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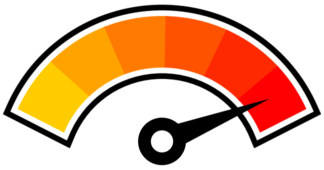
HOW TO WORK COOLING CAPACITY

This guide is useful in ensuing that chiller cooling capacity matches or exceeds heat load.



Excess heat build up can:

- shorten component/product lifespans
- distort experiment results
- affect nearby equipment
- cause safety hazards

A carefully sized chiller can last upwards of 15 years with proper care and maintenance.

Method 1

This method to work out cooling capacity is useful where data is limited.

- Consult manufacturer documentation
- Normally, figures for thermal load are described to help source 3rd party chillers
- These documents may also describe flow and pressure requirements
- Contact us at ATC - we may have sized for similar applications

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Method 2

This method to work out cooling capacity is useful where it is possible to view a product rating label.

$$Q=P*SF$$

Q = Heat load in Watts (W)
P = Rating plate Power in Watts (W)
SF = Safety Factor

This method assumes that ALL energy used by the application is converted to heat
This method is likely to result in an overestimate.

Working example:

*Q = P*SF*
*Q = 1000*1.2*
Q = 1200W

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Method 3

This method to work out cooling capacity is useful where it is possible to measure the AC power supply output

$$Q=P=(V*I*PF)*SF$$

Q = Heat load in Watts (W)
P = Application Power Consumption in Watts (W)
V=Voltage of AC supply in Volts (V)
PF = Power Factor
SF = Safety Factor

This method looks at the amount of energy released into an AC circuit, versus the amount provided at source.
This method also assumes that ALL energy used by the application is converted to heat apart from power supply.

Working example:

*Q = P = (V*I*PF)*SF*
*Q = P = (240*3*0.85)*1.2*
Q = P = 734.4W
Q = 734.4W

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Method 4

This method to work out cooling capacity is useful where the application output power and estimated efficiency are known.

$$Q=P=(W/\eta)*SF$$

Q = Heat load in Watts (W)
P = Absorbed Power in Watts (W)
W = Output Power in Watts (W)
η = Efficiency (0.1, i.e. 70% efficient = 0.7)
SF = Safety Factor

This method takes rated output power from a datasheet or rating label and asks the user to assess the efficiency (always <100%). Absorbed power will therefore be higher.
This is a strong method, especially if prior knowledge of equipment is known. For example, electrical motors can be anywhere between 40-70% efficient.

Working example:

$Q = P = (W/\eta)*SF$
$Q = P = (370/0.7)*1.2$
$Q = P = 529*1.2$
$Q = P = 635W$
$Q = 635W$

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Method 5

This method to work out cooling capacity is useful where the pump flow rate, inlet and outlet temperatures are known.

$$Q=((\rho*Q_v*C_p*\Delta T)/60)*SF$$

Q = Heat load in Watts (W)
ρ = Density of circulated fluid (kg/m^3)
Q_v = Volumetric flow rate of circulated fluid (L/min)
C_p = Specific heat capacity of circulated fluid (kJ/kg °C)
ΔT = Temperature difference between inlet and outlet (°C)
SF = Safety Factor

Useful in an incumbent chiller or thermal management device is already in place.
Pump flow rate can be seen on rating label if type is positive displacement, or from pump flow curve if pressure is measurable. An inline flow meter is most accurate.
Chiller 'actual' temperature is the outlet value. For inlet, a measurement is needed.
If an existing process is using running tap water, ΔT is the difference between tap water temperature and application outlet. Often a bucket and stopwatch are used to measure flow rate!

Working example:

$Q = ((\rho*Q_v*C_p*\Delta T)/60)*SF$
$Q = ((998*9.7*4.19*5)/60)*1.2$
$Q = (202809/60)*1.2$
$Q = 3380*1.2$
$Q = 4056W$

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Method 6

This method to work out cooling capacity is useful where fluid volume, desired temperature change, and duration are known.

$$m=(\rho*V)/1000$$

$$Q=((m*C_p*\Delta T)/t)*SF$$

Q = Heat load in Watts (W)
m = Mass of circulated fluid (kg)
ρ = Density of circulated fluid (kg/m^3)
V = Total circuit volume of circulated fluid in litres (L)
C_p = Specific heat capacity of circulated fluid (kJ/kg °C)
ΔT = Difference between start temp and target (°C)
t = Timeframe to achieve temperature change, in seconds (s)
SF = Safety Factor

This method sizes a 'pull-down' cooling capacity, i.e. capacity required to do a cooling job within a constrained period of time.
It assumes no additional heat is being put into the circulated volume.

Working example:

$m = (\rho*V)/1000$	$Q = ((m*C_p*\Delta T)/t)*SF$
$m = (998*65)/1000$	$Q = ((64.87*4.19*15)/1800)*1.2$
$m = 64.87kg$	$Q = (4077/1800)81.2$
	$Q = 2.718kW$

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For further assistance

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