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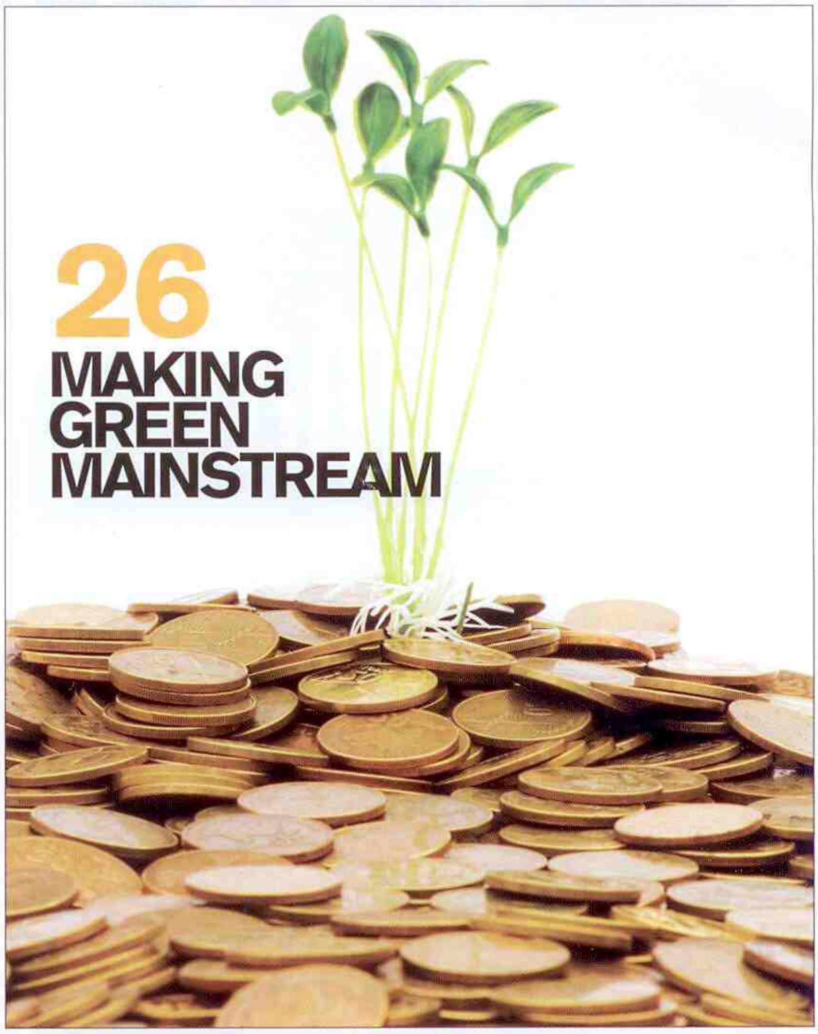
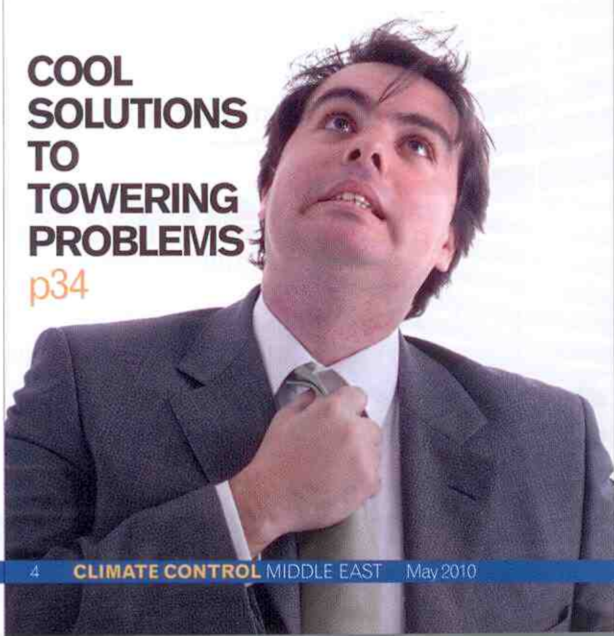




Cool solutions to towering problems

ASLAN AL-BARAZI TAKES A CLOSE LOOK AT DIFFERENT TYPES OF COOLING TOWER SEPARATORS AND FILTRATION EQUIPMENT TO DEMONSTRATE HOW TO MAXIMISE THE EFFICACY AND EFFICIENCY OF COOLING SYSTEMS.

