Pfeffer Filtertechnik

It‘s all about clean water.

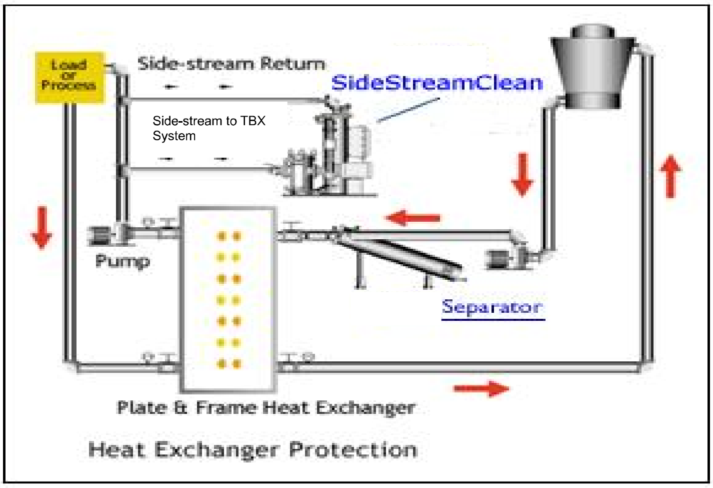
Filtration For Cooling Towers & Heat Exchangers

Evaporative cooling has largely withstood the test of time, both in terms of cost efficiency and overall performance. Various makes, models, styles and configurations are available, each offering specific advantages and benefits. Generally speaking, from a durability point-of-view, cooling towers fall into three categories: Packaged towers, made of metal construction, have a maximum life expectancy of about 15 years; Field-erected towers, made of wood, have a maximum life expectancy of about 15-20 years; and those towers made of ceramic or cast-in-place concrete, which are more durable (and more expensive), often guaranteed to last 15 years. The reality of this life expectancy, however, shows that packaged towers commonly do not last beyond 9 years and field-erected towers reach only about 10-15 years.

The issue is not so much a matter of construction, but rather environment, operation and care. Disasters, such as lightning, hurricanes, fires and other significant events take an obvious numerical toll. Chemical imbalance is also a clearly traceable culprit. And unwanted contaminants pose a surprisingly high risk to cooling towers … defining the subject of this article and offering the potential to regain years to the life expectancy and performance of a cooling tower.

To be sure, cooling towers act as effective air scrubbers, drawing dust, dirt, organic matter and airborne particulates into the tower environment. Make-up water also has its share of sand, silt and particle matter, even if it’s city water, which is often reservoir or well water, reasonably susceptible to some concentration of particle matter. Lastly, and most importantly, the process of evaporative cooling is its own worst enemy, creating a potentially significant amount of precipitated grit and scale by way of heating-cooling, acceleration-dormancy and the treatment of water.

The most obvious threat from such contaminants to a cooling water system is at the heat exchanger. These devices rely on small, controlled velocity pathways that can easily clog and foul with particle matter. And long before the painstaking shutdown & cleaning process comes excessive pass-through fluid velocity (beyond design parameters) and reduced heat exchanger efficiency.



No less problematic today is the effect of contaminants in the cooling tower itself. Particle-laden water that passes through a tower's fill inevitably deposits unwanted particle matter into the crevices and across the surfaces, affecting both flow and efficiency characteristics. The water distribution headers and nozzles can become clogged, limiting proper flow and wetting design. And, most problematic of all is the certainty that troublesome solids will find their way to the tower's basin or remote sump, settling there to create yet another range of problems.

With due respect for routine blowdown and proper chemical treatment, particle accumulation in a tower basin or sump is still a problem and a concern. Blowdown itself can be a problem, given its water loss and the need for both make-up water and renewed chemical treatment. Beyond that, however, is the increasingly apparent problem of bacteria and disease, created when solids are allowed to accumulate in a damp, dormant environment, providing the perfect breeding ground. And once the water is contaminated, soon also is the air, leading to respiratory problems such as tuberculosis, staph pneumonia and even Legionella.

Already, the American Society of Hospital Engineers (ASHE) has published a prescription to limit such accumulation problems for its membership facilities, enforcing its directive by citing certification requirements to control the evaporative cooling environment against solids intake and accumulation. The American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) also states in its Handbook the need to keep unwanted contaminants out of the tower environment.

