Current Knowledge & News on Advanced Water-Treatment Technology

Clearwater Signals

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New York's Green Building Tax Credit

New York's innovative tax law – its *green building credit* – serves as an incentive for building owners, developers, and tenants to adopt environmentally sustainable practices. The credit allows them to claim up to $3.75 per square foot for interior work and $7.50 per square foot for exterior work. To qualify for the credit, a licensed architect or engineer must certify the building. Specific requirements must be achieved for energy use, materials selection, indoor-air quality, waste disposal, and water use. Ten percent of the cost of ozone-friendly air conditioning, 30 percent of the installed cost of fuel cells, and 100 percent of the cost of photovoltaic (PV) solar panels may also be recouped through the credit. Thus, by offsetting the initial costs of these investments, the tax credit helps make it more affordable for building owners and developers to embrace a cleaner and healthier future.

• **The Ozone Issue**. It is widely accepted that chlorine and bromine atoms in the upper atmosphere will destroy ozone. In fact, the EPA estimates that one chlorine atom can destroy over 100,000 ozone atoms before finally being removed from the stratosphere. The source of these chemicals is very hard to determine. CFC refrigerants are one source of chlorine, but there are certainly many more, both manmade and natural.

The largest amount of chlorine released in a water-based cooling system is from the cooling tower. Chlorine (liquid bleach) is the most common biocide used in cooling towers. The chlorine is rapidly lost to the atmosphere via evaporation, so more chlorine is continually added. A 1,000-ton chiller operating for 12 hours per day will require the addition of 150 pounds (about 150 gallons of industrial strength liquid chlorine) per month. Over 90% of this chemical is released to the atmosphere in the form of chlorine gas. There may be a legitimate argument as to where all this chlorine gas goes (i.e., how high in the atmosphere it rises), but under Dolphin System technology the argument is academic. There is no chlorine gas going anywhere, not in the ozone layer, not in the air we breathe.

Your Cooling Tower and Drift

• *Particulate Matter A Growing Concern* •

There are six common air pollutant sources that the U.S. Environmental Protection Agency (EPA) regulates across the nation. These six pollutants are: carbon monoxide, nitrogen dioxide, sulfur dioxide, lead, ozone, and particulate matter. Specific health-based standards are set for each of these pollutants. If the ambient (outside) air does not meet the specific standard in a given geographical area, then that region is classified as a "non-attainment" area.

Particulate matter consists of small, non-hazardous particles in the air. Current enforcement applies only to particles less than 10 microns in diameter (PM10). To offer a visual concept on the size of these particles, the dot over the letter "i" is approximately 375 microns in diameter. However, "smaller" does not mean "cleaner" or "less harmful" when it comes to protecting human health and the environment.

In fact, the EPA is focusing on much smaller particles. The agency has established limits regulating particles less than 2.5 microns (PM2.5) to tougher standards, but implementation of these standards will take 5 to 10 years. Why tougher limits on smaller particles? Because small particulate matter can penetrate into sensitive regions of the respiratory tract where they can cause persistent coughing and significant respiratory and cardiovascular-related problems. Children, the elderly, and people with asthma and emphysema are particularly vulnerable. Health problems for sensitive people can get worse if they are exposed to high levels of particulate matter for just a few days in a row.

Large Cooling Tower with Risers at a Hospital

• **Cooling Towers and Particulate Matter**. Cooling towers release PM10 through the process of drift. As air is forced through the tower, small droplets of water can become entrained in the air and escape the confines of the tower. These droplets are not water vapor, but small drops of recirculating water containing the same chemicals and minerals as the tower water. When these droplets are carried out of the tower via drift they will evaporate. Any total dissolved solid (TDS) in the drops will form small airborne particles.

New modern cooling towers are equipped with high-efficiency drift eliminators that reduce the quantity of droplets released into the atmosphere. Drift is usually reported

(Continued on page 2)

Particulate Matter: Major Areas of Concern
General Health. Particulate matter is associated with serious health effects.
Healthcare Demands. Particulate matter is associated with increased hospital admissions and emergency room visits for people with heart and lung disease.
Decline in Productivity. Particulate matter is associated with work and school absences.
Aesthetic and Natural Resource Impacts. Particulate matter is the major source of haze that reduces visibility in many parts of the United States, including our National Parks.
Environmental Effects. Particulate matter settles on soil and water and harms the environment by changing the nutrient and chemical balance.
Cultural Infrastructure Damage. Particulate matter causes erosion and staining of structures including culturally important objects such as monuments and statues.