INTRODUCTION: TOWERS AS AIR WASHERS

"Air wash" technology in humidity control systems is little more than a modified cooling tower. As such, cooling towers clean all the dirt in the air going through the system, leaving the discharge air upwards from the tower pure and clean. Therefore, in addition to providing efficient heat removal through evaporation, a cooling tower doubles, often unintentionally, as an effective air washer.

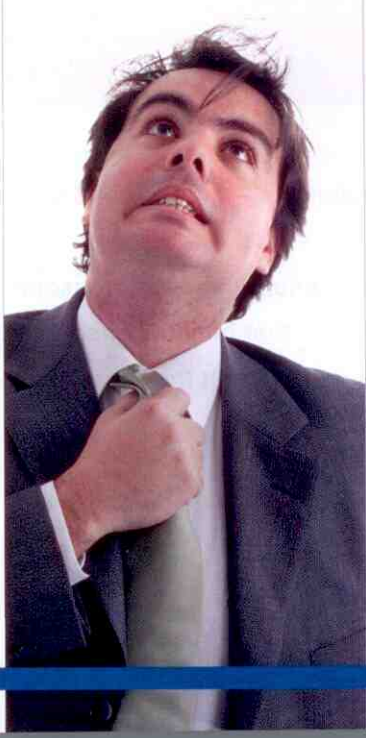
Airborne particles such as pollen, mould spores, sediments, sand and dust are absorbed or trapped by the water droplets falling through the cooling tower. The particle-laden droplets merge with the bulk water supply and are carried into the piping and through the chiller condenser heat exchanger before circulating repeatedly as part of the bulk water flow. The heaviest particles – those with a specific gravity greater than that of water – tend to settle in low-flow areas of the system, such as in the cooling tower basin. Other particles are trapped on the tower fill, and still others are bound to heat transfer surfaces through the formation of scale and "biofilim", when water is not adequately treated.

HAZARDS OF DIRTY WATER

Particles that are lighter than water, such as pollen, add to the biological loading of a cooling system. Organic matter becomes food for colonies of bacteria, leading to a degradation of water quality. If left in the water system, such organic matter contributes to masses of bacteria, in what is termed "biofilm" – a slimy layer of bacteria colonies excreting enzymes that feel "slick" to the touch. A layer of biofilm as thick as a human hair can reduce system heat transfer efficiency by upwards of 20%.

To make matters worse, heavier sediments that settle in cooling tower basins are also prime breeding ground for bacteria and under-deposit corrosion, which can shorten the lifespan of capital equipment. Biofilm on both heat transfer surfaces and beneath tower deposits tend to resist corrosive biocide chemical shocks, as only the surface colonies are killed before the rest of the colony regenerates. In fact, many waterborne bacteria populations double every 20 minutes in prime, warm water conditions found in cooling towers. Thus, organic loading severely degrades water quality and system performance.

A LAYER OF BIOFILM AS THICK AS A HUMAN HAIR CAN REDUCE SYSTEM HEAT TRANSFER EFFICIENCY BY UPWARDS OF 20%.



The location of a cooling towers and the prevailing season are, of course, two significant factors in total particulate loading of a system. Pollen-producing trees and shrubs, sandstorms, and even nearby local construction with concrete cutting, can all pose major challenges for cooling towers, which will ultimately scrub the nearby air.

The origin of particles found in some towers has been traced to locations more than five miles from the site of the tower, as prevailing air currents carry airborne matter. If not properly treated, over time, the cooling tower's sensitive areas such as the cooling tower PVC fill, internal water piping distribution system, chiller condenser heat exchanger, and especially pump seals, experience abnormal wear and tear. Small, dense particles, such as sand, can act like abrasive sandpaper on system components.

Larger particles, such as leaves and scale chips, can clog intake screens, obstruct water paths, and begin to reduce heat transfer efficiency and capital equipment lifespan, leading to increase-related maintenance costs, operational costs, downtime maintenance cost, and ultimately the Life Cycle Costing (LCC) analysis. Indeed, even concentrated minerals in makeup water, such as calcium carbonate and silica will naturally conglomerate and settle down over time, based on spikes to total water conductivity, water PH, alkalinity, and changes to other significant water quality parameters.

Particulate matter in system water becomes a bigger issue than a chemical service provider is often able to tackle. So, what is an owner/operator to do?

