Enclosure Cooling

You need to cool down

Heat inside an enclosure can decrease the life expectancy of controlling units such as your PLC, HMI, AC drives and other items. Excessive heat can cause nuisance faults from your electrical and electronic components: for example, overloads tripping unexpectedly. Heat will also change the expected performance of circuit breakers and fuses, which can cause whole systems to shut down unexpectedly. So, if you have any electronic equipment or other heat sensitive devices, you may need cooling.

What causes all that heat?

There are basically two sources that can cause the enclosure's internal temperature to rise above the ratings of the control equipment.

Internal Sources

The same items that can be damaged by heat may also be the source of the heat. These include items such as:

- Power supplies Servos
- AC Drives/inverters Soft starters
- Transformers PLC systems
- Communication products HMI systems
- Battery back-up systems

External Sources

Other sources of heat that can cause the internal temperature of your enclosure to rise above a desired level involve the external environment. These include items such as:

- Industrial ovens
- Solar heat gain
- Foundry equipment
- Blast furnaces

Get the heat out

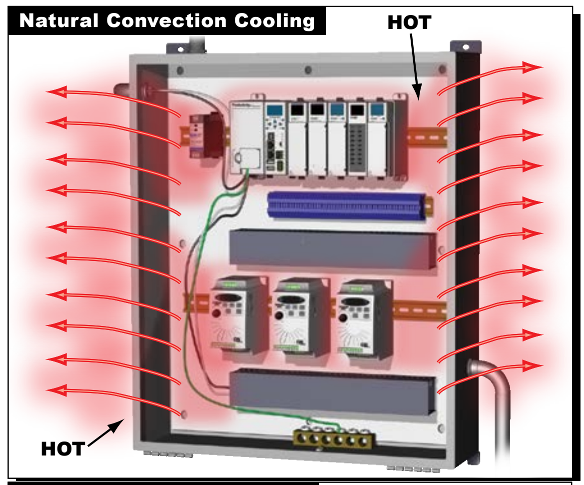
How do you get the heat out of your enclosure and away from those critical components? There are several basic cooling methods available, depending on the cooling requirements and the enclosure environment.

Radiation and Natural Convection Cooling

If the ambient temperature outside the enclosure is cooler than the inside of the enclosure, some heat will be radiated into the atmosphere from the surface of the enclosure. In environments where dust and water intrusion is not a concern, louvers can be added to allow outside air to flow through the enclosure via natural convection - the movement of air due to it's expansion (reduced density) when it's heated and contraction (increased density) when it cools.

On a large scale, natural convection can be a powerful force - it's one of the primary drivers of our weather. But on the scale of an electrical enclosure, its cooling capacity is very limited. For larger heat loads, a more powerful cooling system may be needed.

Since they create openings in the enclosure, louvers are typically limited to NEMA 1 and/or NEMA 3R applications. However, some louvers have optional filters that can be added to maintain NEMA 12 protection.

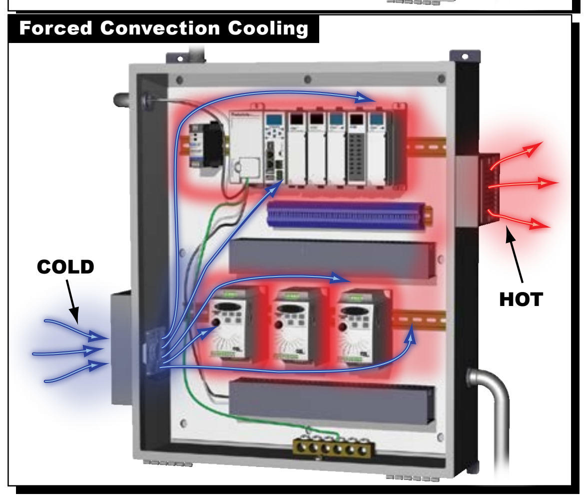


Forced Convection Cooling

The next step up from natural convection is forced convection cooling. The basic cooling mechanism is the same: cooler air from outside the enclosure passes through the enclosure to remove the heat. The difference is that the air is mechanically forced through the enclosure by a filter fan. The fan produces higher air flow rates than natural convection, which in turn increases the amount of heat removed.

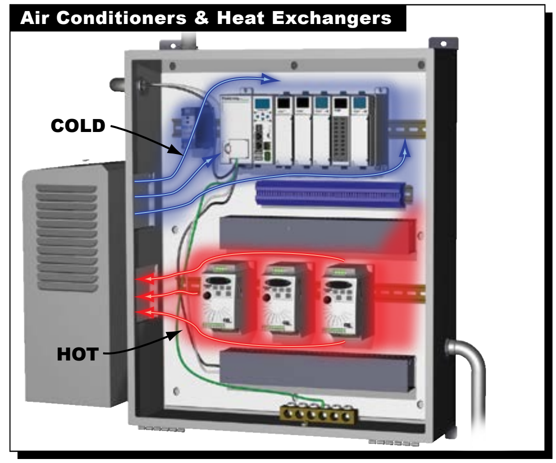
As with natural convection cooling, the ambient air temperature must be lower than the desired enclosure temperature for forced convection to be effective.

A typical forced convection system consists of a fan and a grille, with a filter on the intake device and either a filter or louvers on the exhaust device. The filters and louvers allow the enclosure to maintain NEMA 12 protection. In NEMA 4 or NEMA 4X environments, hoods can be added to both the fan and the grille to prevent the ingress of water.



Enclosure Cooling

Closed Loop Cooling



Air Conditioners & Heat Exchangers

If the environment is harsh, with heavy dust and debris or the presence of airborne chemicals, or there are wash-down requirements, the cooling system must be able to keep the ambient air separate from the air inside the enclosure.

Closed loop systems, which include heat exchangers and air conditioners, circulate the internal air and ambient air through separate chambers connected by a refrigeration system that transfers heat from the internal air stream to the external air stream. Heat exchangers and air conditioners are both closed loop cooling systems. The primary difference in the two is the refrigeration system.

