Heat Exchangers vs. Air Conditioning: ***The Optimal Choice for Cooling Electronics***

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Technological advancements are changing traditional approaches to electronic waste heat dissipation: air conditioning, compressed air and heat exchangers. Air conditioning was considered the method of choice for many years. After all, it was effective particularly in harsh environments and fairly reliable. Many companies probably viewed the expense of 24/7 air conditioning operations to protect enclosed electronics as the unavoidable cost of doing business—a necessary but costly drain on operating budgets. Compressed air is also an effective and acceptable option, but it, too, has considerable operating costs as well as the need for a compressed air source. In addition, all hot spots have to be identified before the commencement of compressed air flow, which may account some reported incidents in which cabinet doors have been left partially open, a potentially dangerous situation that exposes electronics to contamination.

Where technology has made the difference is in the development of the heat exchanger and its ability to cool all potential hot spots at slightly above outside ambient air temperatures. Technological improvements have enabled the heat exchanger, a closed loop system with sealed panels, to effectively circulate air inside the cabinet to keep hot spots from forming—a proactive form of heat dissipation as opposed to the reactive method of responding to hot spots' sudden appearance within the enclosure. While the other methods are likely preferable under certain harsh conditions, the heat exchanger is proving to be extremely effective, less costly and quite adaptable to a majority of applications.

Development of compact heat exchangers

Perhaps the biggest technological impact in the evolution of heat exchangers, which had been produced since the early 20th century, was the development of the compact heat exchanger. Its development was spurred, in part, by the need for more adaptable exchangers as viable alternatives to downsides associated with air conditioning. By the early 1980s, air conditioning was viewed as the easiest and most convenient option for cooling waste heat in the burgeoning field of computerized electronics, but it had its drawbacks in the form of size, weight, energy use, maintenance and relatively short lifespan of the units. It also put enclosures at risk from one of two potentially damaging residual effects of constant operations: condensation settling on the electronics or oil mists. Either or both could render the electronics ineffective.

The change came when IT staff, interested in cost-effective and efficient alternatives, began seriously considering heat exchangers for heat dissipation. Compactness was just one reason. Another was that compact exchangers operate with a closed loop system that protects enclosures from outside air. A third reason: technological improvements in the last two decades have increased the efficiency of heat transfer and dissipation through heat exchangers while air conditioning is generally unchanged from the process used decades ago. One example of technical improvement: the heat pipe, which is used in conjunction with fans and aluminum fins. Fans move the heat either closer to or over the pipe making the heat transfer more efficient. The pipe’s role is to divert heat from the electronics to ensure a much longer lifespan.

In its compactness and capability, the heat pipe is an extremely efficient thermal conductor. Its performance is based on the physical principle of latent heat of vaporization, a concept generally associated with condensation or boiling in which heat is transferred without any significant temperature change. Half of the heat pipe within the unit is exposed to the heat inside the cabinet or enclosure; the other half is exposed to the outside air. Fans circulate the heat inside allowing the heat pipe to more efficiently transfer the heat to outside the enclosure. In addition, plates and fins support the pipe's ability to move the air more quickly and efficiently. Fans are the only external energy source required for either heat transfer or dissipation.

Compact heat exchangers are able to keep outside air and contaminants from entering the enclosure thanks to a flange and neoprene gasket—an important component in the unit that ensures against air exchange, either inside or out. Their heat pipe technology cools the electronics at slightly above ambient temperatures and keeps hot spots from forming. While manufacturers note that operational costs of heat exchangers are significantly below that of 230 volt air conditioners, they also cite their product's lifespan, as much as an astonishing 30 years compared with only two years for those air conditioners that operate constantly in very harsh environments.

Air conditioners: the positives and the negatives

All of the positives about heat exchangers do not change the fact that air conditioners still have an important role in the cooling of enclosed electronics. They are certainly more effective in high ambient climates such as the American Southwest or the Middle East. The concerns, though, mostly center on costs due to significant energy use required for continuously operating air conditioners, maintenance, and wear and tear.

Another potential issue is that many air conditioners still use Freon, a chlorofluorocarbon (CFC) closely regulated by the U.S. Environmental Protection Agency that has declared CFCs to be potentially damaging to the planet's ozone layer. Manufacturers are phasing out Freon from their air conditioners, but many that contain this CFC still operate in various capacities including enclosure cooling. Freon-based air conditioners pose potential environmental issues that most companies would prefer to avoid in this era of green technology.

With air conditioning, there is no concern about hot spots since cooling occurs at well below ambient temperatures. Information technology professionals, however, are beginning to question whether it is necessary to expend the energy and costs to chill electronics in order to protect them. Heat exchangers effectively prevent hot spots even though the cooling is slightly above the ambient temperatures. For those conditions that require cooling at below ambient, manufacturers have developed air to water heat exchangers that use only a gallon of water per minute to achieve the lower temperatures.

Solving the cooling challenges

An example of the performance of heat exchangers in difficult conditions can be found in the experience of a Northern European global manufacturer of computer systems that integrate traffic control and surveillance for airports. The environment for these systems was typical of many airports in harsh climates: dirty, dusty, wet and windy. The manufacturer had determined that costs of set-up and maintenance for air conditioning would be prohibitive for its customers and considered heat exchangers a viable alternative to cool its sophisticated electronics. The company also required that the exchangers had to meet NEMA (National Electrical Manufacturers Association) 4x criteria, meaning that enclosures must provide a “degree of protection” from such contaminants as windblown dust, water and corrosion.

The heat exchanger supplier initiated design and manufacturing changes to assure the company’s requirements were met and provided a loaner model for testing. Following completion, Noren engineers were advised that the exchanger exceeded its specifications while still operating effectively on 48vdc. The manufacturer said one of the major points in the heat exchanger's favor besides its technology was the elimination of "the hassle of maintenance."

As illustrated by the above example, finding the most efficient and cost-effective method for heat transfer will always be a challenge due to a number of variables such as internal and external environments, energy usage and corresponding costs, and equipment lifespan. Yet the expensive operating costs associated with vortex systems and particularly air conditioners may not exclude them from being the preferred choice if the outside and indoor plant environments are so harsh that maximum, constant chilling is required at all times.

For most environments, however, where enclosures of electronics operate, that is not the case. Reduction of heat inside the cabinet at temperatures only slightly above the ambient outside air has proven to be every bit as effective at considerably less cost. While there may be a mindset that colder is always better, analytics prove otherwise and merit consideration when choosing the optimal method of electronic heat dissipation.

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