

# Thermoelectric Cooling : A Closer Look

*Thermoelectric technology is easy to overlook due to upfront cost or power requirements. Once educated about and committed to the technology, however, thermoelectric cooling can be the best choice for harsh environments, especially in remote or hard-to-reach areas.*

By EMILY HUTENSKY

**O** **PENING AN ENCLOSURE** and blowing a fan on heat sensitive components is an inadvisable way to avoid over heating. Exposing equipment to ambient dirt and debris can cause damage over time. It is also can increase the risk of shock to those working around the area. For these reasons, it is best to have a cooling component in place as part of your system. Before going into a detailed look at thermoelectric cooling, a few other technologies are briefly outlined below.

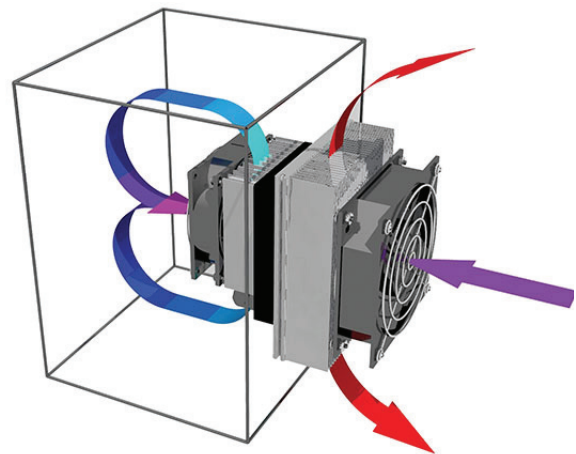
Vapor-cycle air conditioners have their place but are a maintenance challenge when placed in hard-to-access, remote areas. Whether it is difficult installation, refrigerant leaks due to nearby vibrations, expensive compressor replacements or all of the above, end users can find refrigerant based cooling 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. Finally, compressed air products will require the expense of maintaining a compressed air supply.

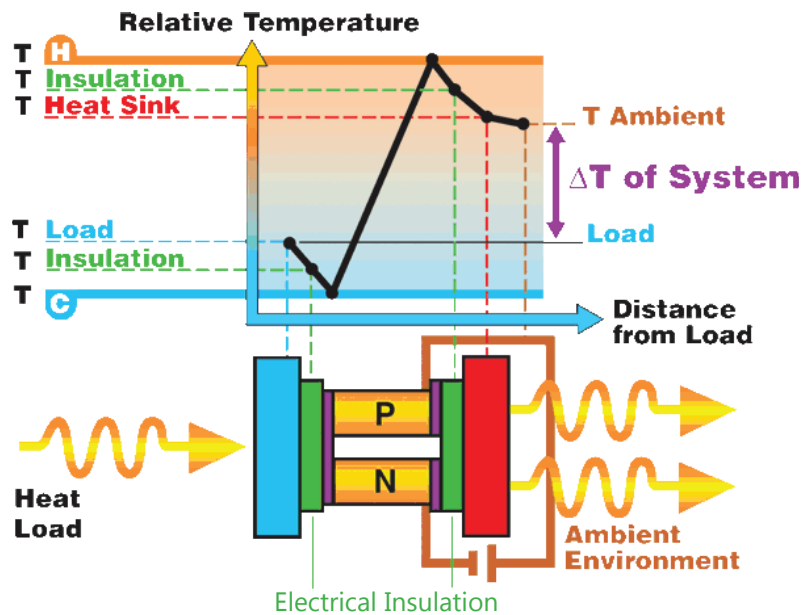
Thermoelectric technology has seen advances and improvements in recent years. An overview of the technology will outline benefits and drawbacks to the end user followed by discussion of the newest innovations.

## Thermoelectric Cooling : A Closer Look

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



The cooling is created via the Peltier effect: a solid-state method of heat transfer through dissimilar semiconductor materials. The three main working parts in a thermoelectric refrigeration system are a cold junction, a heat sink, and a DC power source. Two dissimilar conductors replace the refrigerant in both liquid and vapor form. The cold sink (evaporator surface) becomes cold through absorption of energy by the electrons as they pass from one semiconductor to another, instead of energy absorption by the refrigerant as it changes from liquid to vapor. The DC power source pumps the electrons from one semiconductor to another, and the heat sink (condenser) discharges the accumulated heat energy from the system.