The refrigeration system in an air-to-air heat exchanger is a set of sealed tubes of alcohol. Heat absorbed from the internal enclosure air boils the liquid alcohol at the bottom of the tube, causing it to rise to the top. The heat is then rejected to the cooler ambient air stream, causing the alcohol to condense back to a liquid and fall to the bottom.

Heat exchangers are very efficient because the refrigeration system has no moving parts - the only moving parts are the fans. But for the heat to transfer through the system, the ambient air must be colder than the air inside the enclosure, just as it must be for filter fans.

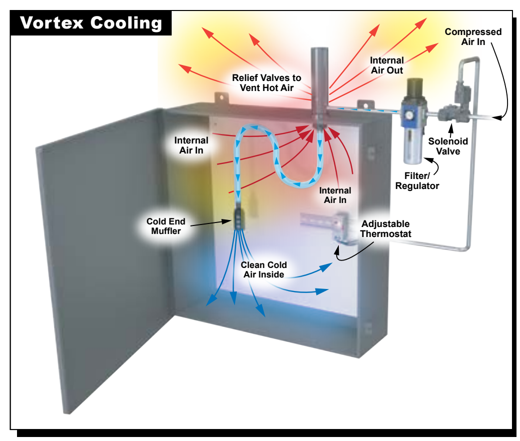
If the ambient air temperature is too high, and a source of chilled water is available, then an air-to-water heat exchanger may be the ideal solution. Air-to-water heat exchangers use fans to blow across tubes with chilled water running through them. This creates a very effective closed loop cooling effect, but requires an external source of chilled water.

Enclosure air conditioners function in the same manner as a residential or automotive air conditioner, with refrigeration loop powered by a compressor. The refrigerant absorbs heat from the internal air at the evaporator coil and rejects it to the ambient air at the condenser coil. Unlike heat exchangers, they can provide cooling even if the ambient temperature is higher than the enclosure temperature. They can also be scaled to handle larger heat loads than any other cooling system.

Enclosure air conditioners are available for NEMA 12, NEMA 4 and NEMA 4X applications.

Vortex Coolers

Vortex coolers create a stream of extremely cold air from a supply of filtered compressed air. The cold air is injected into the enclosure, displacing warm air which is exhausted back through the vortex cooler. While not a closed-loop system, they can be used in the same harsh environments since the cold air injected into the enclosure is filtered air from a compressed air system, not ambient air. Vortex coolers can also be used where the ambient temperature is higher than the enclosure temperature.



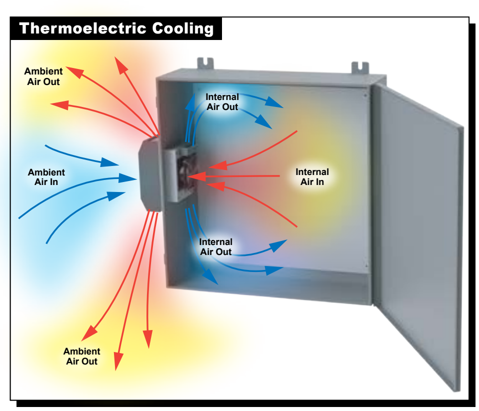
Vortex Cooling

Since vortex coolers prevent the ingress of ambient air or sprayed water and are made from corrosion-resistant materials, they can be used on NEMA 4X enclosures in harsh, wash-down, and/or corrosive environments.

Vortex coolers are commonly used in lieu of a small or medium enclosure air conditioner in applications where there isn't adequate space to mount an air conditioner, provided there is an adequate supply of compressed air.

Thermoelectric Coolers

Another alternative to a conventional air conditioner is a thermoelectric cooler, which is sometimes referred to as a Peltier cooler. They function in a manner similar to an air conditioner or heat exchanger, with fans inside and outside the enclosure, but with a thermoelectric unit replacing the fluid-based refrigeration system.



Thermoelectric Cooling

The thermoelectric units consist of an array of semiconductors sandwiched between two ceramic plates. When a DC current is applied to the semiconductor array, heat is driven from one plate to the other, creating a cold side and a warm side. This is known as the Peltier Effect. Fans circulate air across each of the plates, allowing the cold plate to absorb heat from the enclosure and the warm plate to reject it to the ambient air.

Like vortex coolers, thermoelectric coolers can be used with NEMA 4X enclosures in harsh, wash-down, and corrosive environments, and where the ambient temperature exceeds the enclosure temperature.

Thermoelectric coolers are an alternative to air conditioners in small cooling capacity applications where there isn't adequate space for an air conditioner.

Selecting an Enclosure Cooling Device

Cooling Basics

To select the proper cooling device for your enclosure, you need to determine how much heat the device must remove from the enclosure to maintain the desired internal temperature, which is the sum of two component heat loads: **Internal Heat Load** and **Heat Transfer Load**.

Internal Heat Load (Q_i)

The sum of all heat generated by the components within the enclosure. This can be calculated by adding the maximum heat output for each device installed in the enclosure (the worst-case conditions for the enclosure). The maximum heat output is typically specified in watts in the manufacturer's documentation. If it is not, contact the manufacturer to request the heat output or for guidance on how to measure or calculate it.

Heat Transfer Load (Q_x)

The heat gained (positive heat transfer) or lost (negative heat transfer) through the enclosure exterior surface with the surrounding ambient air. This can be calculated with the following formula:

$Q_x = k A \Delta T$ ***(BTU/h),*** where:

k = heat transfer coefficient (BTU/(h·ft²·°F))

The heat transfer coefficient is a measure of how easily an enclosure conducts heat from the internal air to the external air, which varies with the enclosure material. Suggested values for various enclosure materials are provided below:

Enclosure Material	*k, BTU/(h·ft²·°F)*
Painted carbon steel	0.97
Stainless steel	0.83
Aluminum	2.1
Polycarbonate, fiberglass, PVC, ABS	0.62

A = exposed enclosure surface area (ft²)

The total surface area of a rectangular enclosure is:

$A = 2HW + 2HD + 2WD$, ***where:***

H = height

W = width

D = depth

But it's important to properly account for any surfaces that are against walls or floors, as those surfaces will absorb/reject heat from adjacent surfaces at a different rate (that is, have a different k value) than the exposed surfaces. Quantifying that difference is far beyond the scope of this document, but the q value for those surfaces will usually be less than the value for exposed surfaces. Therefore, the conservative design approach should be to ***exclude those surfaces when ΔT < 0 and use the total surface area when ΔT > 0.***

The equations for excluding those surfaces in several common situations are listed below.

