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Pat Graef

COOL YOUR JETS

Operation & Maintenance of Wetted Media Evaporative Coolers

Since February 2004, this column has discussed several technologies and their economics for turbine inlet cooling (TIC). We are now switching gears and starting to discuss operation and maintenance of TIC systems. As might be expected, operation and maintenance of these systems varies with the technology used deployed by the system. Operation and maintenance discussion this month focuses on TIC system that use wetted media evaporative coolers.

Introduction to Wetted Media Evaporative Coolers

Wetted media evaporative coolers (WMEC) are simple devices, which, as the name implies, use a wetted media to bring air into contact with water. Old-fashioned evaporative coolers use hog hair, wood shavings, or mesh for the evaporative surface. Those used in modern systems have highly engineered cross-corrugated paper or glass fiber. Engineered media are designed to provide a high surface area for the water to air to contact, low pressure drop and long life.

The cooler consists of three parts, the media, a reservoir for the water, and a water distribution system. A typical WMEC is shown in Figure 1. The water distribution system puts water on the media and makes sure that as much of the media surface as possible is wetted. Generally, a pump is used to move water to the top of the media, and frequently gravity is used to trickle the water down the media and back to the sump.

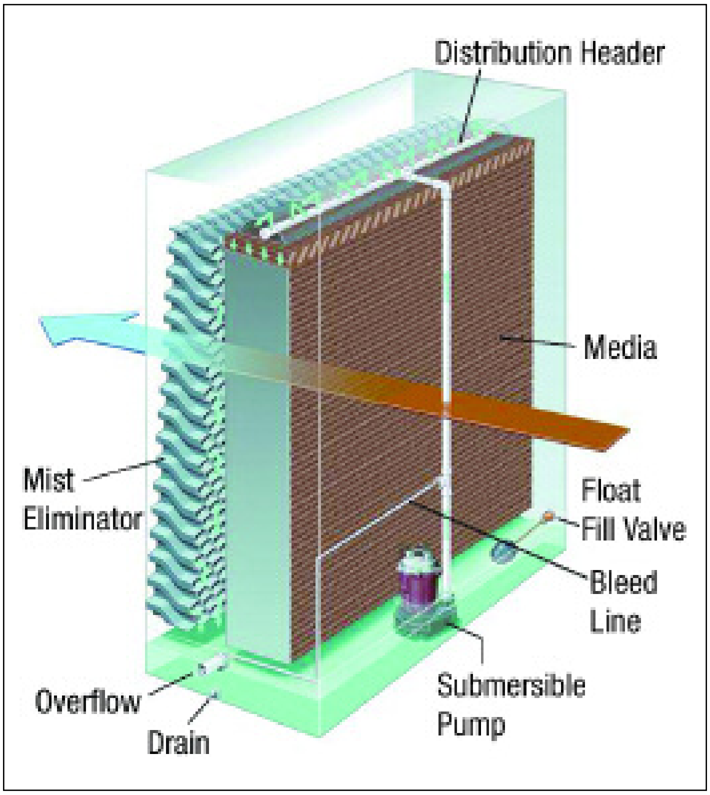

Figure 1. A Typical Wetted Media Evaporative Cooler

Operation & Maintenance Goals

One of the reasons evaporative cooling is so popular is that it produces significant cooling for a small investment and consumes little energy. The goals of an O & M program should be to provide the best possible cooling without water carry-over, while controlling microbial growth and scale.

Pumps, Make-up Water and Drains

Operation of the cooler is very straightforward: Air is drawn through the media by the combustion turbine, while the pump circulates water onto the media. The pump is almost the only moving part, so as long as the pump runs, water flows down the media. Most coolers have a make up water line, with a float valve, to keep the sump full. Making sure that the float valve works and the water supply is on will keep the pump from running dry and damaging seals.

Most submersible pumps use the surrounding water as coolant, so make sure the float is adjusted so the water level is high enough to keep the pump submerged. At the same time, the water level should not be so high that it touches the bottom of the media. The media needs to be able to dry out when the pump is turned off, so make sure there is an inch or so between the media and the water. The sump will also have a standpipe or similar overflow set just below the rim to keep the sump from overflowing. Obviously, do not set the water level so high it can run out the overflow.

Finally, all sumps have provisions to allow drainage of the sump for seasonal shutdown and cleaning. It can be manual or automatic. If it is a solenoid or other automatic valve, locate the control and understand how it operates. Some drains are actuated by a freeze-stat (thermostat). The thermostat will drain the sump if the temperature is low enough to cause freezing. Unfortunately, this may not tie in to the fill valve or the pump. Make sure the fill line does not continue to fill the sump while the drain is open, and that the pump is deactivated whenever the drain is open. Proper operation should be established before the onset of cold weather.

