Reliable Protection of Electronics in Ordinary or Hazardous Locations

There is no dispute that power densities have increased as electrical and electronic enclosure volumes have gotten smaller. Packing components more densely reduces the circuit size and increases speed but leaves little room for heat dissipation. Because many industries, including manufacturing, food, chemical, water and wastewater processing, oil refining and petrochemical processing and others, have become more dependent on sophisticated microprocessors, PLCs and VFDs, the need for proper heat dissipation has become crucial to keep controls protected. Tightly packed enclosures and panels restrict airflow, resulting in rapidly rising internal temperatures, thermal runaway and increasing control failures.

Thermal testing has proven that natural convection cooling is not adequate for today's smaller, high power density enclosures. Heat dissipation by forced convection (fan cooling) is the most frequently used method of cooling. Forced air cooling systems can provide heat transfer rates that are ten times greater than those achievable with natural convection and radiation, but even those rates are not adequate to cool electronic components in many plant environments, where ambient temperatures can often exceed 90°F (32°C).

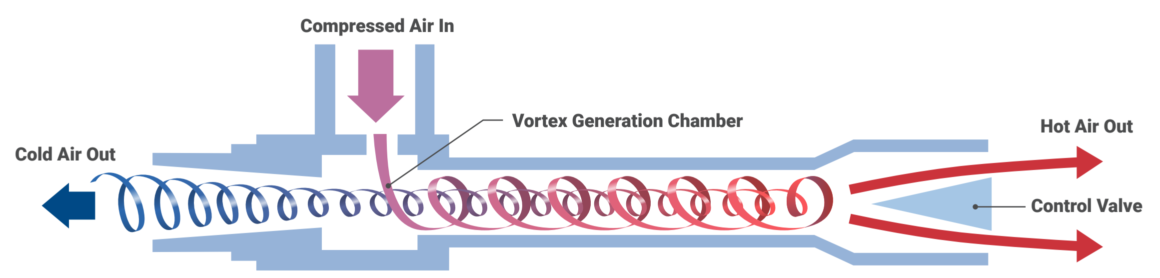
To reduce enclosure temperatures and prevent failure of high-density controls, the internal enclosure temperature must be lowered to below the room temperature. Research by control system manufacturers has shown that for each 18F° (10C°) increase in temperature, online production shutdowns occur twice as often, increasing the failure rate of electronics by 40 percent. Most manufacturers of electronic components specify maximum operating conditions of 104°F (40°C) and 90 percent humidity for proper operation.

Alternatives to conventional cooling methods

The never-ending drive to reduce the cost and size of electronics while increasing speed and complexity has created a significant design dilemma. For enclosures located in ordinary locations (NEMA 12, 4 and 4X environments, for example), forced-air fan cooling and refrigerant based air conditioning is usually selected by designers because fans are relatively inexpensive and easy to install. Unfortunately, the factory air pulled into the enclosure by fans often contains just enough nearly invisible oil aerosols or other contaminants to coat the surfaces of sensitive, expensive electronic boards in control enclosures. Drawbacks of refrigerant based air conditioning include limits on maximum ambient temperature, large physical size, maintenance and high initial cost. For enclosures located in hazardous locations, cooling solutions are limited to just a few types of technologies. While refrigerant based models can be built for HazLoc environments, they are very expensive and costly to maintain. Vortex cooling offers safe and reliable alternatives to the problems with these conventional cooling methods.

Vortex Cooling

A vortex enclosure cooler uses a vortex tube to convert a filtered compressed air supply into refrigerated air without the use of refrigerants or direct electricity. The vortex tube creates cold and hot air by forcing compressed air through a generation chamber that spins the air centrifugally along the inner walls of the tube at a high rate of speed (1,000,000 rpm) toward a control valve. A small percentage of the hot, high speed air is permitted to exit at the control valve. The remainder of the (now slower) airstream is forced to counter-flow through the center of the high-speed airstream, giving up heat as it travels through the center of the generation chamber before it finally exits through the opposite end as cold air. There are no moving parts in a vortex tube, so the systems are reliable, inherently safe and have low maintenance requirements.



