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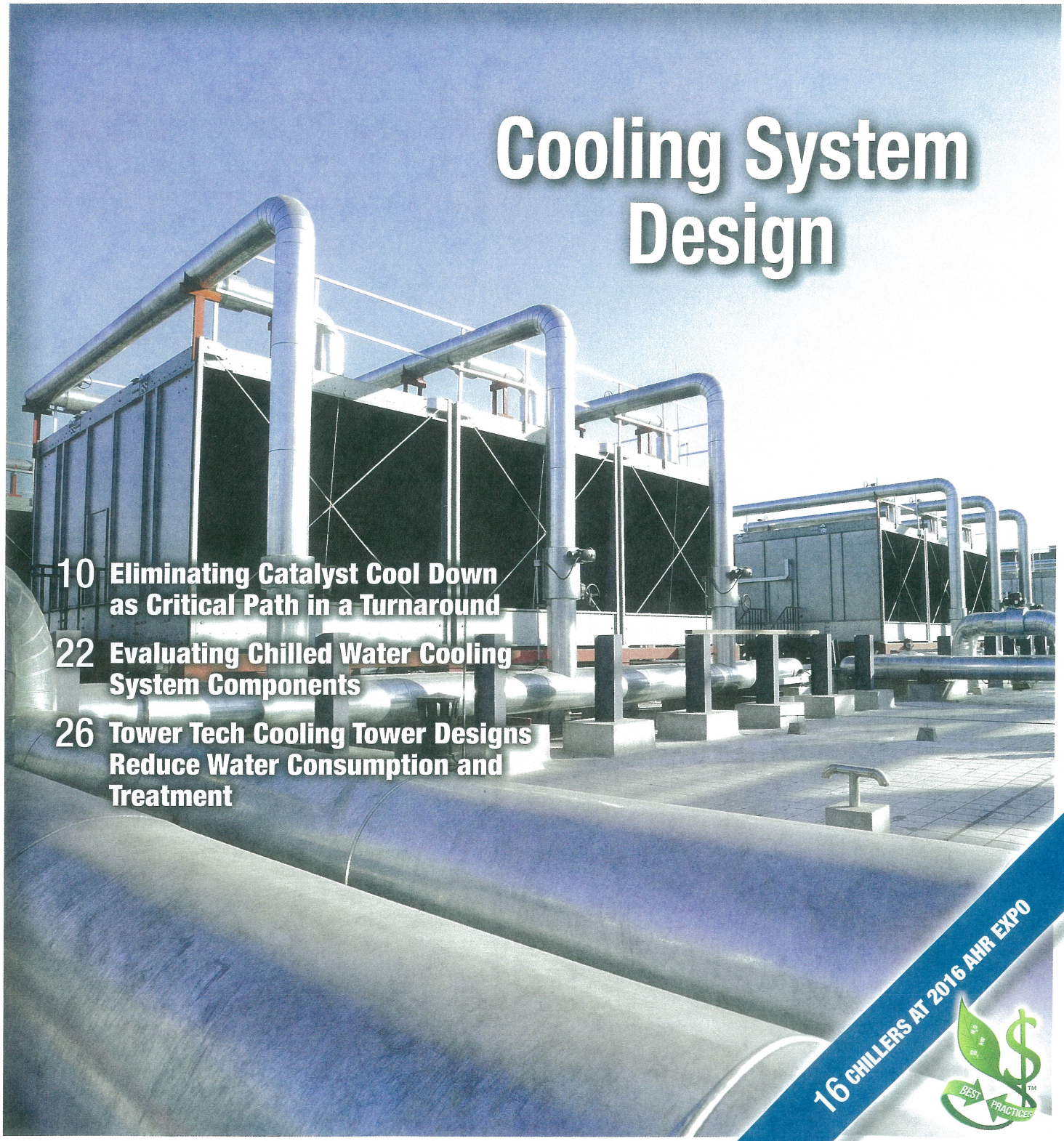

Cooling System Design

16 CHILLERS AT 2016 AHR EXPO

Tower Tech Cooling Tower Designs REDUCE WATER CONSUMPTION AND TREATMENT

By Dr. S. Curtis, Ph.D. © Tower Tech, Inc.

Anecdotal reports from users of Tower Tech cooling towers across the U.S. have indicated the Tower Tech design provides substantial savings to the customer both in terms of lower chemical treatment requirements and substantial water savings. There are a number of mechanisms by which the Tower Tech design facilitates efficient, lower cost water treatment and usage. A few are described in this paper.

Impact of Enclosed Flow-Thru Basin Design & Absence of Side Louvers

"Outside" environmental factors such as wind blown sediment, process contaminants, pollens, etc. have less opportunity to gain entrance into the Tower Tech tower interior. The enclosed basin design and absence of side air louvers diminishes the likelihood of wind-blown solids intrusion. High solids loads can lead to piping and heat exchanger fouling and under deposit corrosion. Furthermore interactive effects between solids and biofilm are minimized. Mechanical methods are able to remove particulates 10 um (micron) and larger, however, little can be done through filtration or separation techniques to handle the majority of particulates under 10 um in size.