Sumps, Screens and Water Piping

Because of the huge amount of surface area in the media, evaporative coolers are good wet scrubbers. Most of the contaminants removed from the air are washed into the bottom of the sump (Figure 2). If allowed to accumulate. It can build up in the pipes and valves and can also clog the distribution system. If sediment is visible in the sump, it should be flushed out, paying particular attention to corners and areas of stagnation. Most evaporative coolers are located downstream of the filters, so the air should be rather clean. Those without filtration will need cleaning more often. A regular cleaning schedule should be developed once you know what to expect.

In dirty environments, the riser, header and distribution system should be flushed every three months. In cleaner environments, it may only be necessary for seasonal start up and shut down. If the pump has a strainer, clean it at the same time. Most coolers have a header pipe with holes in it for distributing water on top of the media. Make sure that no holes are plugged, particularly near the ends. If headers are equipped with flush-outs, turn on the pump and open the flush-outs. Opening and closing the flush outs several times will help "bump" the debris out of the lines. Afterwards check that water is distributed evenly across the width of the media.

Water Flow and Distribution

Having a well-adjusted and maintained water distribution system is the single most important way to prolong media life. Having adequate water flow will flush away dirt and contaminants, which may be harmful to the media. Areas "starved" for water will be the first to clog or soften. Adjust the water flow so that it is even across the face of the media. It is better to have too much water in some areas while keeping all areas wet than to develop any dry streaks by cutting back the flow. Do not use so much water that it splashes off the face and is carried over into the air stream

Bleed and Blow Down

Virtually all of the potential problems with scaling and microbial growth can be avoided by the use of blow down or bleed off. Since only pure water evaporates into the air, minerals, microbial contamination and nutrients become concentrated in the water in the sump and circulating over the media. As the water continues to recirculate, these contaminants become more and more concentrated until they begin to deposit on the media and in the sump. If a suitable bleed off scheme is adopted, it will prevent the concentration of troublesome contaminants.

For this reason, the cooler manufacturers often provide a bleed off line from the pressure side of the water-circulating pump. It is used to "discard to drain" a portion of the circulating water whenever the pump is running. The flow rate is usually controlled using flow meter and a ball valve or needle valve. The rate is set for worst-case scenario, meaning too much water is bled during mild weather when evaporation rates are low. The best way to control the bleed is with a conductivity controller (Figure 3) that senses the concentration of the solids dissolved in the water. When the con-

