Eneref Institute

PR FOR PLANET EARTH™

A REPORT ADVOCATING FOR SOCIALLY RESPONSIBLE SUSTAINABLE DEVELOPMENT

CRITERIA FOR EVALUATION: FINE FILTRATION FOR **HVAC COOLING TOWERS**

ENEREF INSTITUTE EXAMINES FILTRATION SYSTEMS FOR BUILDING COOLING TOWERS.

In order to reduce the concentration of contaminants in HVAC cooling towers, a substantial amount of water must be periodically discharged. However, this discharged water, or blowdown, contains anti-scalant, anti-corrodant and anti-microbiological toxic chemicals used to control scaling, fouling and corrosion. The blowdown is discharged into local sewage or storm water systems and ultimately into the environment. And hazardous materials discharged into local sewage must be treated by municipal sewer agencies. One technology that can help mitigate this problem is cross-flow microsand filtration.

KAISER MEDICAL CENTER SAVED $129,000 ANNUALLY WITH CMF FINE FILTRATION.

Using Vortisand CMF system to replace centrifugal separators, 3 HP pumps replaced 15 HP filter pumps. Maintenance and cleaning was reduced from $87,600/year to $1,500/year.

Due to the wide variation of chemicals used in cooling towers, it is not possible to quantify the exact number of pollutants discharged globally into the environment. However, to protect the ecosystem, technologies that can effectively reduce chemical use should be implemented where practicable.

WATER TREATMENT

Building cooling towers absorb heat from HVAC systems and eject it into the atmosphere. Proper maintenance of cooling towers is essential for reducing bacteria and increasing efficiency. According to ASHRAE/ANSI Standard 188-2018, it should be assumed that bacteria, such as *Legionella*, as well as protozoans and algae can colonize in cooling tower systems.

While proper chemical treatment reduces downtime and protects cooling tower assets, the growing water scarcity faced worldwide urgently calls for fewer chemical treatments and more effective water management.

Many building operators have insufficient knowledge of water treatment to properly and efficiently maintain their cooling towers, especially compared to their knowledge of energy systems. To manage their buildings' water treatment systems, operators typically depend on chemical suppliers, whose product lines include toxic biocides to control pathogen risk.

HIGH-EFFICIENCY CMF

New sustainable technologies have become commercially available to treat cooling towers. These systems maximize efficiency and minimize the spread of microorganisms while also reducing the need for chemical treatments. One such technology, growing in demand, is high-efficiency cross-flow microsand filtration (CMF), which use cross-flow microsand filtration to capture microscopic and even submicron particles. CMF systems not only improve the efficiency of chemicals but also require fewer chemicals to achieve the same results.

Over half of all commercial buildings use water-cooled chillers, including office, healthcare, education, lodging and public buildings. However, as many as 20% of all water-cooled chiller systems in the US use no filtration at all in their cooling towers, according to research by Eneref Institute.

While high-efficiency cross-flow microsand filtration (CMF) is a uniquely effective solution for reducing fouling, according to research by Eneref Institute only about 15% of all US commercial buildings use CMF systems in their cooling towers. Roughly 25% use centrifugal separators; 20% use screen filters; and 20% use cartridge bags, mono- or multimedia filtration and other systems. Not surprisingly, healthcare and university facilities are especially aware of the need to eliminate bacterial contamination and therefore represent the largest share of high-efficiency CMF users.

MEASURE OF EFFICACY

This report looks at the benefits of CMF technology because of its high-value results. Traditional deep-bed multimedia, or sand, filters typically capture particles of 20 microns and above. While such systems can remove up to 90% of contaminant particles by weight, they leave unchecked all fine particles—the particulates

that are most responsible for the fouling that supports *Legionella* and system inefficiency.

By count, fine particles far outnumber larger particles in water cooling tower systems. For example, a single particle 3mm in size is equal in weight to as many as 256 billion 2-micron-sized particles. That explains why cooling tower water analysis reports typically show that 95% of particulates are less than 5 microns in size. When measured by mass, however, 80% of the bulk is comprised of particles greater than 15 microns. Traditional filtration systems reduce the quantity of larger particles but not the smaller particles that cause fouling—demonstrating why parts per million (ppm) is an incomplete measure of total suspended solid (TSS) in water.