Your Cooling Tower and Drift *(Continued from page 1)*

as a percentage of the water circulation rate. Typically, new towers have a drift rate of 0.001% or less. This drift rate assumes that good maintenance is being performed on the drift eliminators. Drift eliminators are more effective on large droplets instead of small ones. The spectrum of drops passing out of a cooling tower has 80% <115 microns, 90% <170 microns and 95% <230 microns.

The larger the particle the less of a problem it is to human health (large particles do not penetrate deeply into the respiratory system). By assuming that a single particle forms from each drop, that the specific gravity of the drop is 1.0 and that of the particle is 2.0, and that the total dissolved solids in the water are at 1,500 ppm, then:

Droplet Diameter	Maximum Particle Diameter
115 microns	5.2 microns
170 microns	7.7 microns
230 microns	10.4 microns

Since 95% of the emitted drift is less than 230 microns, virtually all of the dissolved solids will be converted to airborne particles less than 10 microns in size. In fact, this method is how the EPA calculates the quantity of PM10 released from a cooling tower. (See the sidebar article below to understand how PM10 can be calculated for a cooling tower.)

To reduce the particulate emission, the only choice is to reduce the quantity of TDS in the recirculating water. The only practical way to reduce TDS on a chemically controlled tower is to decrease the cycles of concentration by blowing down more water, thereby increasing water use to reduce air emissions.

• **How the Dolphin System Addresses this Issue.** Using the Dolphin System helps with PM10 and even PM2.5 emissions in two separate ways. First, for the same water use, a tower under Dolphin System control will run at 10% to 30% less TDS than a chemically controlled tower. Instead of keeping minerals in solution, the Dolphin System allows some of the minerals to precipitate as bulk-solution solids. These precipitates are removed from the system by sidestream filtration or blowdown and never enter the air stream. Typically, a 20% reduction in TDS and hence particulate emission is achieved by using the Dolphin with no increase in water use. This reduction goes a long way in addressing EPA concerns.

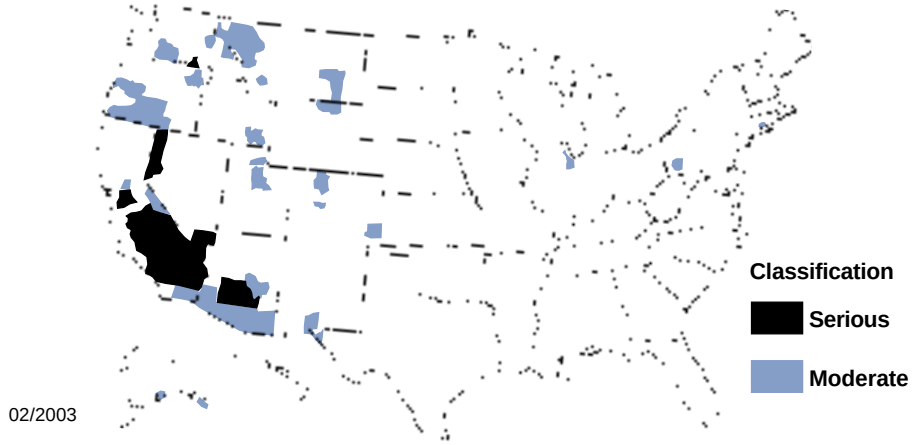
The second improvement in particulate emissions with the Dolphin System is in the morphology of the particulates formed. When a drop of water from a chemically controlled tower is dried, it reaches a high degree of supersaturation, then forms a multitude of very fine particles. Although the total mass of the particles from a drop is the same, there will be many small particles rather than a few large particles. This effect results in a finer and more hazardous pollutant being released.

The hallmark of the Dolphin System is that it provides nucleation sites for precipitation to form. As a drop dries, all of the minerals will grow on a few nucleation sites.

This effect results in larger and less hazardous particulates being released, thereby helping to protect human health and the environment.

• **Conclusion.** Particulate emissions are a serious pollution problem in the U.S. Almost 30 million people in the nation's population reside within non-attainment areas for PM10 emissions. The percentage for non-attainment areas for PM2.5 is likely to be much greater. All large projects in non-attainment areas require offsetting pollution credits to proceed. Even for regions that are in attainment, it is a good practice to keep air pollution as low as reasonably possible. The table on National Ambient Air Quality Standards on the opposite page lists the standard values for PM10 and PM2.5 within the context of the other five common air pollutants. The Dolphin System achieves such goals in a synergistic, cost-effective, energy-savings, and environmentally sustainable framework.

