ANTIFREEZE AND COOLING SYSTEM MAINTENANCE PLAY A CRITICAL ROLE FOR ELECTRONICS

By Matt Erickson

Cooling systems of all types are often poorly maintained, incorrectly serviced, or completely ignored. There is certainly room for improvement in this area in industrial applications, and the wind energy industry is no exception. These problems are likely due to issues within cooling systems that occur over a long period of time, enabling poor maintenance because the harm that's caused is not immediate. However, to help put it in perspective, up to 40 percent of engine failures have been attributed to cooling system problems. Cooling system issues contribute to frustrations within the wind industry, too. Wind farm owners and operators are looking deeper into the increased numbers of insulated gate bipolar transistor (IGBT) failures within their converter's electrical system. The good news is that there are ways to prevent cooling system-related problems.

Although the cooling systems in wind applications are unique, OEMs specify typical automotive antifreeze/coolants, and rightfully so. The materials and components used for cooling electronics are similar to automotive components, and the systems operate on the same principles. However, there are different needs for the wind energy industry that increase the importance of using a high-quality antifreeze product and implementing a proper maintenance program, particularly because of the costs associated with IGBT failures.

Antifreeze consists of three primary components:

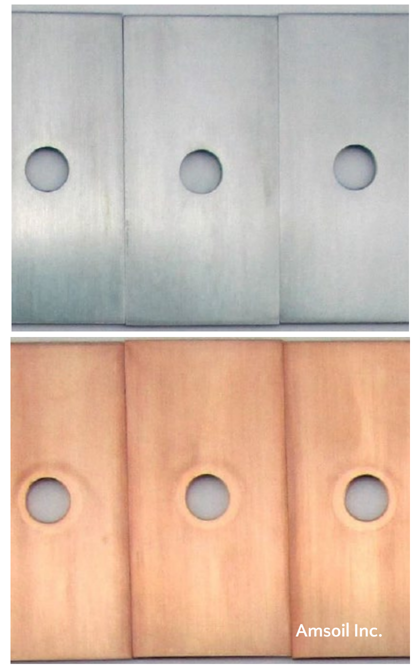
- Water – This is a great heat-transfer fluid, but with it comes some inherent issues such as freezing and corrosion.
- Glycol – This is added to lower the water's freeze point.
- Additives – These protect against corrosion while providing a number of other functions, including cavitation protection, pH control, lubrication, and anti-scale.

The glycol used in antifreeze is either ethylene glycol (EG) or propylene glycol (PG). The most common is EG, which has a slightly better freeze point and a small advantage in heat transfer when compared at a similar mix ratio. It is also less expensive, making it the popular choice. Because EG is hazardous, a bittering agent is added to antifreeze to help prevent ingestion. PG is the more environmentally friendly choice and is safer to use around children, pets, and wildlife because it is biodegradable and has low toxicity. Due to that benefit, some applications and locations require PG formulations.

ADDITIVES DIFFERENTIATE ANTIFREEZE PERFORMANCE

There are three categories of additives, and they can all be blended with the two glycols previously mentioned.

- Inorganic salts – The first additive type is found in the old "green" conventional antifreeze product. These products use inorganic salts such as nitrites, phosphates, and silicates to provide protection against corrosion and cavitation, among others. Inorganic salts work by forming a sacrificial layer over all components, and they are fast-acting. However, some of them are harmful to the environment and they deplete quickly, typically only lasting two years or less. Once they are depleted, they can start working against you by causing aluminum corrosion and deposit issues. Inorganic salts can also be incompatible with each other, leading to a dropout substance in the form of an abrasive or slime. For these reasons, automotive OEMs have moved away from that type of antifreeze, and they have banned the use of certain inorganic salts.
- Organic acids – The next additive type is the high-performance choice called organic acids, often referred to as organic acid technology (OAT) or poly organic acid technology (POAT). Organic acids are only used when and where they are needed. This results in much longer-lasting protection. They also do not have the dropout, scale deposit, or compatibility issues that are inherent to inorganic salts. Therefore, this type of antifreeze can be used in a wide variety of applications, even for mixing with other types of antifreeze as top-off.
- Hybrids – The final option available is a combination of the previous



