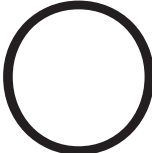


# THERMOELECTRIC COOLING : NEW CONSIDERATIONS

By EMILY HUTENSKY

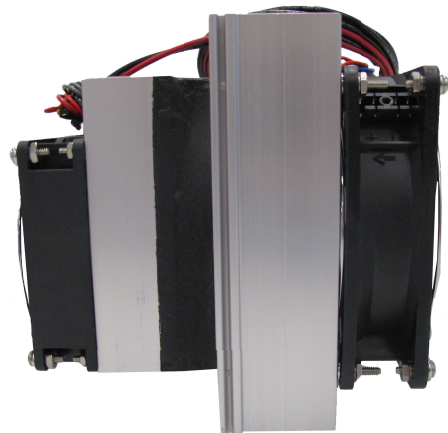
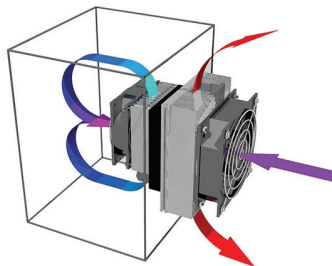
 OPENING AN ENCLOSURE and blowing a fan on heat sensitive components to avoid over-heating is never advisable. Exposing equipment to ambient dirt and debris can cause damage over time and it can increase the risk of shock to those working around the area. For these reasons, it is best to have an active cooling system in place as part of your enclosure. A few different cooling technologies are outlined below.

**Vapor-cycle** air conditioners certainly have their place but pose a maintenance challenge when placed in hard-to-access areas. Whether it is difficult installation, refrigerant leaks due to nearby vibrations, expensive compressor replacements or all of the above, end users can find refrigerant based cooling to be inconvenient and expensive to maintain in certain applications.

**Heat exchangers and heat pipes** are limited in performance due to ambient conditions. Certain applications will require more cooling than these technologies can provide. Note as well that compressed air products will require the expense of maintaining a compressed air supply.

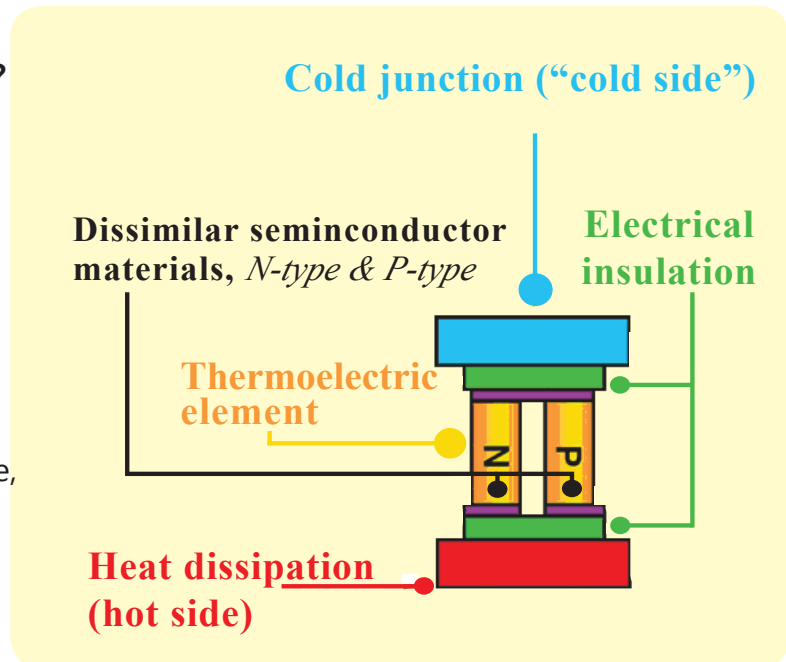
**Thermoelectric technology** is used in certain applications because it is extremely reliable, carries little to no maintenance costs and can perform well in high ambient temperatures and tough environments, including NEMA-4X. There are no refrigerants, compressors, or any moving parts (other than fans). Thermoelectric cooling can be the best choice for cooling control panels, especially in industrial environments. Control cabinets are crucial to prevent from overheating- the productivity of the plant is at stake.

*Thermoelectric air conditioners create a closed loop system.  
There is no exchange of ambient air into the enclosure.*



### How does thermoelectric cooling work?

Thermoelectric cooling is created via the Peltier effect, a solid-state method of heat transfer through dissimilar semiconductor materials. The main parts of a thermoelectric system are a cold junction ("cold side"), a heat sink ("hot side"), and a low voltage DC power source. Powered by the DC power source, extra electrons in N-type semiconductor material and a shortage of electrons in P-type semiconductor material move heat energy from the cold side to the hot side. The heat sink ("hot side") discharges the accumulated heat energy from the system.



### Reliability:

The life expectancy of a thermoelectric device is exceptionally high due to its solid state construction. For individual thermoelectric modules, mean time between failure (MTBF) from 2000,000 to 3000,000 hours (at room temperature) and 100,000 hours at (at 80°C ambient) have been calculated. For protecting controls, this reliability is critical to avoid production downtime.