Wall-mount (excludes back of the enclosure)	$A = HW + 2HD + 2WD$
Freestanding enclosure (excludes the bottom of the enclosure)	$A = 2HW + 2HD + WD$
Freestanding enclosure against a wall (excludes both the bottom and back)	$A = HW + 2HD + WD$
Freestanding enclosure in a corner (excludes the bottom, back, and one side)	$A = HW + HD + WD$

Using these formulas as written will produce answers in either in^2 or mm^2, depending on the enclosure. To convert to ft^2 use the appropriate conversion:

$1\ ft^2 = 144\ in^2$

$1\ ft^2 = 92{,}900\ mm^2$

Selecting an Enclosure Cooling Device

$\Delta T = T_A - T_E$, where T_A is maximum ambient air temperature (°F) and T_E is maximum allowable enclosure air temperature (°F)

Note that ΔT may be negative if the ambient temperature is less than the enclosure temperature. When this is the case, the heat transfer load will also be negative, meaning that the ambient air is providing some degree of cooling. Whereas a positive ΔT indicates that the ambient air is warming the enclosure.

A positive ΔT also indicates that neither a fan nor a heat exchanger is a viable cooling device for this application. Both devices exchange heat between the interior and exterior of the enclosure. Since heat will always move from the higher temperature material to the lower temperature, these devices will add heat to the enclosure which will raise the internal air temperature, not lower it.

The maximum allowable enclosure air temperature will typically be dictated by the maximum operating temperature of the components inside the enclosure. Be sure to choose the component value with the lowest maximum operating temperature.

Required Cooling Capacity (Q_r)

The required cooling capacity (Q_r) for an enclosure is simply the sum of the Internal Heat Load and the Heat Transfer Load. However, as presented these values cannot be simply added since one is typically given in watts and the other in BTU/h. Additionally, fan and heat exchanger sizing formulas require the total heat load in watts, while the cooling capacities of vortex coolers are generally expressed in BTU/h. However, the cooling capacities of air conditioners and thermoelectric coolers may be expressed in either unit, or sometimes both. Apply one of the following conversions to the heat loads to add them:

1 W = 3.41 BTU/h $\quad Q_r \text{ (BTU/h)} = Q_i \times 3.41 \text{ (BTU/h)/W} + Q_x$

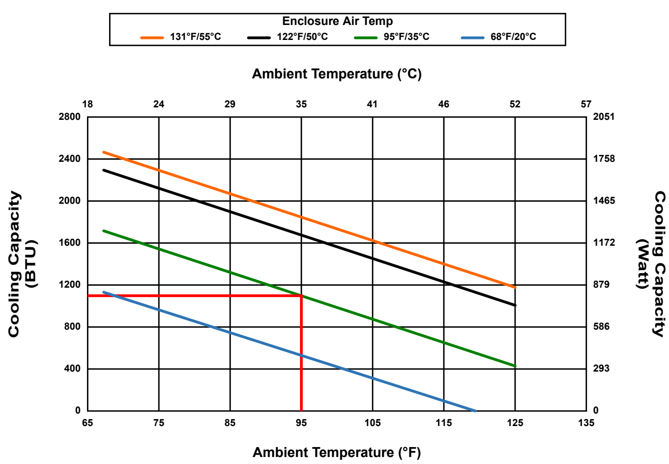
1 BTU/h = 0.293 W $\quad Q_r \text{ (W)} = Q_i + Q_x \times 0.293 \text{ W/(BTU/h)}$

Vortex Cooler Selection

Once the required cooling capacity has been calculated, selection of a vortex cooler is simple – just select a cooler with a nominal cooling capacity greater than the calculated requirement.

Air Conditioner, Air-to-Water Heat Exchanger, and Thermoelectric Cooler Selection

Selecting an air conditioner, air-to-water heat exchanger, or thermoelectric cooler is more complex because their performance depends on both the ambient temperature and the enclosure temperature or the chilled water temperature. Generally, more strenuous operating parameters (higher ambient temperature, lower enclosure air temperature) will reduce the unit's performance. For this reason, manufacturers publish curves that graphically describe the unit's cooling capacity over a range of conditions. Here's an example:



As indicated by the red lines, this air conditioner would be able to remove 1000 BTU/H when the ambient temperature is 95°F and enclosure air temperature is 95°F. If the ambient temperature was only 75°F, the cooling capacity of the unit would increase to approximately 1105 BTU/H as the lower ambient temperature increases the unit's condenser's ability to reject heat to the surrounding atmosphere. Conversely, at a 95°F ambient temperature and a 68°F enclosure air temperature, the unit's capacity would be reduced to approximately 945 BTU/H, as the lower enclosure air temperature would reduce the heat transfer rate between the internal enclosure air and the unit's evaporator coils.

An air-to-water heat exchanger performance curve is similar only the x-axis is the temperature of the chilled water provided to the heat exchanger instead of the ambient air temperature.

To determine if an air conditioner, air-to-water heat exchanger, or thermoelectric cooler meets application requirements, simply plot the two maximum temperatures used in the ΔT calculations and read the corresponding cooling capacity on the y-axis of the chart. If that value exceeds the required cooling capacity, the air conditioner will be adequate for the application. If not, select a larger capacity unit.

