Formulas

Measurement unit abbreviations

A	ampere
BTU	British thermal unit
Btuh	British thermal units per hour
BTU / lb	British thermal units per pound
CFM	cubic feet per minute
dBA	A-weighted decibel
°C	degree Celsius
°F	degree Fahrenheit
ft.	foot
ft²	square foot
ft³	cubic foot
fpm	feet per minute
gal.	imperial gallon
h	height
hp	horsepower
hr	hour
Hz	hertz
in.	inch
in²	square inch
K	kelvin
kg	kilogram
kPa	kilopascal
kPaG	kilopascal gauge
l	length

Formulas (continued)

Measurement unit abbreviations (continued)

L	litre
lb.	pound
m	metre
m^2	square metre
m^3	cubic metre
mA	milliampere
mm	millimetre
mV	millivolt
oz.	ounce
psi	pounds per square inch
psia	pounds per square inch absolute
psig	pounds per square inch gauge
rpm	revolutions per minute
s	second
t	imperial ton
USG	United States gallon
USGPM	United States gallons per minute
V	volt
VA	volt-ampere
VAC	volts alternating current
VDC	volts direct current
w	width
W	watt
w.c.	water column

Formulas (continued)

Conversion factors

To convert	To	Multiply by
°C	°F	1.8 and add 32
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
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

Constants

π	3.1416
1 USG	8.33 lb.
12 000 Btuh	1 t
BTU per 1 000 W (single phase)	3.414
BTU per 1 000 W (three phase)	1.73
Pressure head conversion unit	0.433 psi/ft.
Specific heat of air	1.08
Standard for air at sea level	4.5

Formulas (continued)

Values

α	coefficient of expansion
Area (a)	space occupied by a 2 - dimensional figure
B	base
c	specific heat capacity
d	diameter
ΔE	energy change — i.e. change in energy of a system at constant volume
ΔH	enthalpy change — i.e. change in energy of a system at constant pressure (BTU / lb).
ΔP	
Δpsig	difference in pounds per square inch gauge
ΔT	difference in temperature
ΔU	internal energy change
dens.	density
M	mass
NRE	net refrigeration effect
OA	outdoor air
P	pressure
q	velocity pressure (dynamic pressure)
Q	quantity of heat
r	radius
R	thermal resistance
RA	return air
R - value	resistance to conductive flow of heat
SA	total supply air
THR	total heat of rejection

Formulas (continued)

Values (continued)

U	thermal transmittance
U - factor	overall heat transfer coefficient
Velocity (v)	speed of motion in a given direction

General formulas

Description	Full	Abbreviated
Btuh	4.5 × cubic feet per minute × enthalpy change	$4.5 \times CFM \times \Delta H$
Btuh	500 × United States gallons per minute × temperature diffence in degrees Farenheit	$500 \times USGPM \times \Delta^{\circ}F$
Btuh	U - factor × area in square feet × temperature diffence in degrees Farenheit	$U \times a \text{ in } ft^2 \times \Delta^{\circ}F$
CFM	velocity in feet per minute × area in square feet	$v \text{ in } fpm \times a \text{ in } ft^2$
Coefficient of performance (COP)	$\frac{\text{total heat of rejection}}{\text{net refrigeration effect}}$	$\frac{THR}{NRE}$
Diameter	diameter 1 × revolutions per minute 1 = diameter 2 × revolutions per minute 2	$d_1 \times rpm_1 = d_2 \times rpm_2$
Enthalpy change	internal energy change + (pressure × volume difference)	$\Delta U + P\Delta V$
Expansion	length × temperature diffence × coefficient of expansion	$l \times \Delta T \times \alpha$
Force	pressure × area	$P \times a$

Formulas (continued)

General formulas (continued)

Description	Full	Abbreviated
gpm	$\frac{\text{British thermal units}}{\text{pounds per gallon} \times \text{temperature diffence}}$	$\frac{\text{BTU}}{(\text{lb./gal.}) \times \Delta T}$
gpm	$\frac{\text{total British thermal units per hour}}{\text{temperature diffence} \times \text{mass} \times \text{specific heat capacity}}$	$\frac{\text{total Btuh}}{\Delta T \times M \times c}$
Grade	$\frac{\text{drop or rise}}{\text{run}}$	$\frac{\text{drop or rise}}{\text{run}}$
Outdoor supply air volume (%)	$\frac{\text{outdoor air \%}}{100} = \frac{\text{outdoor air in cubic feet per minute}}{\text{Total in cubic feet per minute}}$	$\frac{OA\%}{100}$
Pressure	height × density	h × dens.
psia	pounds per square inch gauge + 14.7	psig + 14.7
psig	pounds per square inch absolute − 14.7	psia − 14.7
Quantity of heat	cubic feet per minute × 1.08 × temperature diffence	CFM × 1.08 × ΔT
Q (Btuh)	United States gallons per minute × 500 × temperature diffence in degrees Farenheit	USGPM × 500 × Δ°F
Q·CFM	$\frac{\text{volts} \times \text{amperes} \times 3.414}{1.08 \times \text{temperature diffence}}$	$\frac{V \times A \times 3.414}{1.08 \times \Delta T}$
R-value	1/U-factor	1/U
Temperature difference	$\frac{\text{British thermal units per hour}}{500 \times \text{gallons per minute}}$	$\frac{\text{Btuh}}{500 \times \text{gpm}}$
Total supply air	outdoor air % + return air % = 100% total supply of air	OA% + RA% = SA

Formulas (continued)

General formulas (continued)

Description	Full	Abbreviated
U-factor	1/R-value	1/R
U-factor	watts per square metre per kelvin	W/m^2K
Velocity	4 005 × square root of velocity pressure	$4\,005 \times \sqrt{q}$

Total thermal formulas

Description	Full	Abbreviated
Btuh	gallons per minute × area × temp. diff.	gpm × A × ΔT
Btuh	gallons per minute × cubic feet per minute × total change in energy	gpm × CFM × ΔE
Btuh	4.5 × cubic feet per minute × total change in enthalpy	4.5 × CFM × ΔH
gpm	$\frac{\text{British thermal units per hour}}{500 \times \text{temp. diff. of water}}$	$\frac{\text{Btuh}}{500 \times \Delta T \text{ of water}}$

Area formulas

Description	Full	Abbreviated
Circle	π × radius²	πr^2
Cylinder (open top)	(π × radius²) + (π × diameter × height)	$\pi r^2 + \pi dh$
Cylinder (totally enclosed)	(2 × π × radius²) + (π × diameter × height)	$2\pi r^2 + \pi dh$
Rectangle	length × width	l × w
Rectangle box (open top)	(length × width) + 2(width × height) + 2(length × height)	(l × w) + 2(w × h) + 2(l × h)

Formulas (continued)

Area formulas (continued)

Description	Full	Abbreviated
Rectangle box (totally enclosed)	$2(\text{length} \times \text{width}) + 2(\text{width} \times \text{height}) + 2(\text{length} \times \text{height})$	$2(L \times w) + 2(w \times h) + 2(L \times h)$
Sphere	$4 \times \pi \times \text{radius}^2$	$4\pi r^2$
Triangle	$\frac{\text{base} \times \text{height}}{2}$	$\frac{B \times h}{2}$

Volume formulas

Description	Full	Abbreviated
Cylinder	$\pi \times \text{radius}^2 \times \text{height}$	$\pi r^2 h$
Cuboid	$\text{length} \times \text{width} \times \text{height}$	$l \times w \times h$
Sphere	$\frac{4 \times \pi \times \text{radius}^3}{3}$	$\frac{4\pi r^3}{3}$