While chemical treatment is helpful in controlling the increased concentration of dissolved solids in the water, and can be an effective deterrent for biological growth, such treatment does nothing to handle the undissolved solids running through the system. For the above-mentioned reasons, it is especially important to remove from the bulk water supply particles visible to the naked eye – about 40 microns in size and larger.

More expensive micro filtration used to remove particles below five microns, while advantageous to overall system cleanliness, is often cost-prohibitive. As such, inexpensive water filtration, in the form of sand filters or centrifugal separator systems are designed with larger particles in mind, and are particularly helpful in controlling total particulate loading on a tower, without excessive additional energy cost.

Ironically, while most customers ensure they filter the air flowing through their air handling systems, many of them neglect to filter the water through their more capital-intensive cooling systems.

More to the point, the subject under discussion here is the different approach or design a client may opt for when considering the use of either a cooling tower separator or sand filter system. Full stream separators, side stream separators, basin sweeper system and sand filters are the primary options. What customers need to consider are cost-effective solutions to enhance heat transfer efficiency and reduce liability to waterborne diseases such as Legionella. There are, of course, advantages and disadvantages that come with each option. These options are explained:

CETRIFUGAL SEPARATORS AND SEPARATOR SYSTEMS

Full stream separators rely on a separator located after the condenser pump which filters 100% of the water flow and separates up to 97% of particles sized 40 microns and higher in a single pass. Separators succeed through their use of centrifugal velocity, baffles, and solids capture systems in a self-contained and fairly simple design. Utilising an automated blow down through timed purge valve, takes the guesswork out of purge frequency.

The downside of this design is the extra head loss (between 5 to 9 psi), which needs to be accounted for on the frontend in engineering design calculations. The tradeoff for the use of slightly more pump is a significantly cleaner and safer system, and a preservation of capital »

« equipment. Customer payback on filtration systems is typically less than 24 months, when all factors, including maintenance, energy savings, and water savings of the overall tower and cooling system are considered.

Side stream separators are the most popular filtration systems in the industry. Normally, designers incorporate eight to 25% side stream of the total cooling tower flow rate. For example, a design flow rate of 2000gpm through a common header would enable the customer to downsize the total filtration skid package to, say, a 400gpm unit, with its own pump and automated solids purge system.

An effective side stream filtration system includes a well-designed basin sweeper system to properly agitate settled solids in low-flow areas of the system, such as the cooling tower basin. From a

THE ORIGIN OF PARTICLES FOUND IN SOME TOWERS HAS BEEN TRACED TO LOCATIONS MORE THAN FIVE MILES FROM THE SITE OF THE TOWER, AS PREVAILING AIR CURRENTS CARRY AIRBORNE MATTER.

cost comparison standpoint, it is interesting to note that full stream filtration can be significantly more expensive than side stream filtration systems, when comparing direct capital cost. But when added energy input for side stream pump operation is factored into the equation, the energy input required to run the small side stream pump makes the side stream slightly more expensive than it might first appear.

Another factor to consider when deciding between full flow separators and side stream separators is the role of blow down. Options exist for zero bleed where continuous purge through a bag filter returns the clean, filtered water to the tower. A recovery tank necessitates manual cleaning of the bag filter but ultimately saves water. This type of solid capture system can be particularly effective with closed-loop, non-evaporative systems.

It should be noted that whether a customer uses full stream or side stream separators, the bulk water supply will effectively be treated, leading to a reduction in overall system fouling. However, many heavy particles will settle quickly in low-flow areas of the system, such as in the cooling tower basin. Unless those particles are carried to the suction header, they will build up over time, increase biofouling and the likelihood of under-deposit corrosion, and potentially set like concrete, if the natural minerals which settle out from the water are left to adhere.

A pragmatic approach to cleaning tower sumps, therefore, is to use a specialised cooling tower aquatic vacuum cleaner, which is an inexpensive device. Regular manual cleaning, however, can significantly add to the overall operational cost of a system, when tower basins are particularly large.

THE PROS AND CONS OF BASIN SWEEPER SYSTEMS

A more effective alternative to aquatic vacuum is a well-designed basin sweeper system. In the same way as ozone systems were enthusiastically implemented on cooling towers in the 1990s, and then, subsequently, created significant corrosive tower breaches and failures, basin sweeper systems have also been viewed by many in the industry through a "love it" or "hate it" lens. The reason for the wide sway in opinion comes down to application: in the same way that ozone systems work well if the design is accurately balanced, so too, do well-designed sweeper systems – they effectively remove tower sediment. When correctly applied, they lend themselves to a tremendous simplification in operation.