Selecting an Enclosure Cooling Device

The 95°F/95°F point is typically used as the nominal cooling capacity of the unit. But always keep in mind that any nominal capacity only represents one set of operating parameters. If those parameters to not match the actual application conditions, the actual performance of the air conditioner/thermoelectric cooler will be different.

Never rely solely on a nominal cooling capacity when selecting an air conditioner or a thermoelectric cooler! The nominal capacity is solely intended to provide an approximation to get the user “in the ballpark” of the selection process.

In addition to the required cooling capacity, an air conditioner, air-to-water heat exchanger, or thermoelectric cooler should also maintain the NEMA rating of the enclosure. Ideally, it should also operate on a voltage already available within the enclosure to avoid necessitating a transformer or power supply.

Air Conditioner Selection Example

A NEMA 12 Wiegmann N12302412 wall-mount enclosure (30 in high x 24 in wide x 12 in deep) contains a GS4-4060 AC drive (60 HP 460V) that has a maximum allowable operating temperature of 104°F and is inside a plant with a maximum ambient air temperature of 115°F. The GS4-4060 specifications table indicates its maximum Watt Loss to be 1147 W.

Internal heat load:

$$Q_i = 1147\ W \times 3.413\ (BTU/h)/W = 3914\ BTU/h$$

Heat load transfer:

$$k = 0.97\ BTU/(h{\cdot}ft^2{\cdot}°F)$$

$$\Delta T = 115°F - 104°F = 11°F$$ (Reminder: ΔT >0 means that fans or heat exchangers will not cool the enclosure!)

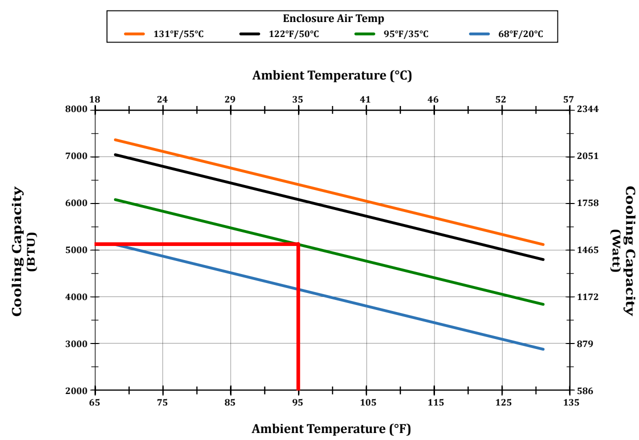
$$A = [2(30\ in \times 24\ in) + 2(30\ in \times 12\ in) + 2(24\ in \times 12\ in)]/144\ in^2/ft^2 = 19\ ft^2$$

$$Q_x = kA\Delta T = (0.97\ BTU/(h{\cdot}ft^2{\cdot}°F))(19\ ft^2)(11°F) = 202\ BTU/h$$

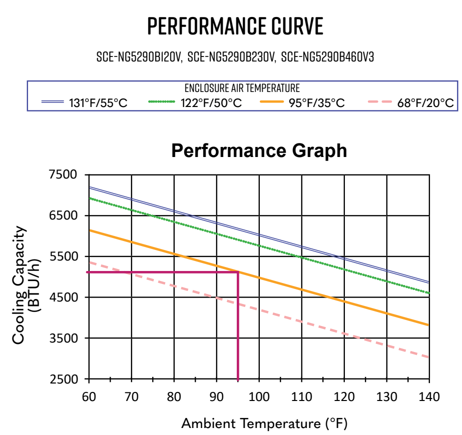
Required cooling capacity:

$$Q_r = Q_i + Q_x = 3914\ BTU/h + 202\ BTU/h = 4116\ BTU/h$$

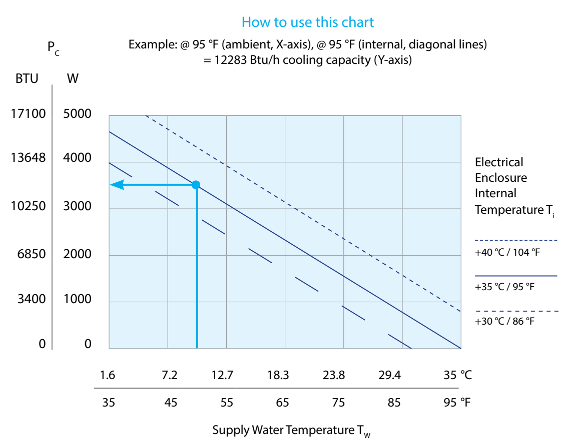
AutomationDirect offers several NEMA 12 460VAC models that meet or exceed 4605 BTU/h at 104°F. The curves for the appropriate sizes of some of these series are shown below.



The NEMA 12 460VAC selection from this series is SCE-AC5100B460V.



The NEMA 12 460VAC selection from this series is SCE-NG5290B460V3.



The NEMA 12 115VAC air-to-water heat exchanger 12358410045 will work as long as chilled water at least 65°F is readily available

Selecting an Enclosure Cooling Device

Air-to-Air Heat Exchanger Selection

Air-to-Air Heat exchanger capacities also depend on the internal enclosure air temperature and the ambient temperature, but the dependency is a simple linear relationship between the capacity and ΔT. So rather than graphing the cooling capacity of the heat exchanger, it is simply expressed in terms of W/°C and compared to the value of $-Q_r/\Delta T$.

To convert ΔT from °F to °C, use the conversion 1°C = 1.8°F.

> Note that this simplified conversion only works for temperature differences. It does not work for measured temperatures since 0°F ≠ 0°C. DO NOT apply this conversion directly to the ambient and enclosure air temperatures. Only apply it to ΔT.

Air-to-Air Heat Exchanger Selection Example

A NEMA 12 Wiegmann N12302412 wall-mount enclosure (30 in high x 24 in wide x 12 in deep) contains a GS4-4010 AC drive (10 HP 460 volt) that has a maximum allowable operating temperature of 104°F and is in a plant that has a maximum ambient air temperature of 90°F.

