Formulas

Measurement unit abbreviations

°C	degree Celsius
°F	degree Fahrenheit
°K	degree Kelvin
A	ampere
BHP	boiler horsepower
BTU	British thermal unit
Btuh	British thermal units per hour
CFH	cubic feet per hour
CFM	cubic feet per minute
ft.	foot
ft^2	square foot
ft^3	cubic foot
gal.	imperial gallon
gpm	imperial gallons per minute
hr	hour
in.	inch
in^2	square inch
in^3	cubic inch
kg	kilogram
kPa	kilopascal
kPaG	kilopascal gauge
kW	kilowatt

Formulas (continued)

Measurement unit abbreviations (continued)

L	litre
lb.	pound
lbf	pound - force
m	metre
m^2	square metre
m^3	cubic metre
min	minute
mm	millimetre
psi	pounds per square inch
psia	pounds per square inch absolute
psig	pounds per square inch gauge
s	second
SCFM	standard cubic feet per minute
SPR	seconds per rotation
t	ton (ice melted over a 24 - hour period)
USG	American gallon
USGPM	American gallons per minute
V	volt
VA	volt - ampere
W	watt

Formulas (continued)

Values

ΔT	temperature difference
B	base
BarG	bar gauge
C	specific heat of fluid
CO_2	carbon dioxide
D	distance
FCS	fully closed signal
FOS	fully open signal
H	height
HV	heating value
I	current (in amperes)
IS	input signal
L	length
M	mass of fluid per hour
P	pressure
P_{base}	base / atmospheric pressure
P_{test}	test pressure
PF	pressure factor
r	radius
R	resistance (in ohms)
SF	safety factor
stoich	stoichiometric

Formulas (continued)

Values (continued)

T	temperature
T_{amb}	ambient temperature
W	width

Constants

π	3.1416
1 ft³ of water	6.228 gal.
1 USG	8.33 lb.
45° offset	1.414
12 000 BTU (cooling capacity)	1 t
Air - fuel ratio	14.7
Base / atmospheric pressure	14.73 psig / psia
Boiler horsepower (BHP)	33 500
BTU per 1 000 W (single phase)	3.414
BTU per 1 000 W (three phase)	1.73
Heat content – natural gas	1 000 BTU / ft³
Heat content – propane	2 500 BTU / ft³
Pressure head conversion unit	0.433 psi / ft.
Specific heat of air	1.08
Standard for air at sea level	4.5

Formulas (continued)

Conversion factors

To convert	To	Multiply by
°C	°F	1.8 and add 32
°C	°K	1 and add 273
decimal	second	60
ft^2	in^2	144
ft^3	USG	7.48
kg	lb.	2.205
kPa	lbf/ft^2	20.88
kPa	lbf/in^2 (psi)	0.1450
kPaG	lbf/in^2 gauge (psig)	0.1450
L	USG	0.2200
L / min	USGPM	0.2641
L / s	gpm	13.20
m	ft.	3.281
m^2	ft^2	10.76
m^3	ft^3	35.31
mm	in.	0.03937

Formulas (continued)

General formulas

Descriptions	Full	Abbreviated
% of CO_2	$\frac{\text{stoichiometric } CO_2}{1 + (\%\text{ of excess air} \div 100)}$	$\frac{\text{stoich } CO_2}{1 + \left(\frac{\%\text{ excess air}}{100}\right)}$
Actuator position (%)	$\frac{\text{input signal} - \text{fully closed signal}}{\text{fully open signal} - \text{fully closed signal}}$	$\frac{IS - FCS}{FOS - FCS}$
Btuh	mass of fluid per hour × specific heat of fluid × temperature difference	$M \times C \times \Delta T$
CFH	$\left(\frac{\text{appliance output in Btuh}}{\text{appliance efficiency \%}}\right)$ ÷ heating value	$\frac{\text{output}}{\text{efficiency}} \div HV$
CFH	$\frac{\text{appliance output in Btuh}}{\text{heating value}}$	$\frac{\text{output}}{HV}$
CFH	(dial size ÷ seconds per rotation) × seconds in 1 hour × pressure factor	$\frac{\text{dial}}{SPR} \times 3\,600 \times PF$
CFH	$\frac{\text{seconds in 1 hour} \times \text{dial size}}{\text{seconds per rotation}}$	$\frac{3\,600 \times \text{dial}}{SPR}$
CFM	$\frac{\left(\text{British thermal units per hour} \times \text{efficiency}\right)}{\text{(specific heat of air} \times \text{temperature difference)}}$	$\frac{Btuh \times E}{1.08 \times \Delta T}$
CO_2 volume (combustion)	appliance output in Btuh × cubic feet of CO_2 per cubic foot of gas ÷ heating value	output × ft^3 of CO_2 / ft^3 of gas ÷ HV
Fuse rating	amperes × safety factor	A × SF