Vortex Tube Technology

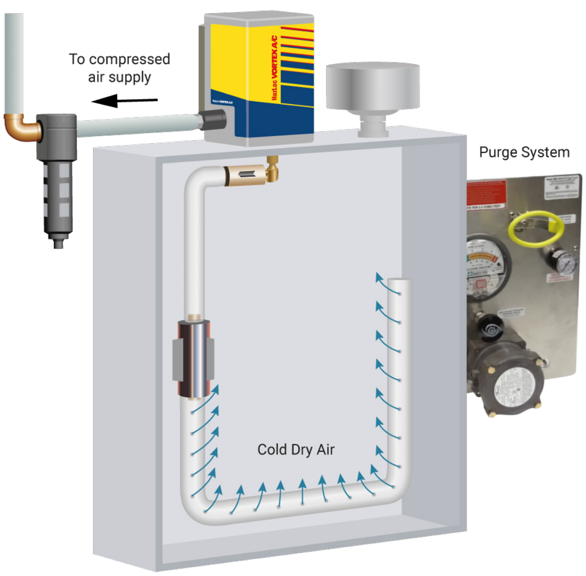
A vortex tube spins compressed air to produce hot and cold air streams, generating temperatures down to 100°F below inlet temperature

The cold air produced is discharged at low pressure and low velocity into the enclosure, while the hot air in the enclosure is vented outside the enclosure box through an integral relief valve. The relief valve, baffling and cooler to enclosure seal maintains the integrity of NEMA rated boxes in ordinary locations.

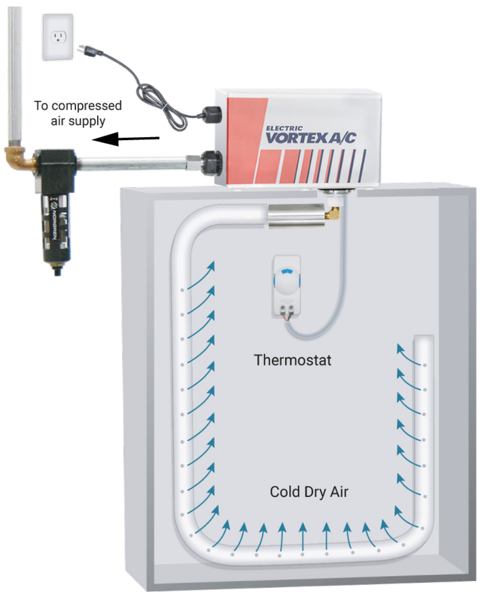
Vortex cooling is also an ideal solution for cooling enclosures located in hazardous locations because they are inherently safe when used in areas with temperature classifications of T4 or higher. There are no electrical requirements and no moving parts to generate electrical charges. The only potential ignition source is the hot surface at the hot exhaust. When supplied with compressed air that does not exceed 120°F (49°C), specially designed and certified vortex enclosure coolers are approved for Class I, II and III Division 2 (ATEX Zones 2 and 22) and Class 1, Div 1 (Groups A,B,C,D), Class 2, Div 1 (Groups F & G), Class III locations (ATEX Zones 1 & 21) and can be used with an approved purge system.

The cooled air that is introduced into the enclosure is filtered and dried to 5 microns before it enters the vortex cooler, creating a clean, cool and controlled environment inside the enclosure to keep electronics up and running. An added benefit is that the vortex cooler produces a slight positive pressure inside the enclosure to keep out dust and dirt. Hazardous location models rely on a purge system to maintain safe enclosure pressures when the vortex cooler is not operating. An integral check valve keeps the enclosure sealed when the unit is not cooling so the purge system maintains enclosure pressure.

