Air Inlet Water Management

Cooling towers bring water and air into contact to drive heat transfer. At the interface, where air and water first meet, an important objective is to retain water inside the tower. Water escaping the tower must be replaced in the form of make-up water, and there may be safety or cleanliness implications at the facility. Under certain operating conditions the air inlet can be a source of water loss due to two different phenomena (see note regarding water chemistry):

- Aspiration (also known as fines or misting) – produced when water droplets impact structural members, splash-fill media or a horizontal surface such as the cold water basin of a counterflow cooling tower. This impact atomizes the drops, breaking them into fine particles that are often lighter than air. These microscopic particles or fines then migrate out the air inlet opening, producing a mist adjacent to the tower.
- Splash Out – occurs when water is blown out, drawn out or simply flies out of the air inlet. This is almost inevitable with fans off or at very low speed.

These are natural phenomena that normally arise with a low air velocity through the inlet, made more pronounced with tall air inlet openings. Wind effects often increase the potential for splash out as well as aspiration. This holds especially true at corners and cell partitions due to eddy currents – areas of reverse airflow. Positive airflow (into the cooling tower) is required to minimize aspiration or splash out.

Therefore fan operation at very low speed, periodic reversal intended to de-ice louvers, and shutting off fans is counterproductive to water retention. Cooling towers are typically sized for peak summer conditions. On a design day, fans operate at full speed to satisfy the specified thermal condition. And, consequently, airflow through the air inlet into the tower is at a maximum. Water management at the air inlet is usually acceptable under this scenario.

A common strategy applied in the industry involves reduced fan speed to conserve fan power and operating expense. Periods of low heat load, cooler ambient temperatures, or both can lead to these operational adjustments. Turning off fans altogether may even be possible on the coldest days while still maintaining desired water temperatures. However, reducing speed or turning off fans makes the air inlet vulnerable to ambient conditions and wind effects. This concentrates water on the inlet face, which

Counterflow Cooling Tower – Fan is on in near cell, but off in further cells. Note splash-out and small cloud of mist (aspiration), both common with fans off.

can help reduce the buildup of air inlet ice in freezing weather. Unfortunately it may also result in water loss through the air inlet. When fans are turned off and water flow over the fill is maintained, water migrates towards the air inlet and some may exit the tower. Additionally, the falling water may induce a reverse draft through the fan discharge and out the air inlet. This may further exacerbate the splash out situation.

These challenges are not considered a design problem, but rather a characteristic to be addressed and managed through operational procedures. Refer to the following table for possible cooling tower design and operational parameters that help to control water loss.

Design Feature / Operational Procedure	Counterflow Cooling Tower	Crossflow Cooling Tower
Ensure the louvers are in good condition and properly installed*	✔	✔
Operate fans at low speed rather than turning off completely	✔	✔
Use hot water bypass which directs return water into the cold water basin instead of distributing water over fill*	✔	✔
Install cellular louvers to help capture water*	✔	
Provide adequate curb offset for cold water basin	✔	
Install a layer of film-fill at operating water level of cold water basin to help prevent droplet atomization (aspiration)*	✔	

**Optional equipment to be specified by the purchaser*

Some water loss from cooling tower inlets is unavoidable while fans are turned off. However, these losses can be reduced by the purchaser defining requirements for water management in the early planning stages. Cooling tower design and operation can then be adjusted accordingly to pursue these objectives.

Water Chemistry Note: Certain water treatment chemicals and constituents found in reclaimed water can reduce surface tension. Reduced water surface tension promotes the formation of very fine water droplets and aspiration. Therefore it is important to review water chemistry prior to the cooling tower design phase and diligently monitor during operation, particularly when reclaimed water is used as a make-up source.

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TR-019 | ISSUED 02/2017

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