IDENTIFY THE CONTAMINANTS

Before you can solve the problem, you must define the problem. Only then can you begin to identify the solutions that are appropriate and available. Given the sources described earlier in this article, you can expect several contaminants.

Inorganic solids – Sand, silt, dust and dirt can come from the water supply/make-up water and via the air intakes (cooling towers are great air scrubbers!).

Organic solids – Leaves, grasses, cottonwood seeds, algae, pollen, insects and other floatable debris find their way into the tower environment.

Precipitated solids – As water evaporates, it leaves behind the minerals, which become grit and scale.

In general, these contaminants appear as either settleable solids or as floatable solids. The distinction is important, given that settleable solids are largely the type of solids that accumulate in a tower basin or remote sump, whereas both solids types can be a problem to the heat exchangers, tower distribution headers, nozzles and fill.

Particle size is another issue. While a broad range of particle sizes may appear in a cooling tower environment, only those that can accumulate to troublesome levels should be of concern. To put it in perspective, 40 microns is about the smallest particle that can be seen by the human eye. Human hair is about 30-120 microns. Beach sand starts at about 150-200 microns. Pollens range from 20-200 microns. Red blood cells are about 7-10 microns. Virus spores range from 0.01 to 0.1 micron. And most bacteria is graded at 5 microns or less. In fact, according to the Water Quality Association, drinking water standards range from 0.5 to 5 microns and only bacteria is a concern at that size, typically removed only via disinfection, not filtration.

In essence, attempting to filter extremely fine particles may be more costly and less effective. Affordable protection makes more sense than absolute perfection.

DETERMINE THE SYSTEM NEEDS

Put simply, identify what needs protection from the contaminants. The heat exchangers. The cooling tower basin or remote sump. The tower fill and/or distribution headers/nozzles.

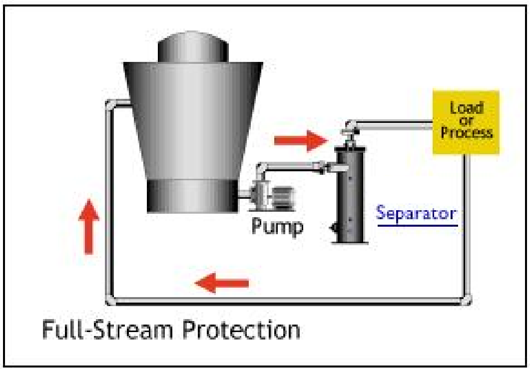
Assess the costs associated with the problem. Downtime. Cleaning. Repairs and/or replacements. Outside services. Overtime labor & maintenance. These factors will become important when comparing the cost of the problem with the cost of the solution.

FILTRATION TECHNIQUES

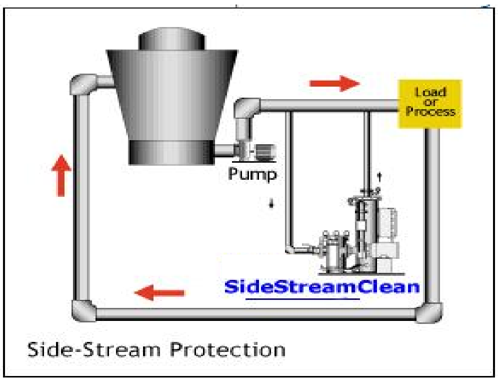
In general, there are five approaches widely accepted as the techniques for controlling solids in an evaporative cooling system. Each addresses the problem in a different way and has its own distinct value and benefits.

Full-stream filtration – This technique calls for the installation of the filter at the system supply pump's discharge (from the tower basin or remote sump), prior to the heat exchangers/chillers. The filter is sized according to the full flow of the pump, filtering all the water that passes on to the heat exchangers/chillers.

The primary value of this approach is the protection of the heat exchangers/chillers, estimated to increase the operating cycle of the heat exchanger by 8x before servicing requirements (based on experiences with users who have kept good "before & after" records). This technique, it should be noted, does not directly address the problem of basin/remote sump solids accumulation. Although effective filtration can reduce overall solids concentration, the tower environment itself does attract and create unwanted solids that can settle in the basin and never pass on to the heat exchanger.