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### Why Thermoelectric?

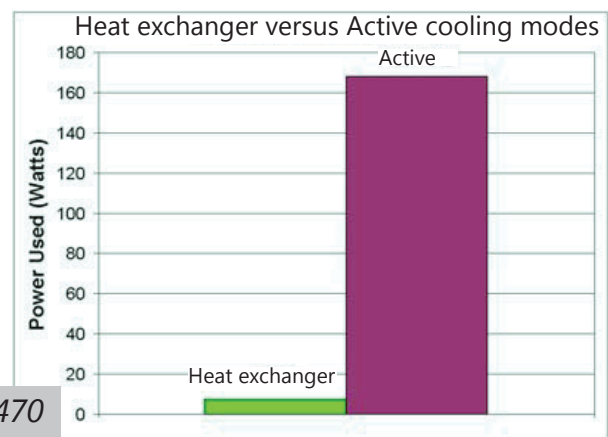
Thermoelectric air conditioners are free of refrigerants or other ozone depleting chemicals. These are solid-state cooling products. There are no filters to change, no compressor and the only moving parts are the fans. This means there is virtually no maintenance required and a long life expectancy.

Military applications in harsh field environments have utilized thermoelectric cooling for its ability to withstand corrosive environments, shock and vibration and high ambient temperatures. Military-grade sealed fans and components are used in thermoelectric air conditioners to meet harsh conditions including maintaining NEMA-4X enclosures.



*Military transit case cooling example. Thermoelectric air conditioners can be built for mobile applications, full shock & vibration, and corrosive environments such as salt spray and blowing sand.*

Performance ratings and power efficiency 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 cooler. This allows for thermoelectric cooling to be used in applications as small as camera housing (typically 100 to 200 BTU/hr) or as large as communications and equipment enclosures (typically 3,500 to 6,000 BTU/hr). Some models can offer a power saving heat exchanger mode. In low demand situations, power consumption can be reduced by as much as 80%.



*teca Model AHP-470*

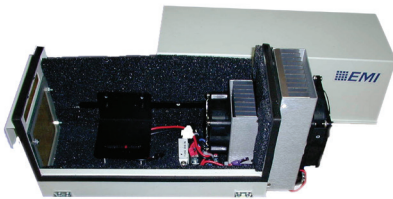
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Thermoelectric air conditioners are typically more expensive to purchase up front compared to a refrigerant based cooler or a simple heat exchanger. However, the reduced need for maintenance and replacement parts must be considered as part of the value added to using the technology. Under normal conditions, a thermoelectric air conditioner may last 7 years (or much longer in some cases), without requiring a repair.

### Recent Changes to Thermoelectric Technology

In recent years, there have been innovations and improved products in the thermoelectric market. 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. This is partly design innovation but also due to higher quality, more robust materials that are now available to manufacturers, such as more efficient heat sinks and more reliable thermoelectric modules.



*Camera housing cooling example. Small cooling applications of 100 or 200 BTU/hr are common. Even small thermoelectric air conditioners can be built to thrive in harsh military conditions.*



*Large enclosure cooling example. Up to 6,000 BTU/hr of cooling is now possible with thermoelectric cooling. This allows for use of the technology in ever broader applications.*

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Modern thermoelectric modules are able to heat more efficiently as well as cool (via reversing the polarity of the module). This allows more thermoelectric products to offer both cooling and reliable heating as the demand exists. By using the thermoelectric modules for heating, efficiency is increased since electric heaters are not needed. For either cooling-only needs or heat-and-cool applications, there is a greater ability for tight temperature controls.

### Summary

Thermoelectric cooling remains somewhat of a specialty method of cooling. It is more expensive upfront than compressor-based air conditioners. It is best suited to harsh outdoor environments or to applications where low maintenance is required. However with improvements to the technology and the designs, there are now more reasons to consider it.

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