SIDESTREAM FILTRATION FOR OPEN RECIRCULATING COOLING WATER SYSTEMS

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As more cooling water systems are susceptible to fouling from airborne contamination and makeup from unclarified river water and biotreatment effluent, a sidestream filter becomes more integral to good cooling tower operation and an excellent way to reduce blowdown.



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As more and more open re-circulating cooling water systems suffer from increased particulate contamination from the air, the use of sidestream filtration becomes critical to efficient operation of the cooling water system and optimum utilization of existing water resources. In many areas of the country where water costs are high and supplies tight, the implementation of zero blowdown strategies and recycled make-up from waste water and other secondary sources cause suspended solids in the bulk water to result in deposition and loss of heat transfer. Reduced cooling water flow to heat exchangers and accelerated corrosion rates on both mild steel and copper alloys can also result. As methods are proposed to reduce water losses through blowdown reduction, the use of side stream filtration for suspended solids reduction has become an essential design element in these systems.

In addition to process cooling water systems, commercial systems such as condenser water cooling for large air conditioning plants using centrifugal as well as steam absorption systems, especially in large urban areas can realize substantial benefits from sidestream filtration to reduce airborne contaminants such as alumino-silicate silt and dirt. Sidestream filtration in commercial applications can reduce or eliminate tower sump cleaning, maintain chiller tubes in a cleaner condition without mud accumulations and generally keep the system in peak operating condition. Following is a summary of the benefits of sidestream filtration to operators of cooling tower systems.

Benefits of Sidestream Filtration

Cleaner tower water and a cleaner system can be translated into water savings and longer equipment life. Following are some factors that can be used to justify installation.

• Because a sidestream filter will increase the rate of solids removal from the cooling water system, the corrosion inhibitor can lay a protective film on clean metal rather than fouled surfaces. This helps to reduce corrosion rates, thereby increasing exchanger life.

• The filter will work with depositcontrol agents to keep the cooling system cleaner. These agents keep small particles in suspension and the filter then can remove these along with the other larger particles.



• When good chemical treatment and a sidestream filter are coupled, there is less need to shut down a cooling water system completely for sump and internal cleaning. Periodic onstream cleaning is facilitated because the filter will lessen redeposition of just-loosened solids.

• In the cleaner system that the filter provides, heat transfer can be maximized for longer periods of time, thus helping to relieve some of the system stresses during the hot summer months.

• Removal of suspended solids from cooling water allows, in some instances, higher cycles of concentration, which reduces the quantity of blowdown water and, consequently, the amount of makeup water and treatment chemcals.

• In cooling water systems with biological problems, a filter will remove large growths as well as dead agglomerates. Removal of these growths will reduce the demand for chlorine and expensive non-oxidizing biocides.

If the filter factor, *f*, a measure of filtration capacity per unit heat removed by a cooling tower, is plotted against filter efficiency factor, *e*, a family of curves results for various cycles of concentration Y, thus, a given-size filter will remove a greater percent of solids as Y is increased.

Figure 1



- SS_f = Suspended solids in circulating water using filter
- SS₀ = Suspended solids in circulating water without filter
- SS_{fo} = Suspended solids in filter outlet
- $e = Efficiency factor (1-SS_{fo}/SS_{f})$

If an overall material balance and a solids balance are calculated around the tower in a cooling system (shaded area above), curves can be derived which relate the filter efficiency factor, SSt/SS_o, in a filter to the cycles of concentration and the filter factor, f.

Sizing the Filter

What, then, is an adequately sized filter? And how may it be determined in advance for each system? Using Syntec data on effective particle-size removal

in make-up, ppm, or make-up rate

divided by blowdown rate - M/B)

B = Blowdown rate = E/Y-1, gpm

M = Makeup rate = B + E, gpm

a plant engineer can easily determine the reduction of suspended solids in his system. It can often be helpful to determine the particle size distribution in the system. Matching this information to predicted particle-size removal, determines the filter efficiency factor, e, defined as:

 $e = 1 - SS_{fo}/SS_{f}$ (Figure 1)

where SS_{fo} is the suspended solids in water leaving the filter and SS_f is the suspended solids in water entering the filter. If e = 0, no filtration is occurring; if e = 1, there is 100% removal of suspended particles by the filter.

Some filters, such as sand filters, are only 20-30% effective (e = 0.30) in removing particles that enter the bed. Effectiveness of any filter depends not only on the media, but also on the size and distribution of the particles found in the system. A multi-media filter will remove nearly 100% of such particles as ferric hydroxide, suspended scale particles, silt, mud and corrosion products. Some types of biological growth and particles in the submicron range will tend to pass through.

It is possible to fix the value for the *e* variable — the filter type by considering the characteristics of a sidestream filter for cooling water. The filter should (1) remove those suspended particles with the greatest tendency to settle. Deposit-control agents can keep small particles from settling, thereby permitting their removal by blowdown or a later pass through the filter; (2) be least expensive for a given throughput of water; and (3) require a minimal backwash rate.



Multi-Media Filtration is Often the Best Choice

From these criteria, multi-media filters will most often be the best choice. They are the most efficient at solids removal and unlike sand filters, do not tend to become fouled and "blinded" at the top of the filter bed. Because of their unique media and density distribution, multi-media filters utilize most of the depth of the bed in particle removal rather than the first 2 or 3 inches.



A typical multi-media sidestream filter in process cooling water service

The amount of water required to backwash a filter can be estimated at 10 gpm per square foot of filter bed area. A 36-inch diameter filter with filter bed area of 7 sq ft will require a backwash flow rate of 70 gpm. If cooling water is used for backwash, this can be a source of uncontrolled blowdown from the system resulting in lowered cycles of concentration as well as loss of treatment chemical from the system. This is one of the reasons an automatic separate source backwashing option is popular in many cooling tower filter installations. Instead of backwashing with tower water, remote isolation valves allow city water to preferentially backwash the filter, saving cooling tower water and valuable chemical treatment.

The time required for the filter to reduce the suspended solids to the desired level is about eight turnovers; a turnover is the amount of time required to filter all of the water in the system once. If the size of the system isn't known, it can be estimated as 10-15 times the circulation rate. For example, if the circulation rate is 20,000 gpm, then a system capacity of 200,000-300,000 gal. can be expected. If a filter that handles 3% of the circulation (600 gpm) is used and the system contains 300,000 gal, then the time for one turnover is 500 min. and the time for equilibrium is 2 days, 19 hours.

Before the filter is placed in service the cooling water system should be as clean as possible, especially the tower sump. This will reduce the frequency of backwashes during startup; if too frequent, these could lower the sump level to a low point or overload waste treatment facilities.



Conclusion

Sidestream filtration is an important adjunct to modern cooling tower operation. Filtration reduces significantly the level and concentration of suspended solids in the system due to poor quality make-up, dust laden air, process contamination or biological fouling. Proper sizing of the filter is important to efficent operation and your Syntec representative is uniquely qualified to recommend and size the right filter for your application.

Sidestream filtration can result in cleaner heat transfer surfaces, more efficient operation and lower costs.

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Electronic controls can provide a high dregree of flexibility in filter operation