HOW CMF WORKS

CMF systems differ from traditional flow media filters in a number of ways. Rather than a simple vertical flow, water is cross-flowed, tangentially, across the top layer of the media bed by an injector. The flow scours the media's top surface layer, preventing surface blinding by lifting larger particles into suspension. The media bed then becomes a clean, free space in which fine particulates are trapped. In this way, CMF technology allows for optimal use of the media surface area and removes particles down to submicron levels—smaller than one micron—thus protecting the cooling tower by reducing the risk of fouling, scaling and corrosion.

FILTERS MISS PARTICLES

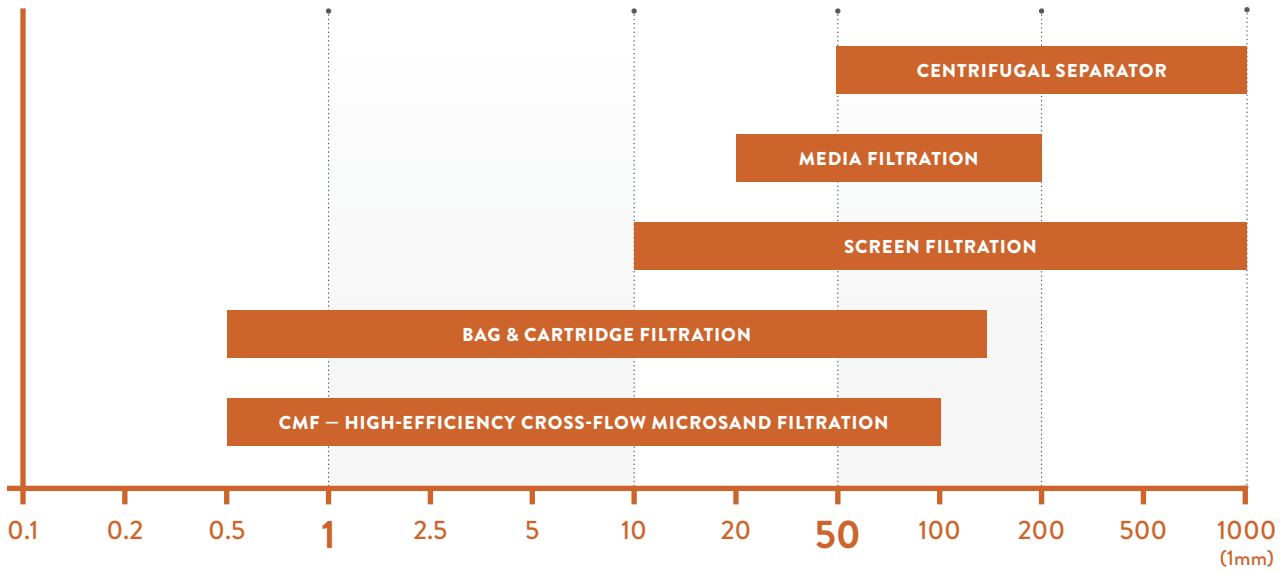
No filtration system can remove dissolved solids or increase the cycle of concentration (the ratio of dissolved solids in the cooling tower to dissolved solids in the make-up water). Because dissolved solids are removed by purging water and topping up the tower with fresh make-up water, frequent blowdown is the only viable solution to reduce the concentration of total dissolved solids (TDS). However, frequent blowdown sends toxic chemicals into the environment, perpetuating the cycle.

CHEMICAL TREATMENTS

Unlike total dissolved solids, total suspended solids (TSS) can be reduced by filtration. Reducing TSS makes chlorine and other disinfectants more effective, allowing chemical treatments to be reduced by as much as 35%. Therefore the rate of corrosion from oxidizing

FILTRATION TECHNOLOGY

AN EVALUATION OF AVAILABLE TECHNOLOGIES



chemicals is reduced as well as chemical odor. Furthermore, it may no longer be necessary to use coagulants to fuse and jettison small particulates. The lessened chemical requirements not only reduce material and labor cost but, more significantly, provide environmental benefits by decreasing the number of toxic chemicals entering the ecosystem.

FOULING AND SCALING

When suspended solid particles accumulate and settle on heat transfer surfaces, or heat exchangers, fouling occurs. Fouling decreases the efficiency of heat exchangers, increases maintenance and forces shutdowns. Fouling can also be caused by airborne sediment such as dirt and silt.

With significant microbial growth, microorganisms create a gel-like biofilm. Biofilm is another source of fouling, as it creates a layer that protects microorganisms from disinfectant chemicals, which makes cleaning difficult. Biofilm also prevents anticorrosion chemicals from reaching the heat exchanger's surface. Moreover, biofilm formation prevents microorganisms from being easily flushed away during cooling tower blowdown. By filtering particulates less than 5 microns in size, CMF reduces fouling, thereby maintaining the equipment efficiency designed by manufacturers.