Steel and copper specimens after an ASTM D2570 simulated service corrosion testing of an OAT antifreeze where no signs of corrosion are shown, easily passing the test.

two, appropriately called hybrids or hybrid organic acid technology (HOAT). These are a mix of inorganic salts and organic acids, and the way they work is that once the inorganic salts deplete, the organic acids take over. The HOAT provides a blended performance result by alleviating some of the issues with inorganic salts by limiting the quantities and relying on the organic acids to boost the long-term performance. The inorganic salt(s) used in these products vary by application because automotive OEMs have banned various salts from their products due to performance issues. For example, Asian OEMs don't allow any silicates because they tend to drop out, forming hard particles that can cause seals to leak. They can also lead to scale deposits that insulate surfaces and lead to overheating.

METHODS FOR CHANGING ANTIFREEZE

There are two ways to accomplish conversion to a different antifreeze type. The ideal way is to use an acid-based flush to ensure any scale deposits that are already present are cleaned out. Otherwise, these can be incorrectly interpreted as a problem with the new antifreeze when routine maintenance is performed. This flush generally requires the following steps:

1. Drain the system's antifreeze
2. Fill with water and acid-based flush product
3. Run the pump
4. Drain and refill with water
5. Run the pump
6. Drain and fill with new antifreeze

This procedure adds cost and time to the changeover process, so it is not always a realistic option.

Antifreezes are generally compatible; therefore, in some cases, it is also acceptable to simply drain the current antifreeze and replace it with the new one. This can certainly be done when the new antifreeze is a quality OAT product because it is fully compatible with all other antifreezes. If the new antifreeze is a hybrid, be cautious and check which inorganic salts are used to confirm compatibility. A simple drain and refill method does not remove deposits left behind by the previous product. However, quality OAT will ensure that no additional deposits form. This method is recommended for cooling systems that appear to be in good shape. Fully flushing, draining, and refilling the system are recommended for systems with issues such as increased operating temperatures or visible deposits and cloudiness.

PERFORM ROUTINE MAINTENANCE FOR BEST RESULTS

Antifreeze maintenance is an important consideration because avoidable issues can arise from incorrect practices. The maintenance requirements are slightly different depending on the type of antifreeze used. For hybrids, an extra step must be taken to monitor the inorganic salts so that the fluid can be changed once the salts are depleted. In the over-the-road truck industry, supplemental coolant additives (SCA) are sometimes used to replenish the inorganic salts and extend the drain interval.

OAT simplifies maintenance processes because they do not have the inorganic salts that deplete over time. Otherwise, both antifreeze types should have a maintenance program that includes a simple visual inspection and top-off as required, as well as a pH check. For open systems that may experience water evaporation, an additional glycol ratio check is recommended. If any contamination such as an odd color or cloudiness is noticed, change the antifreeze and inspect the system for the source of the contamination or leaks. If the system is low on fluid, top it off with a premixed product only. If the glycol ratio is off, make an adjustment using only distilled water or a water source that has been tested and approved for cooling systems. Water quality is one of the biggest issues with cooling systems, often contributing to scale deposits and pH issues. An ideal antifreeze mixture will be between 40 and 60 percent glycol to ensure proper freeze protection, heat transfer capability, and that the additive concentration is properly balanced for corrosion protection. The target range for pH is between 7 and 11, depending on the antifreeze type.

Test strips are available to check pH, monitor inorganic salt content, and determine the freeze protection based on the glycol ratio. This can be done by dipping them in the antifreeze and matching the color to a scale. Test strips cost little and provide immediate results, but they are not exact. For more precise results, a full analysis is recommended by pulling a sample and sending it to a lab. A refractometer is the most accurate way to check the glycol ratio in the field.

Although automotive antifreeze/coolants sufficiently protect wind cooling systems, ensuring that equipment stays up and running properly requires routine maintenance. Using a premium OAT antifreeze/coolant is a great first step as it eliminates many of the costly problems associated with the inorganic salts found in both conventional "green" and hybrid antifreeze/coolants and simplifies maintenance processes by lasting longer and eliminating compatibility issues. Although there are many rising issues in the wind industry, we can take a deeper look into other industrial applications and learn from their mistakes to find solutions. Even the simplest products can have the greatest long-term effects. Investing in wind cooling systems now can decrease the issues a wind farm may face down the road.