> "Environmental factors such as wind blown sediment, process contaminants, pollens, etc. have less opportunity to gain entrance into the Tower Tech tower interior."
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Higher solids loads in the tower system can dramatically impact the system's oxidizer demand, therefore more chlorine is needed to maintain a sufficiently high level of residual.

Dust particulates under 10 um in size can act as seed nuclei for crystal formation - the first step in the scaling process. The Tower Tech design, as described above, reduces the entrainment of small size dust particulates thereby addressing one vehicle for nucleation.

Dust particulates of all sizes carry electrical charges. Scale inhibitor polymers and phosphonates can bind to the dust particulates and thus become unavailable to coat newly emerging crystals. Adsorption of the inhibitor onto new crystal surfaces is necessary for retarding continued growth via steric hindrance. The Tower Tech tower design prevents unnecessary "wastage" of inhibitor.

Impact of Flow-Thru Basin Design

The Tower Tech "Flow-Thru Basin" design provides 5-7 fps flow velocities through the tower basin. Flow rate is a key determining factor in the formation, maintenance and loosening of biofilm layers. High flow rates placed perpendicular to the diffusion of nutrients into biofilm will impair the transport of nutrients and removal of metabolic by-products. This will drastically impact the ability to sustain biofilm "life". Furthermore high velocity water flow will assist in sloughing off adhering cells preventing them from forming the critical glycocalyx layer necessary for adhesion and biofilm protection. Experts suggest that a flow rate of less than 3 fps is necessary to allow for reasonable biofilm growth. In fact instructions for operating "biofilm monitors" require that velocity settings through the monitor not exceed ~3 fps. The Tower Tech design limits biofilm growth and with it ensuing scale adhesion and under deposit corrosion.

Impact of Reduced System Volume

System volume may be positively impacted in installations using the Tower Tech design. In conventionally designed towers for the process industries the basin capacity can be estimated to be 7-10 times the recirculation rate. With Tower Tech's "Flow-Thru (elevated) Basin" design the basin capacity required is only 1.75-2 times the recirculation rate. Likewise in conventionally designed towers for the HVAC market the basin capacity can be estimated to be 0.7 - 1.3 times the recirculation rate. With Tower Tech's "Flow-Thru" basin design the basin capacity required is only ~0.2-0.3 times the recirculation rate. This results in significant savings with regards to total amount of water requiring biocidal treatment.

Reducing the System Volume can dramatically affect the Holding Time Index (HTI) of the cooling system. The Holding Time Index is the time required to remove 50% of the water from the cooling system. The Holding Time Index of a process cooling system using a conventionally designed 12,000 GPM tower[1] can be estimated to be 15 hours. Using the Tower Tech design the HTI can be decreased

Tower Tech Cooling Towers feature "Flow-Thru" basin designs

TOWER TECH COOLING TOWER DESIGNS REDUCE WATER CONSUMPTION AND TREATMENT

SUMMARY OF WATER AND TREATMENT SAVINGS[9]:				
	HVAC EXAMPLE (1,800 GPM)		PROCESS EXAMPLE (12,000 GPM)	
CATEGORY	CONVENTIONAL DESIGN	TOWER TECH DESIGN	CONVENTIONAL DESIGN	TOWER TECH DESIGN
Biocides	$5,959	$3,489	$39,453	$24,819
Scale & Corrosion Chemicals	$13,476	$8,983	$197,810	$131,874
Water & Sewer Charges	$19,235	$14,056	$409,968	$336,384
Total	$38,670	$26,528	$647,231	$493,077
Treatment Savings		-36% cost (+$6,963)		-34% cost (+$80,570)
Total Savings		- 31% cost (+$12,142)		-24% cost (+$154,154)

to only 3.75 hours. The Holding Time Index of an HVAC cooling system using a conventionally designed 1,200 GPM tower[2] can be estimated to be 5 hours. Using the Tower Tech design the HTI can be decreased to only 2 hours. Increasing the holding time has a direct effect on crystal kinetics of growth. The longer the holding time, the more prevalent larger scale crystals will become. This is due to the fact that larger scale crystals grow preferentially faster to small sized scale crystals. It is the larger scale crystals that reach a density sufficient to begin to settle out on tower and system surfaces leading to scale film formation.

Reducing the Holding Time Index can also be considered an effective way to reduce the planktonic (free-living or unattached bacterial flora) cell population within the cooling tower system. Extrapolating from the study of bacterial populations in chemostats (bacterial cell cultures) - increasing the turnover of a system (inverse of HTI) can lead to washout of the bacterial population. Wash out of course will only occur if no new cells are seeded into the system. In the Tower Tech tower due to the more closed in design there is less opportunity for bacterially laden dust particulates to enter into the system. Coupled with the higher turnover rates, the Tower Tech tower can drastically curtail planktonic population growth.