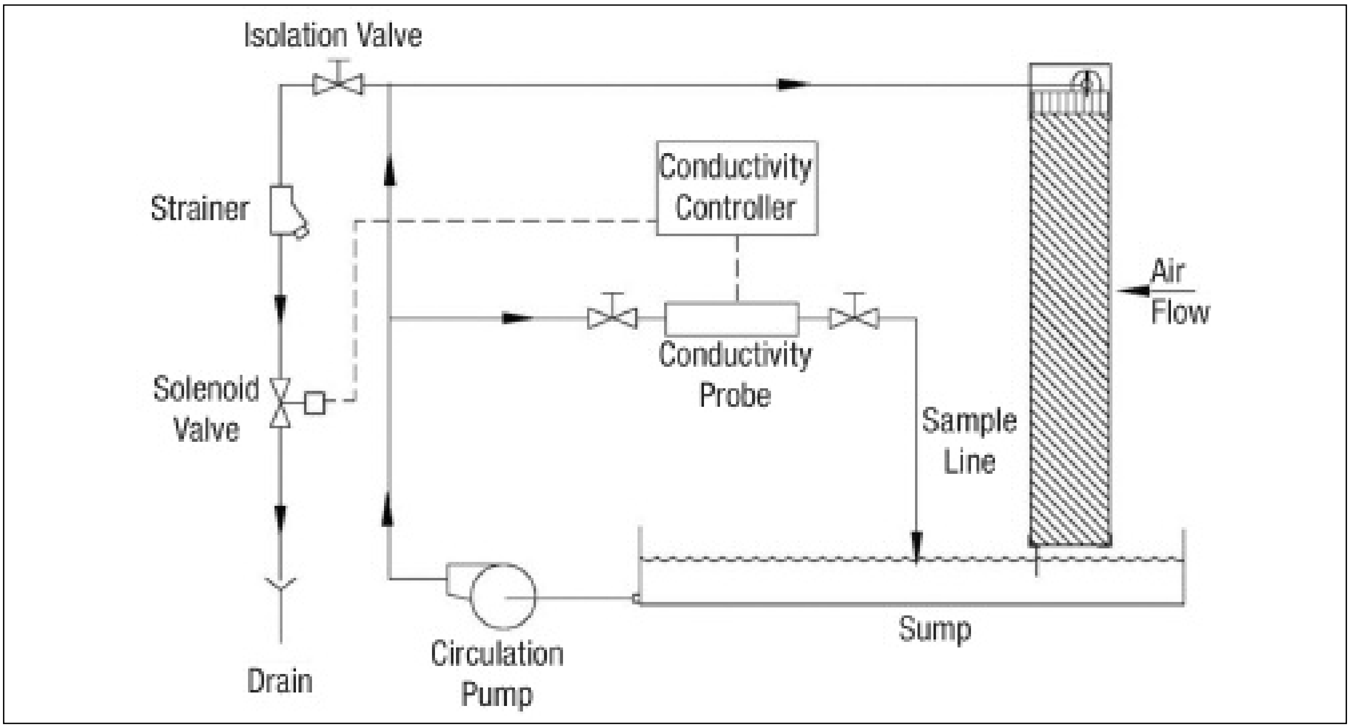

Figure 3. A Typical Bleed Control System Using A Conductivity Probe

ductivity reaches a preset level, the bleed valve is signaled to open. The concentrated water is replaced by clean make-up water. The bleed valve will stay open until enough concentrated water is replaced by clean water and the conductivity is reduced to the lower set point.

Another strategy is "blow down" or periodically dumping of all of the water in the sump and replacing it with fresh water. This control strategy should be automated. The drain line should be fitted with an automatic valve. The valve is opened periodically and the sump drained and re-filled. The pump and fill line should be turned off or locked out when the valve is open to prevent wasting water. This strategy can be activated using a timer or a conductivity controller. It is recommended for systems in dirty environments where sediment and debris in the sump need to be removed on a regular basis. It is also recommended for systems using high purity water that needs little to no bleed-off.

Whether bleed off or blow down is used, it is vital that the media are inspected periodically for evidence of scaling and microbial growth. The media will begin to take on a whitish color as scale begins to form. If you this is observed, the blow down cycle should be more frequent, or the bleed flow rate should be increased. If the media are not scaling, but show evidence of microbial growth, clean the system thoroughly and keep a watch for sediment accumulation in the sump. If the system is clean, there will not be nutrients to sustain microbial growth.

Water Treatment

If the system is properly maintained, chemical treatment is rarely necessary. Chemicals cost money, add to the maintenance required, have adverse effects on the media and can get into the air stream. Most water treatment chemicals were developed for use in cooling towers to protect the heat exchanger, not the cooling tower. In this scenario, the heat exchanger is always submerged. For evaporative coolers, the object is to protect the media that are not only the heat exchanger, but also the place where evaporation occurs. Most chemicals are not as effective in the evaporative cooling wet/dry environment. Further, these chemicals can dry out on the media and become part of the very problem you are trying to correct.

Most combustion turbine manufacturers do not approve of the use of biocides because there is not enough experience with their effect on sensitive turbine components. Oxidizing biocides are not allowed because they will soften the media and corrode cooler parts.

Algae and bacteria (slime) are rarely an issue in TIC systems. Most evaporative cooling media is not exposed to light, so algae cannot grow. Bacteria can grow in the dark if there is sufficient nutrients and moisture. Control of nutrients was discussed in the previous section. To keep slime from growing on the media, the pump should be turned off approximately half-hour before the CT is shut down. This will completely dry the media and not contribute to further growth of slime.

Like any piece of equipment, evaporative coolers will run better and last longer if well maintained. Following a few simple procedures will provide better cooling, prolong the life of the media and components, and lower the life cycle cost of the cooler.

Costs

Periodic maintenance costs relate to direct labor to clean, flush and adjust the systems. As a rough guide, a single bank of a TIC would require two men for approximately two hours. On average, a single bank provides cooling for approximately 25 MW of generating capacity. This means a cost of 0.16 person-hours per MW every three months. To provide seasonal startup and shutdown, this figure should be increased to 0.20 person-hours per MW.

Media replacement is necessary once every four to 10 years depending upon the amount of preventative maintenance, hours of use and water quality. Media replacement will cost 0.20 person-hours per MW and $100 -$200 per MW for the media. The old media can usually be disposed of in non-hazardous landfills. The volume of the media is approximately 7 cubic feet per MW.

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Figure 2. A Sump Area with Accumulation

Pat Graef is Engineering and Development Manager for Munters Corporation Evaporative Cooling Division located in Fort Myers, Fla. She has over 30 years experience in the manufacture, application and maintenance of evaporative cooling equipment. She has served as president of the Evaporative Cooling Institute, and currently serves as treasurer and board member of the Turbine Inlet Cooling Association