### Real World Use & Application Examples

Control panels requiring anywhere from 100 BTU/HR to 6,000 BTU/HR of cooling can be protected with a thermoelectric cooler. Many industries have a need for thermoelectric cooling in certain applications. Automation industries frequently choose thermoelectric cooling for their system controls as well as monitors, sensitive instruments and other equipment. Tough ambient environments are common in automation industries like: Intermodal; Railway/Mobile; Food & Beverage Manufacturing; Wastewater Treatment; and Paper Milling, to name some examples. Ambient conditions can include high temperatures, washdown, dust or other debris, corrosive areas, etc. Thermoelectric cooling is valued for its reliability and its performance under such harsh conditions.



*An outdoor intermodal automation control cabinet utilizes thermoelectric cooling.*

## Thermoelectric Cooling : New Considerations



**Left:** cooling control electronics in a beverage plant.

**Right:** Automated sorting equipment cooling with large Peltier units.



**The reduced need for maintenance & replacement parts must be considered as part of the value added to choosing thermoelectric technology.**

Cooling electronics equipment in NEMA-4X and CID2 enclosures poses additional risks from the ambient conditions. Thermoelectric air conditioners can maintain the integrity of NEMA-4X and CID2 enclosures, keeping ambient heat and environmental debris from entering the enclosure. Thermoelectric air conditioners actually perform better in higher ambient temperatures. Corrosive ambient conditions such as blowing sand or salt spray do not pose a threat. Nor does shock and vibration exposure. Military-grade sealed fans and components are used in some thermoelectric air conditioners to meet these harsh conditions.

### Why Thermoelectric?

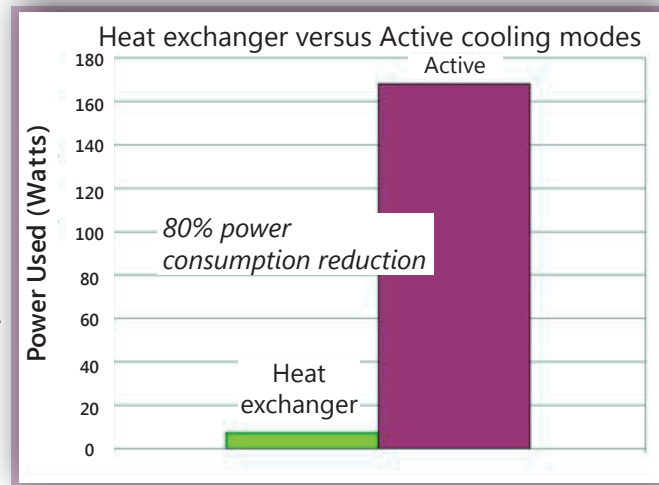
#### *Value added :*

Thermoelectric air conditioners are environmentally friendly. Free of refrigerants or other ozone depleting chemicals, thermoelectric coolers are solid-state products. There is virtually no maintenance associated with a thermoelectric cooler. There is no filter to change, no compressor and the only moving part is the fan. This also means a long service life (also see 'Reliability', previous page). Under normal conditions, a thermoelectric air conditioner may last 7 years (or much longer in many cases), without requiring a repair. Such repairs are likely to be simple, such as replacing a fan. The reduced need for maintenance and replacement parts must be considered as part of the value added to using the technology.

## Thermoelectric Cooling : New Considerations

### *Efficiency:*

Some coolers can offer a power saving heat exchanger mode. In low demand situations, power consumption can be reduced by as much as 80%. The polarity of the thermoelectric module can now be reversed to heat instead of cool (without sacrificing reliability as in days past). This allows more thermoelectric products to both cool and heat enclosures. By using the thermoelectric modules for heating, efficiency is increased since electric heaters are no longer needed. Using advanced materials in combination with innovative designs any thermoelectric solution is, today, able to cool or heat as demand requires with tighter and more precise temperature control.



*power efficiency example:  
teca model AHP-470*

**T**oday thermoelectric technology can be used in ever broader applications thanks to the advent of high performance products.

### *Performance:*

Performance ratings are significantly improved from what was available in the past. It is now possible to get up to a half ton of cooling from a thermoelectric air conditioner. This allows for thermoelectric cooling to be used in applications as small as surveillance camera housing (typically 100 to 200 BTU/HR) or as large as communications and power equipment enclosures (typically 3,500 to 6,000 BTU/HR).



*Power equipment cooling with half-ton thermoelectric air conditioners*



### Recent Changes to Thermoelectric Technology

In recent years, there have been innovations and improved products in the thermoelectric market. This is partly design innovation but also due to higher quality, more robust materials that are now available to manufacturers. This includes high efficiency heat sinks and thermoelectric modules with significantly increased reliability and efficiency. In the past, thermoelectric air conditioners were limited in performance to about 2,000 BTU/hr. Now, increasingly efficient designs are allowing for air conditioners with up to a half ton of cooling.

**M**odern thermoelectric coolers can cool more,  
and with greater efficiency.

### Summary

Thermoelectric cooling remains somewhat of a specialty method of cooling. It is more expensive to manufacture compared to other cooling technologies. But it is also incredibly reliable and requires virtually no maintenance. The initial purchase price is well justified by the lack of maintenance costs in the long run and the ease of use. It is best suited to harsh outdoor environments or to applications where low maintenance is desired. Considering modern improvements to the technology and the new product designs, there are now more reasons to consider it and - happily - many more places where it can be used.

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