Full current protection



Some current protection

Side-stream filtration – The typical practice is to divert 10-20% of the full-stream flow through a filter and back into the full-stream flow prior to the heat exchangers/chillers. Redirecting the side-stream flow back to pump suction is not recommended, since that would reduce flow to the heat exchangers or require an increase in the pump output. The logic of this technique is filtering the water at a rate greater than the anticipated input of contaminants.

Lower side-stream percentages are occasionally employed, but not recommended. Location (such as near open fields or windy, dusty situations) and seasonal conditions (such as pollen season, harvesting or spring blossoming) may effect higher contaminant potential and using a low-percentage side-stream may not overcome these conditions.

This approach is estimated to increase the operating cycle of a cooling tower's heat exchangers by 3x before servicing requirements (based on experiences with users who have kept good "before & after" records). It is commonly employed when the full-stream flow is extremely high, making full-stream filtration impractical, cost-wise. Like full-stream, this technique does not address the problem of solids accumulation in the tower basin or remote sump.

System turnover – Sometimes misunderstood as side-stream or basin-cleaning, this technique requires the calculation of the total volume of water in the cooling loop (in the basin/sump, piping, heat exchangers, etc.) and selects a once-an-hour rate of turnover (total water volume, divided by 60 = US gpm flow rate). Often, this flow rate is very similar to that of side-streaming, but accounts for greater system fluid volume, due to extensive piping, enlarged basin size, etc.

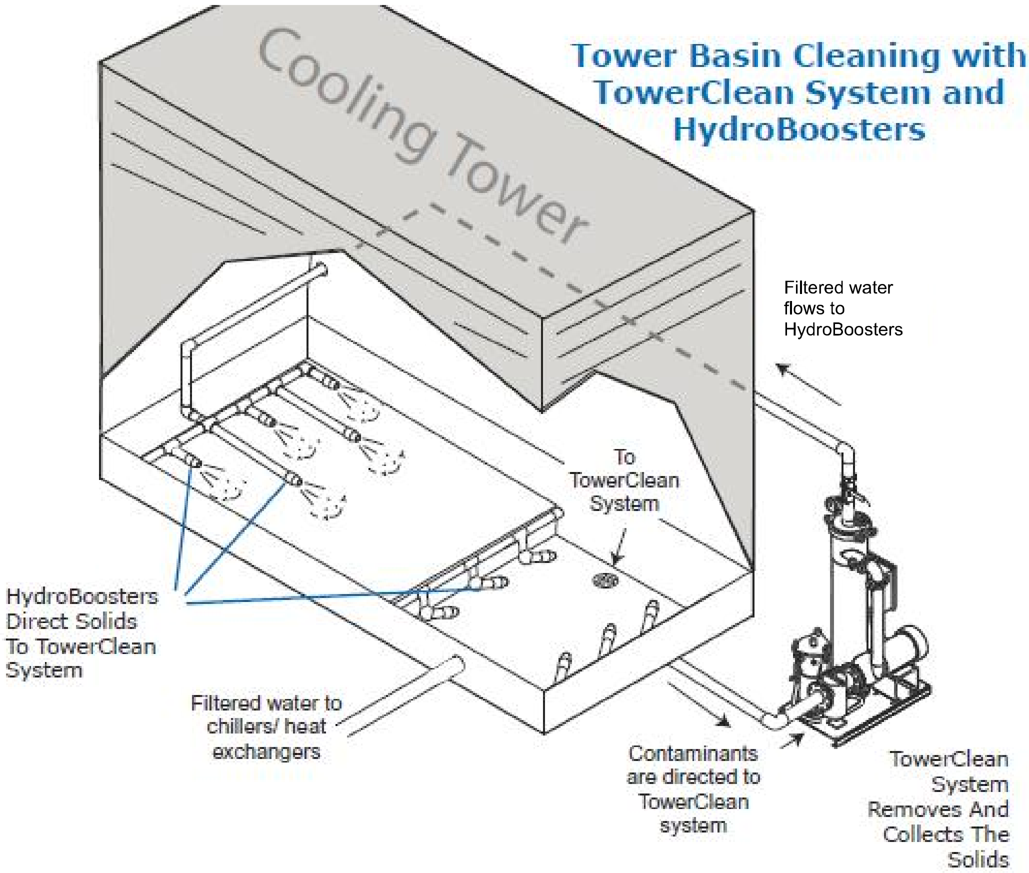
With system turnover, the estimated increase in operating cycle of a heat exchanger is 3x before servicing requirements (based on experiences with users who have kept good "before & after" records). Like the techniques above, this approach does not address the issue of solids accumulation in the tower basin or remote sump.

