

Total Evaporation Deposits on Tower Fill

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Cooling Systems
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Film Fill Tower Designs

Modern HVAC systems and industrial cooling towers generally use film fill, which is constructed of stacked, tightly-packed plastic sheeting. Film fill rejects heat better than older wooden slat designs due to its greater surface area and increased water-to-air contact. This allows smaller, space-saving tower designs and lowers the initial capital investment. One trade-off is that film fill is much more susceptible to fouling problems.

Evaporation Deposits on Film Fill

Under certain conditions, a mineral deposit can accumulate on the outer edges of the fill. This type of deposit is called deposition from Total Evaporation (TE). Small amounts of this scale usually do not affect tower performance, but severe fouling can obstruct airflow and interfere with efficient tower operation.

Causes of TE Deposits

TE deposits result from concentrated cooling water solutions being exposed to intermittent wet and dry conditions that leave minerals behind as the tower fill edge dries out. The same effect can also occur on evaporative condenser tubes if there are areas of tubes not completely contacted by water spray or the condenser pumps are cycled on and off.

How TE Occurs

In towers with high or constant fan speed, the air draft tends to draw the curtain of water toward the middle of the tower. To reduce overall energy use, newer systems can be designed so fans are staged, fan speed reduced, or fans stopped when tower water temperatures reach a programmed set point. The sudden, reduced airflow across the tower allows the flowing curtain of water to fall more to the outside edge of the plastic fill. The outside edges now become the wetted surfaces. When fans are restarted or adjusted to a higher speed, the increased airflow tends to draw the thin sheet of water back to the central fill area. The water film on the outside edges dries out as air moves over it, leaving the dissolved minerals behind. Gradually, the build-up grows and the deposit becomes appreciable. The condition is worsened when mineral concentrations are close to the solubility limits where scale can start to form.

TE can also be a problem in towers that are oversized based on normal load conditions, such as a common tower (or connected tower cells) handling multiple chillers that are staged according to load. The tower is sized for the combined chiller load. When the number of chillers online is varied depending on climatic conditions, airflow, and/or water flows are reduced from design capacity and TE deposition will be more noticeable.

Diagnosing TE Deposits

The location of the deposits and laboratory analyses are important to confirming that TE is occurring and its cause. Analyses of the deposit, makeup and cooling system water, and an understanding of how the towers are operated are all used to diagnose the problem. As a general rule, if water-soluble compounds, such as sodium chloride (salt) are present in the deposit and intermittent wet-dry conditions exist on the outside tower fill, then TE is the likely cause.



Film Fill



Deposit Accumulation Causing Water to Discharge From the Side of Tower Fill

The absence of water-soluble compounds does not rule out TE, but water chemistry should be checked. Analyses may indicate that over-concentration of specific minerals is occurring at the outside edge, especially if the system is being operated at or near maximum allowable cycles of concentration. Localized mineral precipitation in these high airflow areas does not necessarily mean that there is a bulk-water scaling problem in the condenser or heat exchange areas, especially if there is good control of cycles of concentration and the proper treatment parameters are being followed. To help confirm this, other factors should be looked at, such as chiller condenser head pressures, approach temperatures, and water composition.

Preventing TE Deposits

Unfortunately, there is no easy, clear-cut solution to preventing fill deposition from TE. After deposit analysis and observations have shown that TE is occurring, several procedures can be tried to minimize its formation

1. If operating at or near maximum allowable cycles of concentration, reduce tower water dissolved solids by slightly increasing bleed.
2. Feed supplemental dispersants to extend mineral solubility. Effectiveness varies greatly depending on deposit composition, degree of water contact, and airflow changes.
3. If the system has an energy management system with staged fans, variable fan speed, and lead/lag control of multiple chillers and multiple tower cells, alternate tower fan and tower cell use.
4. Balance water distribution on tower returns to ensure water is evenly distributed across the tower and each cell. If return flows are not balanced properly, the outside fill on one side will have more water flow than the other. Ideally, a multiple chiller and/or tower cell system will have pneumatic control valves to regulate water return flows and isolate individual return lines when not in use.
5. Side-stream filtration may help with removal of general contaminants that could collect on fill and act as seed sites for deposit growth.

Increasing inhibitor feed above normal limits is usually ineffective in preventing TE deposits. The use of supplemental dispersants or cleaners depends on deposit composition, exposure time, and the ability to gain consistent water contact on the fill edge, the lack of which is the major reason for the deposit formation. Partial softening of the tower water can be evaluated on a case-by-case basis, but may be cost prohibitive and would be totally ineffective against deposits other than those related to hardness.

Cleaning TE Deposits

The best option may be to regularly clean the tower fill at scheduled downtimes. Light pressurized wash of the fill with makeup water may be sufficient to loosen and dislodge deposits. Before washing, run the circulation pumps with the fans turned off for 24 hours to allow water to move to the outside edge and wet the fill. Care should be taken to ensure the pressure used for the wash is not too high to damage the plastic fill. Start at the lowest pressure that will dislodge deposits.

For more adherent deposits that do not contain high levels of silica or silicates, sprayed-on application of inhibited cleaners or special dispersants and chelating agents have been used with varying degrees of success in loosening fill deposits. Extreme care should be taken if an acidic cleaner is to be used to avoid corrosion of system metals. Acid solutions should NOT be used with galvanized towers unless formulated with galvanized metal inhibitors; even then, steps need to be taken to avoid damaging tower surfaces.

For best advice on using dispersants or cleaners, contact Chem-Aqua Engineering.



Band of Fill Deposits on Vertical Offset Fill (contributing factors were fan modulation and water being near saturation limits)*

*Observation Notes: the cooling system had one tower operated with constant fan speed and one tower with modulated fans. Fill deposits occurred in the tower with modulated fans in a band approximately two to three inches wide. When the tower fans were off, water flow was observed to be primarily within this two to three inch zone. When the fans turned on, flow was drawn in to the inside of this band. The inner zone was predominately deposit free.