The GS4-4010 specifications table indicates its maximum Watt Loss to be 292 watts.

Internal heat load:

$Q_i = 292\ W$

Heat load transfer:

$k = 0.97\ BTU/(h \cdot ft2 \cdot °F)$

$\Delta T = 90°F - 104°F = -14°F$ (Since ΔT <0, a heat exchanger is a potentially valid cooling device)

$\Delta T = -14°F/(1.8°F/°C) = -7.8°C$

$A = [(30\ in \times 24\ in) + 2(30\ in \times 12\ in) + 2(24\ in \times 12\ in)]/144\ in^2/ft^2 = 14\ ft^2$

$Q_x = kA\Delta T = (0.97\ BTU/(h \cdot ft^2 \cdot °F))(14\ ft^2)(-14°F) = -190\ BTU/h \times 0.293\ W/(BTU/h) = -56\ W$

Required cooling capacity:

$Q_r = Q_i + Q_x = 292\ W - 56\ W = 236\ W$

$-Q_r/\Delta T = -236\ W/-7.8°C = 30\ W/°C$

A Stratus heat exchanger with a capacity of at least 30 W/°C is needed, such as a TE30-030-17-04.

Selecting an Enclosure Cooling Device

Fan Selection

A fan cools the enclosure simply by displacing the hot air within the enclosure with cooler air from the outside. Combining the specific heat of air, the density of air, and various conversion factors into a single coefficient gives a simple equation for correlating a fan's required airflow rate to the enclosure's required cooling capacity:

$$F_r = -(3.17\ CFM\cdot°F/W)Q_r / \Delta T$$

Once the fan airflow requirement is determined, fan selection is simply a matter of finding a fan with an airflow greater than the required airflow. Most applications will require an accompanying grille and one or more filters which will restrict airflow to some degree. (Exceptions would be a NEMA 1 enclosure or a similar circumstance where an open vent can be used for exhaust/makeup air.) Therefore, the fan selection should almost always be made based on the "Airflow with Grille and Filters (CFM)" column of the specifications, not the fan's Free Airflow.

Fan Selection Example

A NEMA 12 Wiegmann N12302412 wall-mount enclosure (30 in high x 24 in wide x 12 in deep) contains a GS4-2025 AC drive (25 HP 230 volt) that has a maximum allowable operating temperature of 104°F and is in a plant that has a maximum ambient air temperature of 92°F.

The GS4-2025 specifications table indicates its maximum Watt Loss to be 733 watts.

Internal heat load:

$$Q_i = 733\ W$$

Heat load transfer:

$$k = 0.97\ BTU/(h\cdot ft^2\cdot°F)$$

$$\Delta T = 92°F - 104°F = -12°F \text{ (Since } \Delta T < 0\text{, a fan is a potentially valid cooling device)}$$

$$A = [(30\ in \times 24\ in) + 2(30\ in \times 12\ in) + 2(24\ in \times 12\ in)]/144\ in^2/ft^2 = 14\ ft^2$$

$$Q_x = kA\Delta T = (0.97\ BTU/(h\cdot ft^2\cdot°F))(12\ ft^2)(-12°F) = -163\ BTU/h \times 0.293\ W/(BTU/h) = -48\ W$$

Required cooling capacity:

$$Q_r = Q_i + Q_x = 733\ W - 48\ W = 685\ W$$

Required air flow:

$$F_r = -(3.17\ CFM\cdot°F/W)(685\ W)/-12°F = 181\ CFM$$

Possible 230VAC fan & grille combinations include:

- Stego 018840-40 exhaust fan with 118840-30 grille (187 CFM)
- Fandis FF20A230UE1 intake fan with FF20U grille (209 CFM)
- Stego 018740-30 intake fan with 118740-00 grille (220 CFM)
- Stego 018840-00 exhaust fan with 118840-30 grille (243 CFM)
- Fandis TP19U230B1 roof-mount exhaust fan with FF20U grille (297 CFM)

Vortex Coolers

Applications

Compressed air cooling is used where conventional enclosure cooling byair conditioners or heat exchangers is not possible. (Examples: Small to medium size enclosures, nonmetallic enclosures, and areas where the size of cooling devices is restricted)

Mounting holes

- Mounts in a 0.25in [6 mm] electrical conduit knockout

Agency Approvals

- UL Recognized component [File E329932]UL/ NEMA 4, 4X

c UL US

Features

- Relief valves and seals built into the vortex coolers which enable the units to maintain the sealed nature of NEMA enclosures
- No freon
- Small physical size
- Creates cool air without refrigerants (no CFCs, HCFCs)
- Exceptionally reliable - no moving parts and virtually no maintenance
- No fans
- Stainless steel construction
- All replacement generators fit any of the vortex coolers. No need to purchase a new cooler if you need to change your cooling capacity
- 5-year warranty

Requirements

- Uses clean, dry, oil-free compressed air (80 to 100 PSIG / 70° F or below) required to achieve published BTU/H ratings. Lower pressures and/or higher temperatures will reduce BTU/H rating
- A 5-micron water and particulate removal filter must be installed prior to any vortex cooler operation
- An oil removal filter can be installed between the 5-micron filter and the Vortex Cooler if oil is present in the compressed air line
- Thermostats, filters, regulators, and valves that work with Stratus Vortex Coolers are sold separately. Kits that include these items are listed later in this section
- Operation above 100 PSIG is not recommended. The use of a pressure regulator will be necessary for higher pressures
- How vortex coolers create cold air