Formulas (continued)

Gauge pressure reading	$\left(\frac{(\text{pressure} + \text{air-fuel ratio}) \times \left(\begin{matrix}\text{temperature difference} \\ + \text{ temperature}\end{matrix}\right)}{\begin{matrix}\text{ambient temperature} \\ + \text{ temperature}\end{matrix}}\right) - \text{air-fuel ratio}$	$\left(\frac{(P + 14.7) \times (\Delta T + T)}{T_{amb} + T}\right) - 14.7$
Input (Btuh)	$\frac{\text{appliance output in Btuh}}{\text{appliance efficiency \%}}$	$\frac{\text{output}}{\text{efficiency}}$
Input (Btuh)	(base pressure + dial size) × cubic feet per hour ÷ base pressure × heating value	$\left(\frac{[P_{base} + \text{dial}] \times CFH}{P_{base}}\right) \times HV$
Input (Btuh)	cubic feet per hour × heating value	CFH × HV
Input (Btuh)	$\left(\frac{\text{seconds in 1 hour} \times \text{bar gauge}}{\text{seconds per rotation}}\right) \times \left(\frac{\text{base pressure} + \text{bar gauge}}{\text{base pressure}}\right) \times \text{heating value}$	$\left(\frac{3\,600 \times BarG}{SPR}\right) \times \left(\frac{P_{base} + BarG}{P_{base}}\right) \times HV$
Net stack temperature	downstream flue temperature − ambient temperature	downstream flue $T - T_{amb}$
Output (Btuh)	temperature difference × 1 USG × minutes in 1 hour × American gallons per minute	$\Delta T \times 8.33 \times 60 \times USGPM$
Output (Btuh)	total number of boiler horsepower × number of boilers	# BHP × 33 500 × # boilers

Formulas (continued)

Power	volt × ampere	V × A
Pressure factor	(base pressure + bar gauge) ÷ base pressure	$\frac{P_{base} + BarG}{P_{base}}$
Pressure test	$\left(\frac{[\text{combustion rate} \times \text{number of cylinders}] + (136.354 \times \text{air-fuel ratio})}{[\text{test pressure} \times \text{number of cylinders}] + 136.354}\right) - \text{air-fuel ratio}$	$\left(\frac{[\text{comb. rate} \times \#\ \text{cyl.}] + (136.354 \times 14.7)}{[P_{test} \times \#\ \text{cyl.}] + 136.354}\right) - 14.7$
Purge time	cubic feet per minute × number of air changes ÷ exhaust fan capacity measured in standard cubic feet per minute	$\frac{CFM \times \#\ \text{air changes}}{SCFM}$
Seconds per rotation	$\frac{\text{cubic feet per hour}}{(\text{seconds in 1 hour} \times \text{pressure factor})} \times \text{dial size}$	$\left(\frac{CFH}{3\,600 \times PF}\right) \times \text{dial}$
Travel	offset distance × 45° offset constant	offset D × 1.414
Volt-ampere	current × voltage	I × E
Voltage	current × resistance	I × R

Formulas (continued)

Area formulas

Description	Full	Abbreviated
Circle	$\pi \times$ radius squared	πr^2
Rectangle	length $\times$ width	$L \times W$
Sphere	$4 \times \pi \times$ radius squared	$4\pi r^2$
Triangle	$\frac{\text{base} \times \text{height}}{2}$	$\frac{B \times H}{2}$

Volume formulas

Description	Full	Abbreviated
Cuboid	length $\times$ width $\times$ height	$L \times W \times H$
Cylinder	$\pi \times$ radius squared $\times$ height	$\pi r^2 H$
Sphere	$\frac{4 \times \pi \times \text{radius cubed}}{3}$	$\frac{4\pi r^3}{3}$