Vortex coolers are available in cooling capacities up to 5000 btuh (1465 watts). All ordinary locations models are UL Listed and are controlled via an adjustable electric or mechanical thermostat. Recently introduced electric models are completely self-contained, are “plug and play” and can be top or side mounted and maintain the NEMA 4/4X rating of the enclosure. Hazardous locations models are UL Classified or ATEX approved and are regulated with a fixed mechanical thermostat that maintains enclosure temperatures between 75 to 100°F (24 to 38°C). The typical high pitch noise that most people associate with vortex tubes has been eliminated in all of the newer models using a variety of sound abatement techniques, reducing sound levels to as low as 62 dB.



HazLoc Vortex A/C Enclosure Cooler



Electric Vortex A/C Enclosure Cooler

Reliable Protection

Compact, multifunction electronic controls, VFDs, servos and PLCs are extremely sensitive to heat and contamination. Excessive heat causes components to “cook”, digital displays to misread, controls to drift, and breakers to trip below their rated loads. The result often is lost productivity from machines and production line shutdowns.

Vortex coolers offer a solution. By using an internal vortex tube to convert factory compressed air into a clean, dry, low pressure cold airstream that is distributed throughout the enclosure, these systems provide efficient, safe and reliable enclosure protection from heat and dirt related problems for electronics in ordinary and hazardous locations.

Common Questions About Vortex Coolers

1. **Are vortex coolers suitable for hazardous locations?**

   Yes, specially designed and certified Vortex Enclosure Coolers are approved for use in Hazardous Locations when used with an approved purge system.

Product Name	ProtEx	HazLoc	ATEX
Rating	ATEX Zones 1 & 21 Class I Div 1, Class II Div 1, Class III Groups A, B, C, D, F, G Temp Class T3	Class I Div 2, Class II Div 2, Class III Groups A, B, C, D, F, G Temp Class T4	Zones 2 & 22 Temp Class T4

2. **My Freon air conditioner is located near an oven and in the summer it "cuts out" when ambient temperatures get too high. Can I effectively use a vortex cooler here?**

   Yes, vortex coolers will operate trouble-free in extreme temperatures and in dirty inhospitable environments. When the compressed air supply is kept properly filtered and dried, a vortex cooler will lower the incoming compressed air supply to 40 to 50°F (22 to 28°C) or more. Be sure to avoid running the compressed air supply lines too close to the oven.

3. **I currently use a filter-fan to draw air into the enclosure, but it cannot keep the controls cool enough in the hotter summer months. Can I install a vortex cooler and operate it with the fan during those hot months?**

   No, not efficiently. The fan will continue to pull in warmer humid air. The humidity in the ambient air will condense on the much colder vortex cooler components, causing damaging water droplets to form. You must remove the fan and filter and seal the openings in the enclosure to prevent ambient air from entering the enclosure. The fan can be located inside the enclosure, if desired, to circulate the cold air.

4. **Is maintenance required?**

   Because vortex coolers have no moving parts, they are reliable and require little maintenance. It is only necessary to change elements in the compressed air filter at regularly scheduled intervals. If a dirty filter element reduces the pressure available at the vortex cooler, the air consumption and the cooling capacity will drop. Mechanical thermostat models (including NEMA 12, NEMA 4/4X, HazLoc, ATEX and ProtEx models) require 90 to 100 psig (6.2 to 6.9 bar) to operate properly, so it is critical to keep the compressed air filter clean.

5. **The components in my purged control panel are designed for ordinary locations and the panel is located in a Class I, Div. 2 hazardous location. However, the ambient temperature is greater than the design conditions and the controls are malfunctioning during the hot summer months. Can I use an "ordinary location" vortex cooler or is a hazardous location model necessary?**

   A hazardous locations model is required. Although the components are safe when enclosed in a purged and pressurized enclosure, the vortex cooler must be able to maintain the Class and Division rating of the panel. In addition, the size of the spark arrestor vent may need to be increased to accept the additional cool air flow from the vortex cooler so desired enclosure pressure is not exceeded.