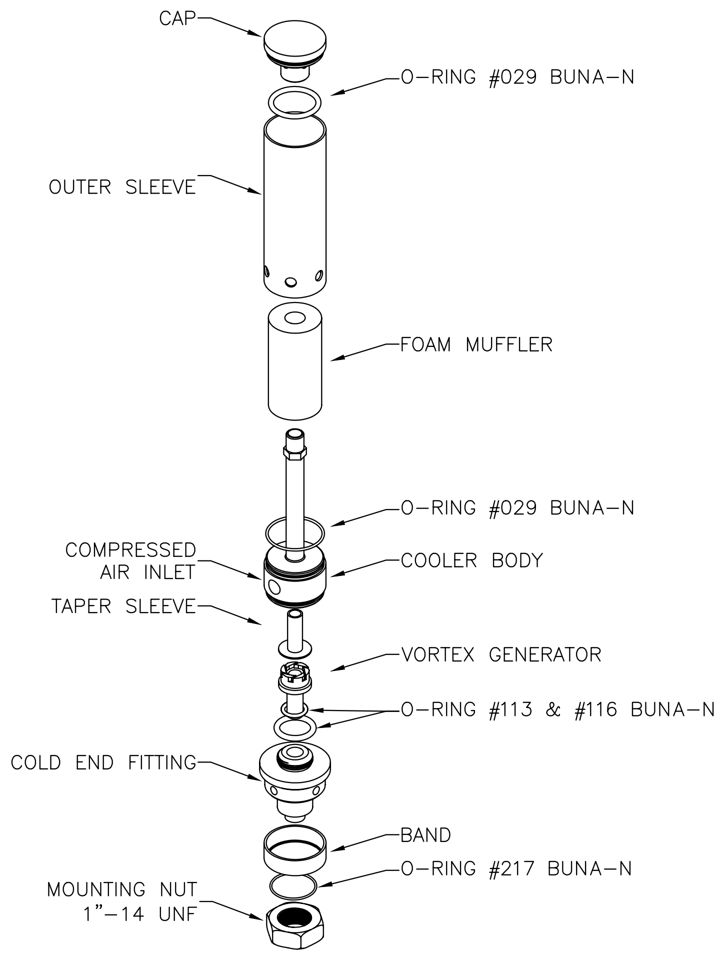
Compressed air is injected into the vortex tube at extremely high speeds and that creates a cyclone, or vortex, spinning a million revolutions per minute. Part of the air is forced to spin inward to the center and travels up a long tube where a valve turns the spinning column of air inside itself. The inside column of air gives up its heat to the outside column. The cold air is directed out the cold end of the Vortex Tube and the hot air is directed out the other end of the Vortex Tube. And since there are no moving parts there is little need for maintenance.

Part Type	Part Number	Price	Description	Capacity BTUH [W]	Air Consumption SCFM [SLPM]
Vortex Coolers	TV08-005-4X	$362.00	Stratus vortex cooler, stainless steel body. For NEMA 4/4X/12 enclosures. Distribution tube and muffler included.	500 [147]	8 [227]
	TV10-006-4X	$362.00	Stratus vortex cooler, stainless steel body. For NEMA 4/4X/12 enclosures. Distribution tube and muffler included.	600 [176]	10 [283]
	TV15-010-4X	$362.00	Stratus vortex cooler, stainless steel body. For NEMA 4/4X/12 enclosures. Distribution tube and muffler included.	1000 [293]	15 [425]
	TV25-018-4X	$362.00	Stratus vortex cooler, stainless steel body. For NEMA 4/4X/12 enclosures. Distribution tube and muffler included.	1800 [528]	25 [708]
	TV35-025-4X	$362.00	Stratus vortex cooler, stainless steel body. For NEMA 4/4X/12 enclosures. Distribution tube and muffler included.	2500 [732]	35 [991]
Replacement Generators	TV08-G	$11.25	Stratus vortex generator, replacement, polypropylene, white. Fits all Stratus TV series vortex cooler bodies.	500 [147]	8 [227]
	TV10-G	$11.25	Stratus vortex generator, replacement, polypropylene, orange. Fits all Stratus TV series vortex cooler bodies.	600 [176]	10 [283]
	TV15-G	$11.25	Stratus vortex generator, replacement, polypropylene, red. Fits all Stratus TV series vortex cooler bodies.	1000 [293]	15 [425]
	TV25-G	$11.25	Stratus vortex generator, replacement, polypropylene, blue. Fits all Stratus TV series vortex cooler bodies.	1800 [528]	25 [708]
	TV35-G	$11.25	Stratus vortex generator, replacement, polypropylene, yellow. Fits all Stratus TV series vortex cooler bodies.	2500 [732]	35 [991]

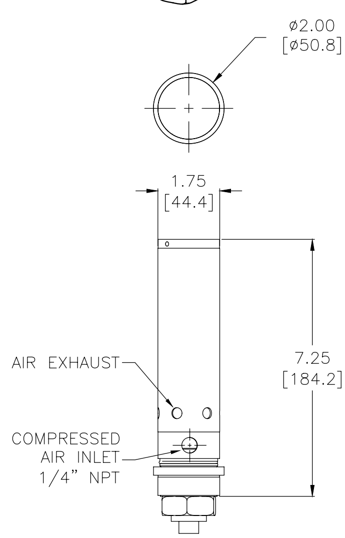
Vortex Coolers

Part Type	Part Number	Price	Description
Replacement Parts	TVACC-TS	$15.00	Stratus taper sleeve, replacement, brass. For use with all Stratus vortex coolers.
	TVACC-TUBE	$16.00	Stratus distribution tube, replacement, flexible PVC. For use with all Stratus vortex coolers.
	TVACC-MUFFLER	$13.75	Stratus muffler, replacement, polypropylene. For use with all Stratus vortex coolers.

Assembly



Dimensions



Vortex Cooler Kits

Features

- A complete kit for your vortex cooling applications
- Includes the vortex cooler, filter/regulator, 5-micron replacement filter element, solenoid valve and adjustable thermostat
- Adjustable thermostat has N.O. contacts, 32 to 140° F temperature range with a 7° F switching differential
- Kits are available in 500, 600, 1000, 1800, and 2500 BTUH capacities
- 120VAC and 24VDC kits available
- Important Installation Instructions
- Be sure to replace the 40-micron filter element in the filter/regulator with the 5-micron replacement filter

The 5-micron filter is required to separate harmful foreign matter from the air supply. This is required to maintain a clean supply of air to the cooler, allowing virtually maintenance-free operation.

