max. of 1)}}$$

$$\text{Input power (kW)} = \frac{\text{Hydraulic power (kW)}}{\text{Overall efficiency (max. of 1)}}$$

$$\text{Torque at pump shaft (Nm)} = \frac{\text{Hydraulic power (kW)}}{62.83 \times \text{Torque efficiency (max. of 1)}}$$