Regional Areas Designated Nonattainment for PM10



HOW PM10 CAN BE CALCULATED…

The following example is for a 1,000 ton cooling tower operating 24 hours per day with a total dissolved solid concentration of 1500 ppm and a drift rate of 0.001%. (Note: the EPA, in Compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition, Volume I: Stationary Point and Area Sources paragraph 13.4, assumes that the drift from all towers is 0.02%, resulting in a 20 times higher release of particulates).

Given:
Tonnage = 1,000
Circulation rate = 3,000 gpm
Drift = 3,000 X 0.00001 = 0.03 gpm

See Page 3 for National Ambient Air Quality Standards

Then:
PM10 = 0.03 gpm x 8.337 lb/gallon x 1500 ppm x 453.59 grams/lb = 0.17 grams/min = 170,000µg/min.

If the tower has an L/G ratio (pounds of water divided by the pounds of air) of 1.3, then the airflow = 3,000gpm X 8.337 lbs/gal / 1.3 = 19,239 lbs/min.

For air with a density of 0.075 lbs/CF, these parameters will result in airflow of 256,523 CFM or 7,267 m^3/min.

The average concentration of particulate in the exhaust from this tower is 23.4 µg/m^3 (170,000 / 7,267). This value is compared to a PM10 annual arithmetic mean of 50 µg/m^3 and a PM2.5 of 15 µg/m^3.

While this may be the true emission, EPA assumes that all cooling towers emit drift at a rate of 0.02%, 20 times higher than what new towers actually emit. Using this factor increases the calculated particulate emissions also by 20 times…a very problematic situation, particularly in a non-attainment region.

An Enlightened Perspective:
The Gecko's Paw, the Dolphin System, and Van der Walls

• **Background**. *Engineers and biologists recently have come to a consensus on how nature's supreme climbers can race up a polished glass wall at a meter per second and support their entire body weight with only a single toe. The discovery may now allow engineers to create prototypes of a synthetic gecko adhesive.*

The Gecko: One Toe is All It Takes

"We have solved the puzzle of how geckos use millions of tiny foot hairs to adhere to even molecularly smooth surfaces such as polished glass," said Kellar Autumn, a lead author of an article on the research. A team of researchers from Lewis & Clark College, the University of California at Berkeley, the University of California at Santa Barbara, and Stanford University confirmed speculation that a gecko's climbing ability depends on a weak molecular attractive phenomenon called the Van der Waals force.

• **The Dolphin System's Water-Treatment Connection**. The most visible effect of Dolphin System treatment on cooling tower or fountain water is the crystal clarity of the recirculating water. Over a relatively short period of time the murky, turbid water in the tower or fountain will turn remarkably clear. The Van der Waals force that causes this effect is one of the weakest forces in nature, yet it is the same one that allows geckos to run up walls.

• **The Science**. Murky water in cooling towers is caused by a dispersion of small, suspended solids. These suspended particles develop a strong surface charge (usually negative) that prevents their agglomeration. The like surface charges keep the particles apart. Traditional methods of dissipating this charge involve adding a material with a high positive valence such as ferric ions (Fe^{+3}) or aluminum ions (Al^{+3}). This process is called coagulation (from the Latin "to drive together") and is a critical step in most potable water treatment plants. The Dolphin System dissipates the surface charges by use of a pulsing electric field instead of the addition of a charged ion, but the results are similar.

After the surface charge is dissipated, the Van der Waals force that allows geckos to climb walls takes over. Van der Waals forces arise from the time-variant distribution of electron charge around an atom. This variation results in dipole charges (with a positive and negative end) even on symmetrical atoms. These dipoles on adjacent atoms and molecules will align themselves and attract. This attraction (Van der Waals force) only comes into play when the atoms are close together and when the stronger forces (i.e., surface charges) have been eliminated. Again, although these forces are very weak, their effect is as clear as the gecko on the wall or the water in your cooling tower or fountain.