When installing components, it is important to locate the solenoid valve upstream of the filter/regulator. This assures there are no unnecessary flow restrictions to the cooler and allows the semi-automatic drain feature of the filter/regulator to work properly.

All pneumatic components and the vortex cooler have 0.25 in [6 mm] FNPT air inlets/outlets. To be sure there is ample flow to the vortex cooler, all fittings and piping supplied to the components must be of the same size or larger. Smaller fittings, excessive turns (elbows, tees, etc), or use of plastic tubing fittings will reduce flow and affect the performance of the vortex cooler

Plastic tubing is not recommended as the fittings associated with tubing and tubing inside diameter can reduce airflow. Do not use "quick couplings" anywhere in the system as they create flow restrictions and your cooler will not perform correctly.

Size your supply airline to the solenoid valve correctly. Up to 10 ft [3 m] long runs will require a pipe size of at least 0.25 in [6 mm] (3/8 in [10 mm] for hoses). 10 ft [3 m] to 50 ft [15.24m] long runs will require a pipe size of 3/8 in [10 mm] (0.5in [13 mm] for hoses). 50 ft [15.24m] to 100 ft [30.5m] long runs will require a pipe size of 0.5in [13 mm] (5/8in [16 mm] for hoses).

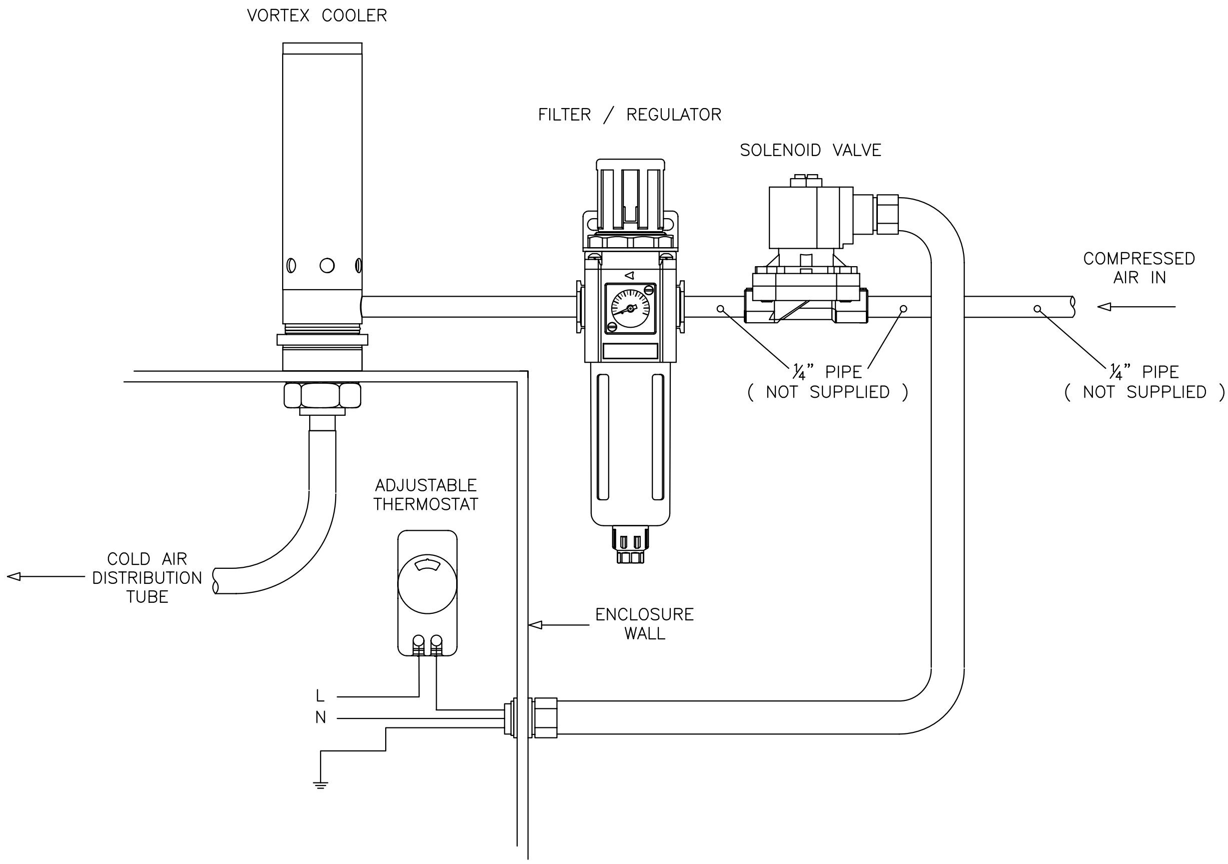
- Maximum supply air pressure on this combination of components is 145psi

Vortex Cooler Kits

Kit Number	Price	Voltage	Capacity BTUH [W]	Air Consumption SCFM [SLPM]	Vortex Cooler Number	Solenoid Valve	Thermostat	Filter/ Regulator	5-micron Filter
TVK08-005-4X-120A	$470.00	120 VAC	500 [147]	8 [227]	TV08-005-4X	DVD-2BC2A-120A	011169-00	AFR2-3233	AFE2-31
TVK10-006-4X-120A	$470.00	120 VAC	600 [176]	10 [283]					
TVK15-010-4X-120A	$470.00	120 VAC	1000 [293]	15 [425]					
TVK25-018-4X-120A	$470.00	120 VAC	1800 [528]	25 [708]					
TVK35-025-4X-120A	$470.00	120 VAC	2500 [732]	35 [991]					
TVK08-005-4X-24D	$470.00	24 VDC	500 [147]	8 [227]					
TVK10-006-4X-24D	$470.00	24 VDC	600 [176]	10 [283]					
TVK15-010-4X-24D	$470.00	24 VDC	1000 [293]	15 [425]					
TVK25-018-4X-24D	$470.00	24 VDC	1800 [528]	25 [708]					
TVK35-025-4X-24D	$470.00	24 VDC	2500 [732]	35 [991]					
Component Warranties					5-Year	1-Year	1-Year	2-Year	2-Year

