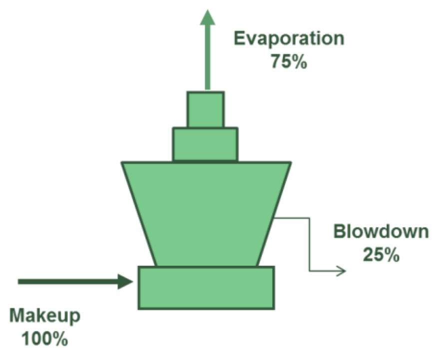
Myths, Misconceptions, Misrepresentations

As utility costs, specifically water and sewer costs, become a bigger and bigger part of the expense of operating an evaporative cooling system, understanding water's role becomes imperative.

Evaporation

By definition, the primary mode of cooling in these types of systems is evaporation. For a given load, a certain percentage of water must be evaporated in order to create the change in water temperature required by the process being cooled. This percentage is constant, in fact a function of thermodynamics, and does not change with the time of year, location, type of cooling tower or evaporative condenser or water quality. Only a change in load or temperature (delta T) through the tower affects the amount of evaporation required.



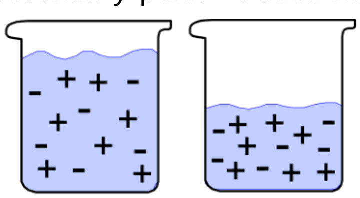
Evaporation makes up the majority of water evaporative cooling systems require. Evaporation is typically 65-85% of the total water used. "Bleed off" constitutes the rest. The number of "cycles of concentration" the cooling system is operating at determines the exact percentage.

An easy way of understanding cycles is to compare a component of the recirculating water with the same component in the make-up water. For example, if the recirculating water has 60 ppm of chloride and the make-up water has 20 ppm, the system is operating at 3 cycles of concentration.

	Recirculating Water	Make Up	Cycles of Concentration
Chlorides	60	20	3

Cycles of Concentration

The key to understanding cycles of concentration is realizing the water evaporating from a system is essentially pure. It does not contain any of the impurities that were in the make-up. As this pure "H_2O" evaporates, everything that was in it stays behind in the recirculating water. Consequently, the levels of impurities in the recirculating water accumulate rather rapidly to levels beyond what the make-up water contained. This phenomenon is called cycling. If left unchecked, the levels of impurities in the recirculating water would continue to accumulate or "cycle" until they would result in deposit formation.



Bleed Off

To keep this from happening, all evaporative cooling systems will "bleed off" or discharge water to keep these impurities from becoming an operational liability. Remember, evaporation allows impurities to concentrate. Bleed off or discharge takes impurities out of the system. This water loss, whether forced or a product of some ancillary function, is the other component that goes into the total make up volume needed to operate an evaporative cooling system.

Conclusions

- While the bleed off of a system will vary to control the cycles of concentration and levels of impurities in the recirculating water, the amount of evaporation required remains a constant.
- Evaporation is 65-85% of the make-up volume required to operate most evaporative cooling systems. Bleed off or other discharges represent 15-35% of the water used in these systems.
- Increasing cycles reduces the amount of bleed off required, but has no impact on evaporation.

The Devil in the Details

It would be nice if the relationship between cycles of concentration and operating costs was linear, but because of the fixed nature of the amount of evaporation required, we see the law of diminishing returns kick in as we explore the specific impact increasing cycles has on costs.

For example, going from 2.5 to 5.0 cycles is a 100% increase in cycles of concentration. However, it will only result in a 24% reduction in water use and less than 20% reduction in costs. Going from 4 to 8 cycles is also a 100% increase in cycles, but will only result in a 13% reduction in water use and approximately 9% decrease in costs. 5 cycles to 10 is again a 100% increase in cycles, but will yield only an 11% reduction in water and perhaps no cost savings due to supplemental dispersant and filtration equipment that may be needed to achieve 10 cycles.*

Careful evaluation needs to be made, and the cost and risks thoroughly understood, before a non-traditional, high cycle cooling water program is undertaken. Depending on operating costs, any system running 2, 3, or even 4 cycles seems a viable candidate for higher cycles. But if your system is already operating at 5 to 8 cycles, you have to consider how much effort, risk and money you are willing to invest in an attempt to fractionally reduce what is only 15-20% of your Evaporative Cooling System water costs.

	@ 2.5 COC vs. @ 5 COC		**@ 4 COC vs. @ 8 COC**		**@ 5 COC vs. @ 10 COC**	
Evaporation	4,320	4,320	4,320	4,320	4,320	4,320
Bleed off	2,880	1,080	1,440	617	1,080	480
Total Make Up	7,200	5,400	5,760	4,937	5,400	4,800
Evaporation % of Make Up	60	80	75	87	80	90
Bleed off % of Make Up	40	20	25	13	20	10
Make Up Per Year (Gal)	2,628,000	1,971,000	2,102,400	1,802,005	1,971,000	1,752,000
Treatment Cost	$ 2,945	$ 3,113	$ 1,726	$ 1,995	$ 3,113	1,664
Total Operating Cost	$ 16,085	$ 13,093	$ 12,238	$ 11,121	$ 13,093	10,526
Total Water Reduction (Gal)		**632,000 (24%)**		**277,000 (13%)**		**219,000 (11%)**
Operating Cost Savings Per Year		**$2,992 (19%)**		**$1,117 (9%)**		***TBD**

The above information is based on the following parameters:

- 100 Tons @100% Load 24/7
- 1500 gal System Volume, 100 ppm Make Up Hardness
- $5.00/1000 Gallons Water and Sewer Cost
- $3.00/lb Inhibitor, $5.00/lb Biocide, $0.10/lb Salt
- Water Softener Life Cycle Operating Cost