For more information, go to www.amsoilwind.com.

TRAINED PERSONNEL ARE KEY TO SAFE WIND FARM OPERATIONS

By Jack Wallace

Wind farm owners are doing their best to control spending, and, unfortunately, safety issues can be unintentionally overlooked, exposing contract workers and the wind farm itself to potential danger.

One such example is the practice of allowing the contractor to operate the turbine for "lock-out/tag-out" without spending the necessary time to train and document the training of the contractor on your sites and in your expected operating processes. The reason this is happening is due to manpower shortages and the industry overall not being as aware or vigilant as it should be of the potential risks. A shortcut like this is dangerous. Although the contractor technicians are more than willing to expand their knowledge to operate the turbines, their knowledge most likely is not at the same depth as that of the wind turbine technicians on-site. To ensure turbine safety, qualified and trained technicians should do the lock-out/tag-out procedure on these powerful electrical machines. To be qualified, one should be familiar with the equipment at hand. With that knowledge, they will most likely know what could go wrong and what to do if that happens. This is where the training needs to come in on each site. For example, I consider myself an electrically savvy member of the wind energy industry. However, I know that I am not qualified to go into most turbine controllers and manipulate them. I do not have the proper training. Therefore, I do not venture into areas on a wind farm or in the turbine itself that I feel are unsafe.

Some contractors do not understand the potential danger they are exposed to when it comes to the electrical side of wind turbine operations. They may underestimate the danger and overestimate their skills and knowledge. Being unaware of the turbine-specific dangers is the problem, and that could be life-threatening. Unfortunately, the site personnel rarely go out and train their workers to ensure that the contractors are implementing the correct process. This should be the contractor's priority because it is better to review something that everyone already knows than to let someone out on a wind site who hasn't been properly trained. I have found that the contractor is sometimes interviewed and that the working technicians' safety certifications are looked at to make sure these items are current, but the contractor is rarely trained on the lock-out/tag-out protocols specific for each site.

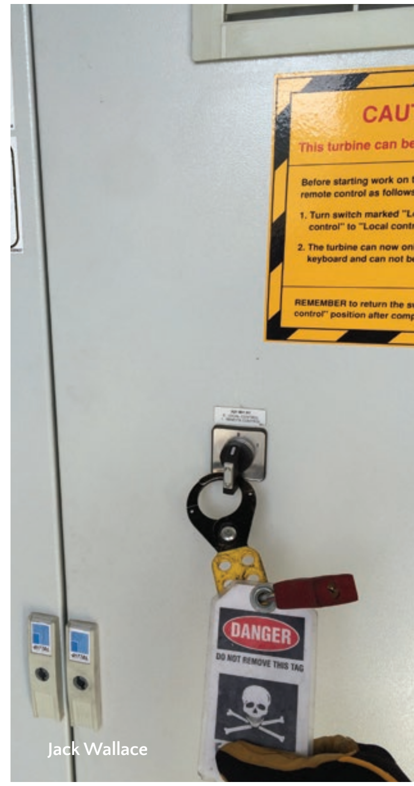
A technician properly protected from arc flash while opening the cabinet on a Siemens 2.3 controller.

Jack Wallace

Some sites require that the contractor technicians take a NFPA 70E-qualified electrician course to make them eligible to perform electrical processes related to the turbine shutdown and lock-out. However, an online course on NFPA 70E electrical safety may not adequately train and qualify them to perform such potentially dangerous tasks as opening an electrical cabinet with exposed conductors behind it on a turbine. The technician needs turbine-specific and task-specific training to be safe while working on these turbines.