Vortex Cooler Kits

Vortex Cooler Kit Installation Example



Thermostats, Filters and Valves for Stratus Vortex Coolers

Thermostats, Filters, and Valves for Stratus Vortex Coolers		
Thermostats (See Small Thermostats for Enclosure Heaters, DIN Rail Mounted later in this section)	***Part Number***	***Description***
	011169-00	Stego thermostat, adjustable, N.O. (close on rise) 32 to 140 deg F, 7 deg F switching differential, 35mm DIN rail mount, for electrical climate control.
	011160-00	Stego thermostat, adjustable, N.O. (close on rise) 0 to 60 deg C, 4K switching differential, 35mm DIN rail mount, for electrical climate control.
Filters ** (See Pneumatics)	***Part Number***	***Description***
	AF2-223-N	NITRA pneumatic filter, particulate and moisture separation, 1/4in female NPT inlet(s), 1/4in female NPT outlet(s), manual/semi-automatic drain, nylon bowl, metal bowl guard. For use with Ax-22 series air prep components.
	AF2-223	NITRA pneumatic filter, particulate and moisture separation, 1/4in female NPT inlet(s), 1/4in female NPT outlet(s), manual/semi-automatic drain, polycarbonate bowl, metal bowl guard. For use with Ax-22 series air prep components.
	AF2-223-D	NITRA pneumatic filter, particulate and moisture separation, 1/4in female NPT inlet(s), 1/4in female NPT outlet(s), manual/semi-automatic drain, die-cast aluminum bowl, sight gauge. For use with Ax-22 series air prep components.
	AFE2-21**	NITRA particulate filter element, replacement, 5 micron particles, high-density polyethylene (HDPE). For use with AF-2 series filters or AFR-2 series filter regulators.
	AF2-323-N	NITRA pneumatic filter, particulate and moisture separation, 1/4in female NPT inlet(s), 1/4in female NPT outlet(s), manual/semi-automatic drain, nylon bowl, metal bowl guard. For use with Ax-32 series air prep components.
	AF2-323	NITRA pneumatic filter, particulate and moisture separation, 1/4in female NPT inlet(s), 1/4in female NPT outlet(s), manual/semi-automatic drain, polycarbonate bowl, metal bowl guard. For use with Ax-32 series air prep components.
	AF2-323-A	NITRA pneumatic filter, particulate and moisture separation, 1/4in female NPT inlet(s), 1/4in female NPT outlet(s), automatic drain, polycarbonate bowl, metal bowl guard. For use with Ax-32 series air prep components.
	AF2-323-D	NITRA pneumatic filter, particulate and moisture separation, 1/4in female NPT inlet(s), 1/4in female NPT outlet(s), manual/semi-automatic drain, die-cast aluminum bowl, sight gauge. For use with Ax-32 series air prep components.
	AF2-323-AD	NITRA pneumatic filter, particulate and moisture separation, 1/4in female NPT inlet(s), 1/4in female NPT outlet(s), automatic drain, die-cast aluminum bowl, sight gauge. For use with Ax-32 series air prep components.
	AFE2-31**	NITRA particulate filter element, replacement, 5 micron particles, high-density polyethylene (HDPE). For use with AF-3 series filters or AFR-3 series filter regulators.
Valves (See Pneumatics)	***Part Number***	***Description***
	DVD-2AC2A-24D	NITRA solenoid valve, 2-way, 2-position, N.C., brass body, 1/4in female NPT inlet(s), 1/4in female NPT outlet(s), Cv=1.55, 24 VDC operating voltage, 18mm DIN style wiring plug.
	DVD-2AC2A-120A	NITRA solenoid valve, 2-way, 2-position, N.C., brass body, 1/4in female NPT inlet(s), 1/4in female NPT outlet(s), Cv=1.55, 120 VAC operating voltage, 18mm DIN style wiring plug.
	DVD-2BC2A-24A	NITRA solenoid valve, 2-way, 2-position, N.C., glass-filled nylon body, 1/4in female NPT inlet(s), 1/4in female NPT outlet(s), Cv=1.55, 24 VAC operating voltage, 11mm DIN style wiring plug.
	DVD-2BC2A-120A	NITRA solenoid valve, 2-way, 2-position, N.C., glass-filled nylon body, 1/4in female NPT inlet(s), 1/4in female NPT outlet(s), Cv=1.55, 120 VAC operating voltage, 11mm DIN style wiring plug.
Note: ** When purchasing filters for your Stratus Vortex Cooler, a 5-micron replacement filter element will need to be purchased in addition to the AF2-2xx or AF2-3xx filter.		

Industrial strength cooling options for your enclosure from AutomationDirect

Heat Exchangers

- For NEMA 4 and 4X enclosures
- Closed loop cooling
- Energy efficient: uses approximately the same power as a filtered fan system
- 120VAC and 24VDC models available
- UL
- Made in the USA

Made in the USA

Air Conditioning Units

- For NEMA 12, 4, 4X type enclosures
- Digital temperature controller
- Active condensate evaporation system
- High unit efficiency
- Tough industrial construction
- Compressor protection system

Made in the USA

Enclosure Vortex Coolers

- For NEMA 12, 4, 4X type enclosures
- Operates on compressed air
- Stainless steel construction
- No moving parts, no maintenance required
- Vortex coolers can be "resized" for changing applications by simply replacing the generator inside the cooler. No need to purchase a new unit
- Replacing the vortex generator takes minutes

Made in the USA

Seifert Thermoelectric Cooling Units

- For NEMA 4, 4X, and 12 enclosures
- Stainless steel housing
- 170, 340, 510, 680 BTU/H cooling capacity
- Recessed mounting
- No maintenance required
- 24VDC and 120VAC power options