The Van der Waals Force at Work in a Crystal-Clear Fountain under Dolphin System Control

National Ambient Air Quality Standards

POLLUTANT	STANDARD VALUE*		STANDARD TYPE
Carbon Monoxide (CO)			
8-hour Average	9 ppm	(10 mg/m^3)	Primary
1-hour Average	35 ppm	(40 mg/m^3)	Primary
Nitrogen Dioxide (NO_2)			
Annual Arithmetic Mean	0.053 ppm	(100 µg/m^3)	Primary & Secondary
Ozone (O_3)			
1-hour Average	0.12 ppm	(235 µg/m^3)	Primary & Secondary
8-hour Average	0.08 ppm	(157 µg/m^3)	Primary & Secondary
Lead (Pb)			
Quarterly Average	1.5 µg/m^3		Primary & Secondary
Particulate (PM 10) *Particles with diameters of 10 micrometers or less*			
Annual Arithmetic Mean	50 µg/m^3		Primary & Secondary
24-hour Average	150 µg/m^3		Primary & Secondary
Particulate (PM 2.5) *Particles with diameters of 2.5 micrometers or less*			
Annual Arithmetic Mean	15 µg/m^3		Primary & Secondary
24-hour Average	65 µg/m^3		Primary & Secondary
Sulfur Dioxide (SO_2)			
Annual Arithmetic Mean	0.030 ppm	(80 µg/m^3)	Primary
24-hour Average	0.14 ppm	(365 µg/m^3)	Primary
3-hour Average	0.50 ppm	(1300 µg/m^3)	Secondary

* Parenthetical value is an approximately equivalent concentration

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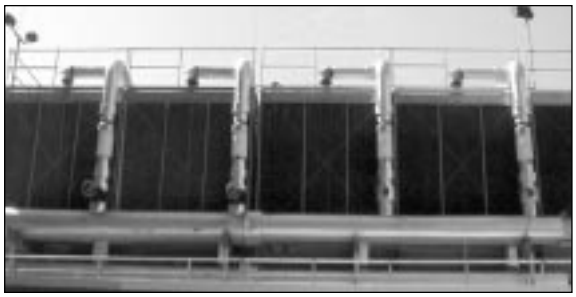

Dolphin Systems are Installed in Hospitals throughout U.S.

NOTE: The Dolphin System™ is covered by U.S. Patent 6,063,267 and other pending patent applications.

UPCOMING • Conferences • Seminars • Trade Shows • Expositions • UPCOMING

Event	*Date & Location*	*Points of Contact*
American Water Works Association 2003 Annual Conference and Exposition. Over 500 exhibitors and a diverse program on water-related issues, including: managing drought, regulatory updates, evaluations of disinfectants, ozone in drinking water, and new methods and technologies used to manage water. www.awwa.org	June 15-19, 2003 Anaheim Convention Center Anaheim, California	American Water Works Association 6666 West Quincy Avenue Denver, CO 80235-3098 Questions: 800-926-7337 or 303-794-7711 Fax: 303-794-3951 www.awwa.org/About/ContactUs.cfm
Building Owners and Managers Association (BOMA) Annual Conference and Office Building Show. Real estate professionals throughout North America and Europe convene to learn about new technologies and meet with vendors who offer the products and services to help buildings become more efficient, environmentally sustainable, and safer. www.boma.org	June 27-July 2, 2003 San Francisco Marriott The Moscone Center San Francisco, California	Building Owners and Managers Association 1201 New York Avenue NW Washington, DC 20005 Questions: 202-408-2662 Fax: 202-371-0181 www.boma.org
64th International Water Conference. A technical forum for advancements in industrial, utility, and wastewater technology. Features include a technical program, exhibit hall, and information-sharing suites. www.eswp.com	October 19-23, 2003 Omni William Penn Hotel Pittsburgh, Pennsylvania	Engineers Society of Western Pennsylvania 337 Fourth Avenue Pittsburgh, PA 15222 Questions: 412-261-0710 Fax: 412-261-1606 conf@eswp.com
Greenbuild International Conference & Expo. A showcase for leading-edge green technologies and an educational program on energy-savings and environmentally sustainable buildings. Sponsored by the U.S. Green Building Council, this event marks the 2nd Annual USGBC Conference. www.usgbc.org	November 12-14, 2003 David L. Lawrence Convention Center Pittsburgh, Pennsylvania	U.S. Green Building Council 1015 18th Street, NW, Suite 805 Washington, DC 20036 Questions: 202-828-7422 or 312-541-0567 Fax: 202-828-5110 or 312-541-0573 info@corexpo.com