It is necessary to take the time to handle turbine operations with a qualified team and have the contractor lock out and tag out on top or in parallel, or you should build an adequate contractor training system that the contractor takes on the wind farm site. It may be as easy as having a savvy contractor work with you on a few turbines and follow your process, or it could be much more complicated. Either way, it's necessary. It may even be beneficial to always maintain operational control and lock out in parallel with the contractor. When it comes to the sub-contractors, I prefer that the site lock the turbine out and have my technicians lock and tag on top or in parallel. It is the safest option for all involved. For some turbines, lock-out/tag-out requires people to open control cabinets that have potentially dangerous electrical hazards. On these sites, extra personal protective equipment is required that includes fire-resistant clothing, a face shield, hearing protection, and electrically rated gloves. In my experience, many technicians do not use proper hearing protection with their arc flash protective gear, and it can be a challenge to have them wear the proper gloves and face shields unless they have experienced an arch flash event. As you can imagine, a subcontractor blade repair technician is not as proficient in the use of safety gear as the site technician should be. Safety professionals in wind have done an exemplary job of ensuring that they are properly geared and trained to perform the work they do at such great heights. Everyone understands the danger of heights intuitively, but the dangers of the turbine control system and its associated electrical components are not as readily visible until there is an accident. Those electrical dangers are growing as the turbines age, and the wind industry needs to be vigilant when it comes to electrical safety for everyone.

For more information, go to www.frontierpro.com.



Jack Wallace

The cabinet on a Siemens 2.3 controller with its controller locked and tags to prevent unauthorized operation.

SIMULATION: A SHIFT AND ADVANCEMENT IN WIND ENERGY TRAINING METHODS

By Tiffany Sanders

Historically, the wind energy industry has been unreceptive to implementing simulation training as a viable alternative for standard training methods. Trade leaders have acknowledged that this primarily stems from a longstanding practice of using traditional, yet effective, on-the-job training (OJT) methods. The industry-wide lack of understanding on simulation benefits is another reason for their delayed adoption. The industry may not be aware of the operational savings and safety benefits aligned with a more technologically advanced training option. Wind energy trade members stand to benefit from learning how simulation modules can be integrated into their existing training program as a supplemental resource.

CURRENT STATE OF TRAINING WITHIN THE WIND ENERGY INDUSTRY

The "Occupational Outlook Handbook" projects that the need for wind turbine service technicians will increase to 108 percent by 2024 (http://www.bls.gov, 2016). The demand for this skilled workforce greatly exceeds the availability of qualified workers, and entry-level training can often take six to eight months to complete. This fact highlights another challenge within the training realm — student throughput. An ongoing issue within the industry has been the absence of a successful method that alleviates the training backlog. Companies must also accommodate the travel costs associated with sending existing technicians to remote training locations stateside and internationally. The good news is that student throughput and travel funding concerns aren't novel or insurmountable in the global training arena. The steady adoption of virtual environments as a supplemental training tactic by government agencies and commercial companies has resulted in reduced operating expenses and improved student performance.

AN EXAMPLE OF SIMULATION TRAINING USED IN THE U.S. GOVERNMENT

The United States Navy, originating in 1775 and touted as the largest employer in the world, accounts for more than 328,000 personnel, 272 combat vessels, and 3,700 aircraft currently in active service (www.navy.com, 2016). In the case of undersea initiatives prior to 2010, sailors were sent to multiple training sites to complete tasks using the actual tactical hardware. This resulted in hefty travel expenses, setup costs, and repair fees. Furthermore, this training method was limited to pre-established hardware configurations so it lacked flexibility in recreating troubleshoot and maintenance scenarios. In 2010, the Navy identified and implemented a solution to aid in reducing their training costs. The multipurpose reconfigurable training system (MRTS) was developed using affordable commercial off-the-shelf (COTS) hardware, such as monitors and computers that feature realistic 2-D and 3-D models, touch-based gestures, and touchscreen technology to simulate tasks that were originally only per-


JHT Incorporated

formed on the tactical equipment. The format of the MRTS trainer was designed so that the configuration of the virtual components could be altered by the instructor to reflect a vessel-specific version of a radio room. The intent for this solution was to offer students an entry-level training tool for maintenance and operator tasks that can be easily shipped to and distributed in multiple naval bases and facilities worldwide. As a result, the U.S. Navy yielded a savings of over $100 million with the use of this new virtual environment training technology.

