Troubleshooting Deposits on Tower Film Fill

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Cooling Systems

Introduction
Film fill is favored by the cooling tower industry due to having a smaller packed volume than splash fill for equivalent heat rejection. Film fill’s greater surface area per volume, lower water velocity and increased water-to-air contact makes it more efficient than splash fill, but with a much greater tendency for fouling. Severe fouling interferes with uniform water-flow and obstructs airflow, resulting in poor tower performance. Heavy deposits can eventually lead to structural fill collapse or damage.

Deposit Problems on Film Fill
Since multiple fouling mechanisms can be occurring, deposits can vary in composition and severity at different locations. Fouling constituents include
1. Biological contamination and bio-films
2. Non-biological organics, such as process contamination, oil, and grease or coal dust around coal-fired boiler plants
3. Precipitated salts from saturated conditions, such as calcium carbonate, calcium sulfate, calcium phosphate, silicates, or alum-based compounds
4. Suspended solids from airborne or waterborne silt
5. Total Evaporation (TE) deposition - scale that accumulates on the outer edges of the fill from wet and dry conditions

Fouling Mechanisms
Deposits can occur in different locations on the fill, depending on the cause(s).

Precipitation of salts from over-concentration can occur near the top of the fill, especially if the bulk water is near or at maximum solubility limits. The water from the distribution deck or spray nozzles is near saturation. The initial evaporation of water causes a super-saturated condition to exist from concentration of minerals and stripping off of some of the dissolved carbon dioxide, raising the pH. The super-saturated condition can progress to over-saturation and precipitation of hardness or other salts occurs, leaving a deposit on the fill. Lower sections of wetted fill can collect some of this deposition between the layers if it sloughs off the top sections due to drying and re-wetting.

Evaporation of water on the outside edges of the fill, known as TE, also leaves deposits as the fill goes through alternating or intermittent wet and dry cycles. TE deposits can contain soluble, as well as insoluble, salts.

Airborne and waterborne silt, clay, dust, and sand particles, along with process contaminants, can collect on the fill and become part of the deposit matrix. The fill acts to filter out these suspended solids as the water flows down the tower.

Fill deposits are worsened by the following mechanisms
• Small obstructions on the fill create seed sites for deposit growth and rapidly grow into an overall fouling condition
• Bio-film formation that acts as a binder for silt, suspended solids and precipitated minerals
Because it acts like a binder, bio-film growth can be a major contributing factor to overall fill fouling. Therefore, good control of microbiological activity is essential. The final deposit matrix can be a cemented combination of calcium and magnesium hardness deposits, suspended solids, initially bound by bio-film and slime containing polysaccharides or cellulose.

**Diagnosing Film Fill Deposits**

The location of the deposits and laboratory results of analyses are important to confirming the cause of tower fill deposition. Analyses of the deposit, makeup, and cooling system water; microbiological analyses; and an understanding of the operational conditions are all used to diagnose the problem.

If deposits are predominately located on the outside edges of the fill, the deposit contains water-soluble salts, and intermittent wet and dry conditions occur, then TE may be the cause. If deposits are located in other wetted zones, then other mechanisms may be at work.

**How to Minimize Fill Deposits**

Minor film fill deposition is inevitable and does not normally hinder performance. To eliminate it completely would be cost prohibitive, since cooling towers naturally act as filters and concentrating devices. Steps can be taken to minimize severe fouling and maintain proper tower airflow, water-flow, and fill life. Before deciding on a course of action, deposit composition and water chemistry need to be confirmed. Preventative and corrective measures include:

- Use oxidizing biocides, such as chlorine and bromine, in conjunction with a bio-dispersant to kill microbiological growth, slime, and bio-film. Removing bio-film will help reduce overall fouling from other constituents.
- If operating near or at maximum allowable cycles of concentration, reduce the cycles incrementally to allow for additional headroom on solubility. If cycles are already low due to high hardness and/or high alkalinity makeup, investigate acid feed for pH control of cooling water or partial softening of makeup as options.
- Supplemental dispersants for silt and suspended solids. Effectiveness will vary depending on degree of water contact and suspended solids loading.
- Supplemental dispersants to extend mineral solubility. Effectiveness will vary depending on degree of water contact and deposit composition.
- Side-stream filtration of cooling water to reduce suspended solids loading, such as pressurized sand filters, media filters, or cyclone type separators.
- Correct balancing of return water across the tower cells to ensure even water distribution and fill wetting to minimize TE deposition.
- Alternate fan and tower cell use to minimize TE deposition.
- Makeup pretreatment with sand or pressure filter filtration, especially if using untreated river or surface water as makeup.
- Online and offline cleaning of fill.

**Cleaning Tower Fill**

Removal of tower fill deposits is not an exact science. The matrix composition, water chemistry, and ability to get good water-to-fill contact are major factors in the success of cleaning. For minor TE deposits on the outside fill edges, a pressurized washing may be sufficient. For fouling in the interior zones, more extensive cleaning using cleaners added to the bulk water or a sprayed-on application may be needed. Certain polymers, phosphonates, and chelating agents have been used to loosen and remove fill deposits with varying degrees of success. If microbiological fouling is a significant component of the deposit matrix, use of halogens according to label directions can be effective as part of the cleaning process.

Consult with Chem-Aqua Engineering for advice on the use of cleaners or supplemental dispersants. Extreme care should be taken if an acidic cleaner is 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. In all cases, a deposit analysis is needed before making any cleaning recommendations.

*Consult product label for proper use rates and application instructions before using.

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