Basin cleaning – Relative to the techniques above, filtration directed specifically for the control of solids accumulation in the cooling tower's basin or remote sump is new to industry. However, its success and value makes it among the most popular approaches today. Basically, water is drawn from the tower basin/sump to the filter package and directly back to the tower basin/sump via a pattern of specialized nozzles to create a directed turbulence of flow designed to influence any settleable particles toward the basin cleaning package pump intake. The size of the filter package is based on the size of the cooling tower's basin or remote sump. A formula of "1 to 3 U.S. gpm per square-foot" is the common rule, dependent on the scope and potential contaminant load to be expected in the tower basin.

Though its technique is directed specifically at the tower basin/sump, the value is nonetheless predictable, estimated to increase the operating cycle of a heat exchanger by 5x before servicing requirements (based on experiences with users who have kept good "before & after" records). Unlike the other techniques above, this technique is the only method that does, indeed, directly address basin/sump accumulation.

Note that this approach requires the appropriate use of a venturi-like nozzle system to increase the total flow activity without the need for a high-volume pump, thereby keeping equipment and pump energy costs to a minimum. Known as Eductors or HydroBoosters, these nozzles increase the flow that passes through them by a factor of 5-6x, enabling the filter package to use a smaller filter and pump, while still achieving the flow activity necessary to sweep the settleable solids across the basin/sump to the filter package's pump intake.

An important element to making this approach work effectively is adhering to the flow and pressure requirements of the chosen nozzles in order to achieve the necessary flow to sweep the solids in the basin/sump and prevent troublesome accumulation. An inadequate flow/pressure to these nozzles minimizes the flow-increase capability of the nozzles, reduces the overall flow activity necessary to sweep solids toward the pump intake & into the filter and, in essence, achieves not much more than the equivalent of the "system turnover" technique discussed earlier.



Make-up water filtration – This technique employs a filter at the make-up water intake to keep unwanted particle matter from entering the system. Its value is limited to keeping make-up water contaminants from contributing to the system contaminant problem. Its limitation is that most solids typically come from the incoming air flow and the creation of solids via the evaporation-precipitation process. To date, no protection factor has been identified with this approach, although a water supply with significant sand, silt or organics could certainly create equally significant problems if not properly filtered.

FILTRATION SELECTION

Once the problem is defined and the solution technique is chosen, all that remains is the selection of the proper filter or separator to achieve the desired results.