REDUCED CONDUCTIVITY

Inorganic calcium salts cause scaling, not fouling. While both fouling and scaling reduce thermal conductivity, or heat transfer, fouling has a greater impact on conductivity. Every thousandth-of-an-inch increase in fouling necessitates a 10% increase in power from the system because the deposits insulate the heat transfer surfaces, impeding heat exchange.

While the thermal conductivity of copper pipes can be as high as 398 W/m^2K, the thermal conductivity of calcium carbonate, the most common cause of scaling, is just 2.26 W/m^2K—or 1% that of copper. Calcium sulfate and calcium phosphate, also common scaling sources, have low conductivity similar to calcium carbonate. Yet biofilm, a root cause of fouling, has a thermal conductivity significantly lower than the salts that cause scaling, just 0.63 W/m^2K. This is why CMF is crucial to maintaining heat transfer efficiency.

FOULING PARTICLES

The rate of fouling is much faster when smaller particles are present in the water than when larger particles are present, explaining why fine filtration is essential. Because the surface of metal is jagged at microscopic sizes, fouling buildup is primarily dependent upon particle size.

As water flows across the metallic surface of the heat exchanger, larger particles won't initially attach; instead they roll and bounce off. However, the fine particles—those that CMF systems are designed to capture—are the first to cling to surfaces, according to research by Müller-Steinhagen published in The Canadian Journal of Chemical Engineering.

For example, if the concentration of 8-micron-sized particles were to double, the fouling heat transfer resistance in the system would increase by only 5%. On the other hand, if the concentration of 1-micron-sized particles were to double, the fouling heat transfer resistance could increase by as much as 150%. See diagram on the following page.

MICROBIAL GROWTH

While no filtration system eliminates *Legionella*, reducing fine particles can break up the shelters where microbes hide from disinfecting chemicals. In this way, high-efficiency CMF technology maximizes the effectiveness of chemicals by diminishing the opportunity for microbes—including protozoa, algae, fungi and *Legionella*—to cultivate and multiply. Reducing fine particles also removes the nutrient source for bacterial growth.

In the United States, Legionnaires' disease is fairly common and serious—one of the top three causes of non-

epidemic, community-acquired pneumonia. According to US Dept of Labor, OSHA estimates that over 25,000 cases of the illness occur each year, causing more than 4,000 deaths. Only preventive measures, such as more effective water filtration, can minimize the potential for *Legionella* outbreaks.

FILTRATION RATES

The best CMF systems on the market can achieve filtration flow rates up to 5 times greater than those of traditional media filters. These high rates can be achieved because CMF systems require less than 5% of the cooling tower water to flow into the filtration media at a time. Traditional technologies may require up to 30% of the cooling tower flow. The shallower bed of CMF systems also requires 50% less water for backwash than traditional deep-bed systems. And with reduced space requirements, CMF systems are ideal for existing facilities with a limited capacity for expansion.