A CASE FOR SIMULATION TRAINING IN THE WIND ENERGY INDUSTRY

While the majority of wind energy OEMs has opted to rely solely on the use of OJT, one global wind power firm recently engaged in a feasibility study to determine the efficacy and cost savings of developing a simulation training solution for service technicians. The company faced a multitude of training barriers that all pointed back to two principal issues — throughput and costs. In an effort to streamline their approach, they partnered with JHT Inc., a training and simulation firm based in Orlando, Florida, to develop a comprehensive business case for a tailored solution aligned with their technical requirements and training environment. The team at JHT Incorporated proposed the wind turbine simulation trainer (WTST). The construct of the WTST is a reconfigurable simulation system for performing authentic maintenance tasks and troubleshooting procedures on multiple wind turbine platforms. With implementation of the WTST, the wind energy firm aimed to realize an optimum balance of cost, reliability, adaptability, and effectiveness.

The primary objectives identified in developing the trainer included:

	FY2015	FY2016	FY2017	FY2018	FY2019
UNDISCOUNTED FLOWS:					
WTST Investment	($780,425)	($802,667)	($759,510)	($1,339,368)	($1,076,078)
WTST Benefits	$567,544	$3,443,199	$5,216,230	$5,006,563	$3,978,263
Net Cash Flow	**($212,881)**	**$2,640,531**	**$4,456,720**	**$3,667,195**	**$2,902,185**
DISCOUNT FACTORS:					
Discount Rate - 10%					
Base Year - FY2015					
Year Index	-	1	2	3	4
Discount Factor	1.0000	0.9091	0.8264	0.7513	0.6830
DISCOUNTED FLOWS:					
Costs	($780,425)	($729,698)	($627,694)	($1,006,287)	($734,976)
Benefits	$567,544	$3,130,181	$4,310,934	$3,761,505	$2,717,207
Net	($212,881)	$2,400,483	$3,683,240	$2,755,218	$1,982,232
Cumulative	**($212,881)**	**$2,187,602**	**$5,870,842**	**$8,626,059**	**$10,608,291**
RETURN ON INVESTMENT (5 YRS.)					
Return On Investment	***4.8***				
Net Present Value	***$10,608,291***				
Internal Rate of Return	***1299%***				

WTST cost-benefit analysis

- Reducing operational costs associated with technical training on turbine equipment
- Meeting the demand for qualified maintenance and troubleshooting technicians
- Achieving troubleshooting excellence and business impact while preserving the safety of technicians

COST BENEFIT ANALYSIS FOR WIND TURBINE SIMULATION TRAINER

The solution, comprised of a virtual 3-D environment and embedded with a realistic simulation of their turbine system, involved student interaction with the components of the wind turbine system through a multi-touch display. A predetermined number of simulated faults were designed for service technicians including: firmware upgrades, power, hydraulic, and lock-out/tag-out procedures using a library of realistic touch gestures from the ProxSIMity™ advanced touch system. The integration of ProxSIMity afforded students the ability to emulate over 100 pressure-sensitive actions within a 2-D or 3-D environment designed specifically for touchscreen-based applications.

THE LATEST IN TOUCH TECHNOLOGY

The use of gesture-based simulation training has found support across many industries including the medical equipment manufacturing sector. A current international conglomerate has integrated ProxSIMity into a customized training solution aimed at training maintenance technicians on several of their medical imaging modalities. Their tailored solution, using COTS 55" touchscreen monitors and computer towers, integrates student training stations (STS) and an instructor operating station (IOS), thereby allowing instructors to conduct classes, assign tasks and procedures, and monitor student performance in cities around the world. They now spend a fraction of previous years' costs on training expenditures.

CONCLUSION

The future for simulation training across all industries as a supplemental tool for OJT is expected to grow significantly as the case for cost savings, ease of throughput, and meeting customer demands becomes more substantiated. The availability of customized, cost-efficient 3-D simulation training solutions optimized for use on affordable COTS hardware presents a strong case that the wind energy industry will also benefit from reconsidering the advantages of their adoption and implementation.

For more information, go to www.jht.com/proxSIMity.