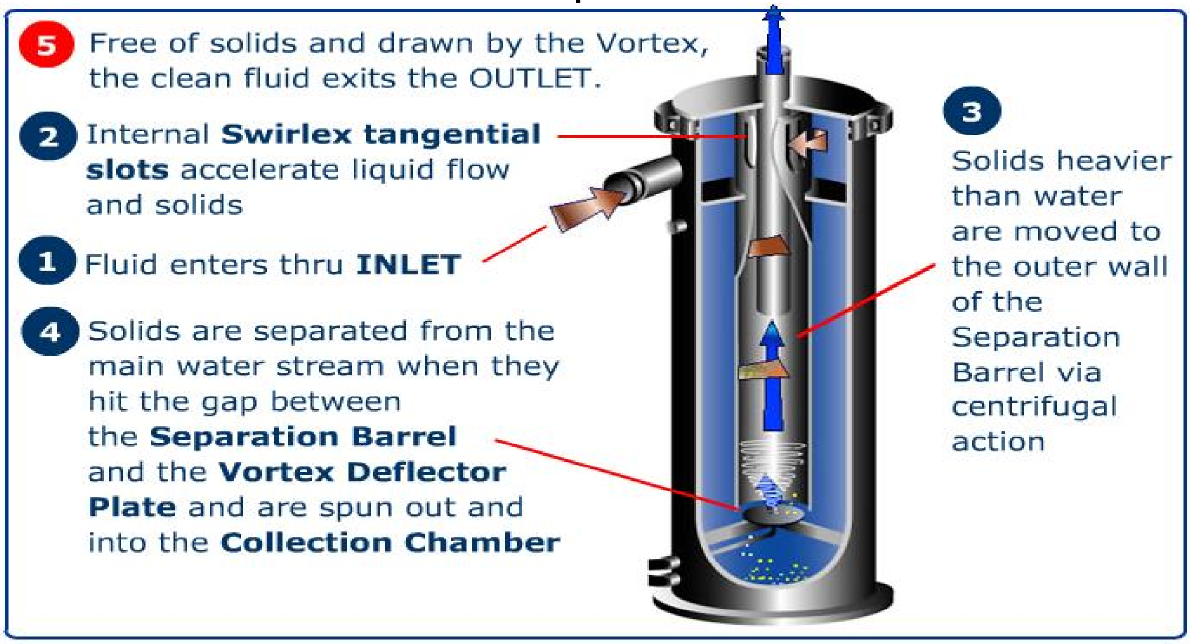
Filter options:

Screen Filters – Bag Filters, cartridge filters or self cleaning screen filters

Sand Filters – Media Bed Filters

Separtors - Solids from liquid separation

How a Pfeffer Separator Works



The following criteria places the proper means for analysis in the control of the buyer. Consider:

- *Particle removal capabilities* – Given what's required, can the filter being evaluated remove the troublesome solids?

- *Flow range* – Will that filter be able to handle the required flow rate?
- *Pressure loss* – How much pressure loss will the filter require? Variable or steady?
- *Liquid loss* – How much water is needed to clean the filter? How will you handle this water loss?
- *Solids*-handling – How will the filtered/separated solids be handled?
- *Replacement parts* – What routines and costs can be expected?
- *Maintenance requirements* – What procedures will be necessary? At what intervals? Downtime? Duplicate hardware?
- *Space requirements* – How much space is available? Will the filter fit in the area designated?

Be sure to take a solution orientation approach to selecting a filter or separator. A complete solution provides the proper filter, a proper means for automating it, an appropriate technique for capturing and handling the filtered/separated solids and the capability to package this solution to minimize engineering, purchasing, installation and operating start-up.

Filtration & separation systems are available for a wide range of problems. Use care in determining the real nature of a given problem, for it is possible to achieve absolute perfection, but it is important to seek affordable protection.

PAYBACK LOGIC OF FILTRATION

It is often said that cost-saving measures are always “in the budget”, but simply mis-directed until discovered at the problem(s) and re-applied at a lower rate toward the solution. Such is the case with proper filtration for an evaporative cooling water system. Calculate the costs associated without filtration and compare them to the cost of the proposed solution. That’s payback value.

Yet another way to identify whether filtration can become a solution is to apply these criteria:

- *Reduced Maintenance Costs: 60-90% savings* – Calculate the costs currently associated with contaminants in the water system. Downtime. Labor. Overtime. Lost productivity. Heat-exchanger cleaning/punch-out services. Easy to see where that cost can be reduced by this percentage.
- *Reduced Energy Costs: 10% savings* – When contaminants foul a heat exchanger or chiller, the result is longer operating cycles to achieve the proper cooling factor. This savings estimate is conservative, at best.

- *Reduced Water Costs: 5-10% savings* – Proper filtration can effectively reduce the frequency of blowdown. Consider not only the cost of the make-up water, but also the cost of sewage/waste discharge fees.
- *Reduced Chemical Costs: 5-15% -* With make-up water and solids fouling comes higher chemical treatment input. Without it, the savings are obvious.

Consider these criteria as a formula for calculating the basic payback associated with proper filtration. Add to these costs the wear and replacement of the tower and heat exchangers/chillers. The damage to pumps. The fouling and repair/replacement of valves & control instruments. The savings are there and the filters will pay for themselves.

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