Geographical considerations, total exposure to fouling, and prevailing weather conditions give credence to the notion that design of an effective basin sweeper system becomes even more important. This is especially true for towers located in the UAE. Consider the following:

A) Given the aggressive sand, dust and haze conditions in the UAE, 10% side stream (for the sweeper system), as most designers incorporate for their local systems, is generally insufficient for effective sediment removal. Griswold & IMEC have confirmed that a higher treatment ratio – often beyond 20% side stream – leads to successful filtration.

B) In a competitive market requiring cooling towers to be "low in height" (low profile), to reduce visual disturbance for people living in the vicinity, this would also mean that the tower basin heights would normally be correspondingly shallow. Likewise, basin water level is also often low. Thus, there is a need to take special care when considering the issues confronting the condenser pump operating at minimum static height levels such as NPSH of the pump, vortexing, and any extra air going through the pump, where cavitations is a risk. A properly designed sweeper system will churn the water slightly, to literally "sweep" the particles towards the tower suction header/s for separator removal. Thus, appropriate caution and necessary design parameters must be used in selecting effective head pressure and system layout.

C) Hydraulic design responsibility of basin: concrete cooling tower basin common in district cooling plants are not normally in the scope of the cooling tower manufacturer, because they are normally built by the civil contractor. Design responsibility needs to be decided in advance during the design stage. The question is, will the consultant, civil contractor, MEP contractor or cooling tower manufacturer handle the design scope responsibility? The design scope needs to be accounted for and addressed during the design stage of the project, so that no confusion arises later on about who is doing what is in terms of related scope.

Basin sweeper systems may make this design responsibility burdensome for those who might prefer a simpler and a more pragmatic approach (like a side stream separator with aquatic vacuum cleaners, for example), while others would prefer a more sophisticated maintenance-free approach, like a sweeper system.

D) Basins range in shape and design between cross-flow to counter-flow towers, for example to concrete basins in industrial applications (with different shapes and designs, as well). It is, therefore, highly recommended that the design be based on a specific cooling tower basin configuration, such that the nozzles and eductors can be accurately situated to create sufficient solids being flushed. In cases of extremely large basins, switching valves can be used to modulate flow from one set of sweeper nozzles to the next, effectively creating a wave, which forces particles towards the suction header.

E) At the time of finalisation of procurement, it is also recommended that the cooling tower and separator manufactures review and approve the basin configuration drawings to ensure proper harmony between the cooling tower manufacturers and the separators manufacturers.

If the above considerations are put in place, then the sweeper system is an excellent option for those clients looking for a significantly less maintenance-intensive operation for effective water filtration.

SAND FILTERS

Sand filters are another option for effective removal of solids. The challenge with sand filters, however, is that in our aggressive environment, with significant particulate loading, sand filters need to be constantly maintained to ensure the media bed is properly fluidised. Undersized systems can foul quickly, and leave little tolerance for heavy sand storms. Without proper maintenance, sand filter beds can become impacted, resulting in the loss of media and significant downtime.

While sand filters can be more effective in removing smaller particles (down to 5 microns, for example) their larger size can make placement cumbersome. Some sand filter manufactures use fibreglass or composite materials to provide a less expensive product to customers. But some of these materials are not UV-resistant. More to the point, fibreglass sand filters are subject to cracking on impact. Even more significantly, backwash of between 60 and 180 seconds (or more) can result in significant water loss during automated purge cycles, whereas, an automated separator purge system that drains to sewer will blow down up to 95% less water. This implies that sand filters would need to be replaced or cleaned on a very high level basis, due to the high particulates loading off the environment in this region from aggressive factors like, sand, dust and other natural contaminants.

CONCLUSION

Elegant and simple solutions are effective in controlling biological and particulate loading of cooling tower systems. Their cost, as only a portion of the total cooling system is a relatively small price to pay for extending the life of capital equipment, reducing system fouling, and maintaining heat transfer efficiency. For a pragmatic and simple approach in optimising water system effectiveness, and for one that contributes to maximising effective, cost-efficient water and energy use, side stream or full stream separators, combined with a properly designed basin sweeper system or manual aquatic vacuum cleaners can create a reasonably short return-on-investment and reduce the headaches of systems operators everywhere. ■

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