Control Enclosure Cooling – Local or Remote?

By Howard Kielar

Maintaining the proper climate inside industrial electrical enclosures is the key to trouble-free operation of the housed electrical components and, more importantly, the often delicate production processes they serve. Packaged air conditioners, specifically designed for enclosures, are commonly used to cool the electrical components installed inside. The conditioners mount directly to the enclosure and are selected based on the amount of heat gain, interior air temperature requirements and, since the heat from the interior is rejected by the condenser of the air conditioner into the area adjacent to the enclosure, are also selected based on the ambient air conditions in the immediate vicinity.

Because industrial applications often involve harsh environments including air laden with dust, grit and/or oil mist and with high ambient temperatures caused by heat generated by nearby process equipment, packaged air conditioners are not always easily applied and a remote cooling solution is required. Remote cooling “moves” the enclosure heat to a location away from its installation site thereby allowing the control enclosure to be sealed against the operating environment. Remote cooling may involve using an air conditioner with a remote condenser or “split” refrigeration system. In this case, the refrigerant compressor and evaporator remain packaged in the locally installed air conditioner, but the condenser, which rejects the heat to ambient, is located in a more environmentally favorable location. Because the refrigerant gas from the compressor must be sent to the remote condenser, and condensed refrigerant liquid must be returned to the conditioner’s evaporator, the piping between the local and remote components become an important part of the split system. If piping size and geometry aren’t properly engineered, the cooling system will be under capacity and the potential for problems with lubrication can cause premature compressor failure. Split systems of this type also require charging the cooling circuit with refrigerant in the field and require one remote condenser for each local conditioner.

Another option for remote cooling involves equipping the control enclosure with an air-to-water heat exchanger that uses chilled water and a fan to condition and re-circulate the air within the cabinet. In this case, the entire refrigeration system is installed in a remote location and chilled water (or a water/ glycol combination) is circulated to the enclosure-mounted device to remove the heat. Circulating a single-phase fluid makes the connecting piping a less critical element of the system. An air-to-water device can prove to be beneficial for many industrial applications. Because the air-to-water heat exchanger uses chilled water instead of vapor compression refrigeration (compressor, evaporator, condenser, etc.) it provides a tremendous amount of cooling in a relatively small package. This economy with respect to installed footprint can provide real benefits for space-challenged installations. In some cases a single air-to-water heat exchanger can take the place of two or more air conditioners.

The air-to-water remote cooling option can also offer increased energy efficiency, when compared to using local air conditioners, in environments where high ambient temperatures result in high refrigerant condensing pressures. As the refrigerant condensing pressure increases, the energy input for the compressor increases resulting higher operating costs. Contaminate-laden ambient air contributes to this situation by fouling the condenser coil and reducing its heat transfer efficiency. These problems are avoided by using a system where the refrigeration source is remote. In fact, if the chiller is located outdoors there are additional efficiency gains to be made when seasonal changes in ambient air temperature allow even lower refrigerant condensing pressures – and lower operating costs.

The remote chiller-based system allows several enclosures to be cooled with a single chiller reducing equipment and installation costs. For this arrangement the chiller is selected to circulate the water flow rate required by the total number of air-to-water heat exchangers and programmed to maintain a fixed water temperature. Each enclosure-mounted heat exchanger controls the amount of coolant that it receives from the common coolant loop based on its own local temperature controller. The controller can be programmed to either maintain a fixed temperature or to maintain a variable temperature relative to the dew point temperature inside the enclosure to avoid condensation.

This coolant loop scenario also provides an easy method of increasing reliability through redundancy. A second full-capacity chiller, installed in parallel with the primary chiller will provide 100% back-up for the cooling system. Simple controls are available to allow the back-up chiller to be brought on line automatically in the event of a cooling failure. These controls can also rotate the lead and lag chillers to provide even duty cycles and ensure that the off line chiller is always ready.

A further benefit can be realized in that maintenance and repair tasks for the remote cooling system are accomplished outside of the process area. Condenser cleaning, filter replacement and/or coolant addition can take place without affecting operations. Remote control panels are available to advise in the operations area of any chiller alarms or warnings. The ease of service and warning enunciation can help reduce the mean time to repair (MTTR) following a failure as well as to help increase the system “up” time or the mean time before failure (MTBF).

Remote cooling can provide many advantages over local packaged air conditioners for control enclosures installed in process environments which have high ambient temperatures and/or which present considerable susceptibility to condenser fouling. As with all system-based solutions, all components – chillers, air-to-water heat exchangers, and controls - must be selected to work together to realize these benefits. A good method to ensure the system performs to its full potential is to use equipment suppliers who can provide and support all items, as well as interface with contractors and engineers.