PERFORMANCE

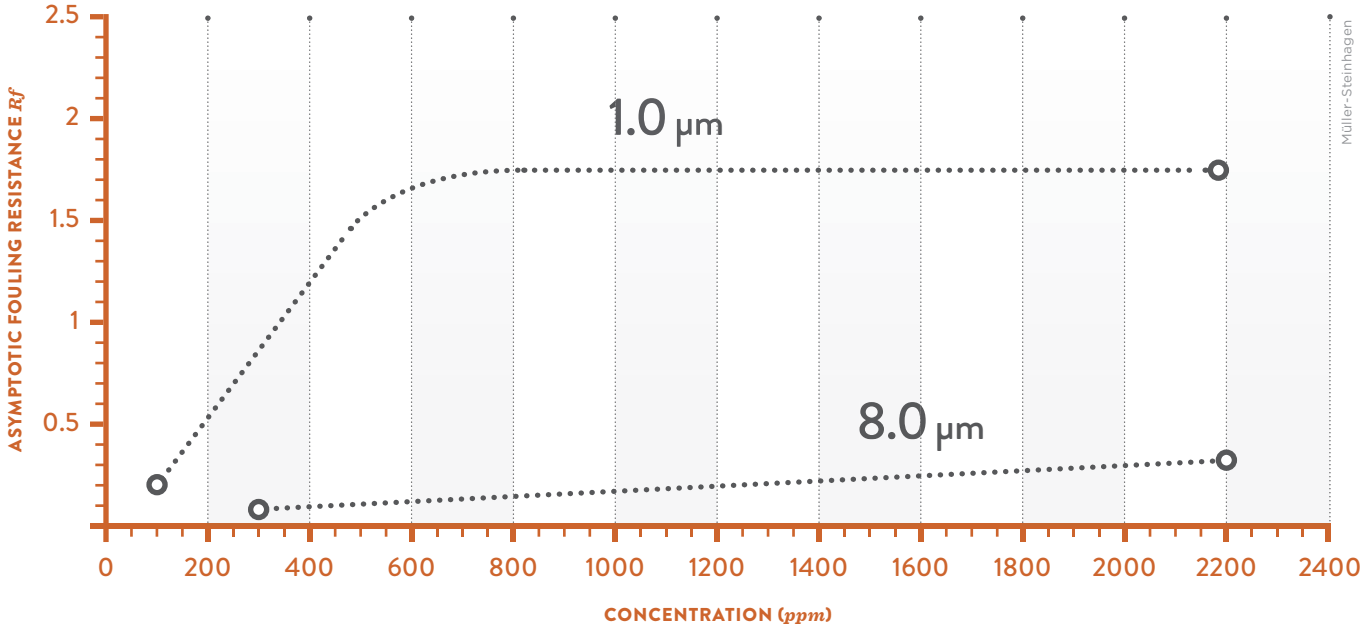
Beyond savings in energy and water use, a significant number of CMF users reported reduced maintenance of their heat exchangers. Users also reported that their systems operated for longer durations, uninterrupted, with minimal upkeep costs and at higher levels of performance.

Still, saving water is a critical benefit of CMF systems. According to the US Government Accountability Office, forty states expect water shortages in some portion of their land under average conditions within the next 10 years. Cooling towers represent one of the largest sectors of water consumption, and competition with other water users—including agriculture, industry and municipalities—will only exacerbate water scarcity.

Blowdown discharged into the environment can be harmful to both fauna and flora. And blowdown contains biocides that can kill the microbes that water treatment plants rely on to remove organic contaminants. A better understanding of water filtration systems will help building operators reduce the quantity of toxic chemicals discharged into the environment, increase both energy and water efficiency, and limit the growth opportunity for pathogens.

FOULING HEAT TRANSFER RESISTANCE

SMALLER PARTICLES CAUSE MORE RESISTANCE



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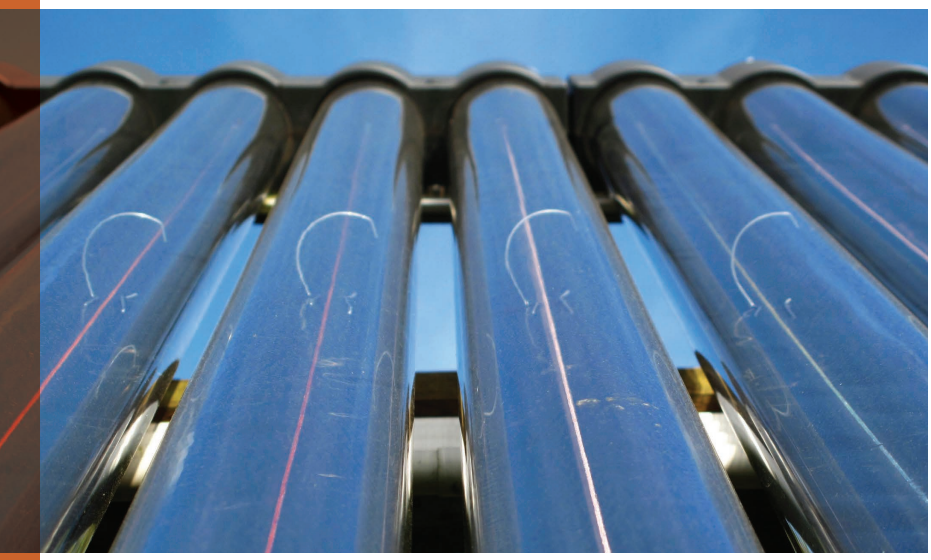

LEAD BY EXAMPLE.

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IS A CAMPAIGN TO PRESERVE OUR NATURAL RESOURCES AND ENJOY THERMAL COMFORT IN OUR HOMES AND BUILDINGS.

TO ACCOMPLISH OUR MISSION, Eneref Institute launched the Water Initiative to champions solutions in line with our mission and deliver sound ideas to significant market influencers. The initiative is designed to encourage responsible behavior of public and private organizations, municipalities and corporations with common sense solutions that can achieve effective results.

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