Impact of Enclosed Flow-Thru Basin Design & Ensuing Absence of Sunlight

Tower Tech's closed in basin design eliminates the entrance of sunlight into the tower water virtually eliminating the ability of algae to proliferate. Algae are aerobic photosynthetic organisms. Photosynthesis is the process by which algae derive their metabolic energy. Given sufficient light and nutrients algae can reproduce rapidly or "bloom" in a conventional tower environment. Furthermore algae can themselves serve as a source of organic nutrients for bacterial life forms to thrive in the tower water. Controlling algae can have a direct impact on controlling bacterial cell populations and in turn biofilms.

Based on System Volume differences and absence of a need for algaecide a Tower Tech HVAC[3] tower at 1,800 GPM will have an estimated biocide cost of $3,958 per annum whereas a conventionally designed tower will require $5,959 per annum. This delivers a ~33% savings on biocides per annum. In the Process Industry a 12,000 GPM Tower Tech cooling tower[4] will have an estimated biocide cost of $29,755 per annum whereas a conventionally designed tower will require

"Tower Tech's closed in basin design eliminates the entrance of sunlight into the tower water virtually eliminating the ability of algae to proliferate."

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$37,397 per annum. This delivers an ~20% savings on biocides per annum.

Ability to Operate at Higher Cycles of Concentration

Early reports indicate that the Tower Tech design can allow operators to achieve on average COC's 1- 2[5] greater than conventionally designed towers. Based on the ability to operate at higher COC's only a Tower Tech HVAC tower at 1,800 GPM will have an estimated chemicals cost[6] of $12,473 per annum whereas a conventionally designed tower will require $17,642 per annum. Costs are even more dramatic in the Process Industry where a 12,000 GPM Tower Tech cooling tower will have an estimated chemicals cost[7] of $156,692 per annum whereas a conventionally designed tower will require $230,444 per annum.

Water and sewer costs can also be reduced due to the ability of the Tower Tech tower to operate at higher COC. For example, using the Tower Tech HVAC tower at 1,800 GPM would result in total water and sewer cost[8] of $15,782 whereas a conventionally designed tower would result in a total water and sewer cost of $19,235. This results in an 18% savings on total water costs. A 12,000 GPM Tower Tech process tower would result in a total water and sewer cost of $336,384 whereas a conventionally designed tower would result in a total water and sewer cost of $409,968. This results in an 18% savings on total water costs.

Reduced system volumes decrease Holding Time Index (HTI) of the cooling system

About Tower Tech:

Tower Tech, Inc., based in Oklahoma City, USA manufactures innovative modular cooling towers designed to reduce installation time and costs, environmental impact, operating costs, and tower maintenance. Design features include: variable flow technology; low Legionella risk; TSE and sea water friendly operation; non-corrosive construction; built-in redundancy; modularity; and low sand/dust entrapment.

Tower Tech's products are used worldwide for comfort cooling, industrial processes, and power generation. Tower Tech's revolutionary cooling towers have been recognized by environmental advocacy groups for their ability to conserve energy and water. BP

For more information, visit www.towertechinc.com or contact Dan Coday, Sales Manager, Tower Tech, Inc. at email: dcoday@towertechinc.com or tel: 405-979-2141

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ENDNOTES

1 Assumes 20°F delta T, 4 COC's and a 1% evaporation rate.

2 Assumes 10°F delta T, 4 COC's and a 1% evaporation rate.

3 Based on both towers operating at 3 COC's, 20 hrs/day, 8 months/ year, maintaining a 10°F delta T and 1% evaporation rate. Does not consider the fact that the Tower Tech tower would allow cycling at a higher level hence a further reduction in biocide requirements.

4 Based on both towers operating at 3 COC's, 24 hrs/day, 365 days/year, maintaining a 20°F delta T and 1% evaporation rate. Does not consider the fact that the Tower Tech tower would allow cycling at a higher level hence a further reduction in biocide requirements.

5 Gain of 1 COC is possible in installations operating at 3-4 using conventional tower designs. Whereas a gain of 2 COC is possible in installations operating at 2-3 COC's using conventional tower designs.

6 Based on the Tower Tech tower achieving 4 COC and conventional design only reaching 3 COC, operation 20 hrs/day, 8 months/ year, maintaining a 10°F delta T and 1% evaporation rate.

7 Based on the Tower Tech tower achieving 4 COC and the conventional design only reaching 3 COC, operation 24 hrs/day, 365 days/year, maintaining a 20°F delta T and 1% evaporation rate.

8 Example assumes a water cost of $1.50/1000 gal and a sewer cost of $2.00/1000 gal. Also takes into account a sewer cost deduction (rebate) for evaporation.

9 Information presented is for illustrative purposes only. Values chosen are based on a general U.S. average for approximate cost of chemicals and water (purchase and disposal). Furthermore, COC's chosen are based a moderately hard to hard water analysis.