American Water Works Association

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PRACTICAL IDEAS FOR WATER OPERATORS

Water Quality
SHADE BALLS BATTLE BROMATE

Operations and Maintenance
VALVE EXERCISING BOOSTS PERFORMANCE

Treatment
CORROSION CONTROL: LESS IS MORE

Asset Management
SOFTWARE AIDS REHABILITATION EFFORTS

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The Los Angeles Department of Water and Power is using an innovative approach to bromate treatment by using "shade balls" to keep bromide and chlorine from reacting with sunlight. BY CAROL TOMERLIN

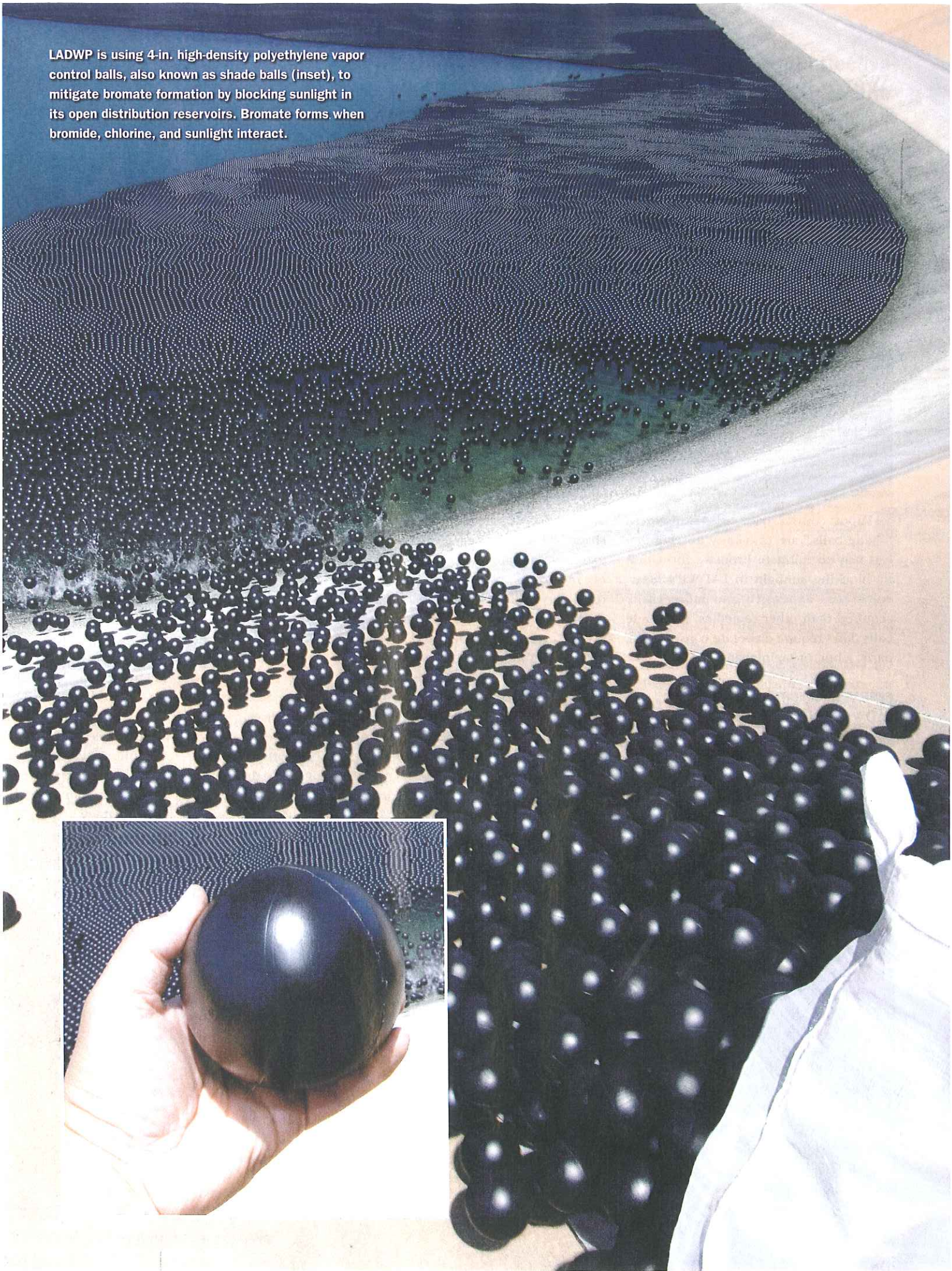
MADE IN THE SHADE

When the Los Angeles Department of Water and Power discovered that three of its open-air posttreatment reservoirs had elevated levels of bromate, it developed an innovative solution: cover the reservoirs with millions of 4-in. black, high-density polyethylene vapor control balls.

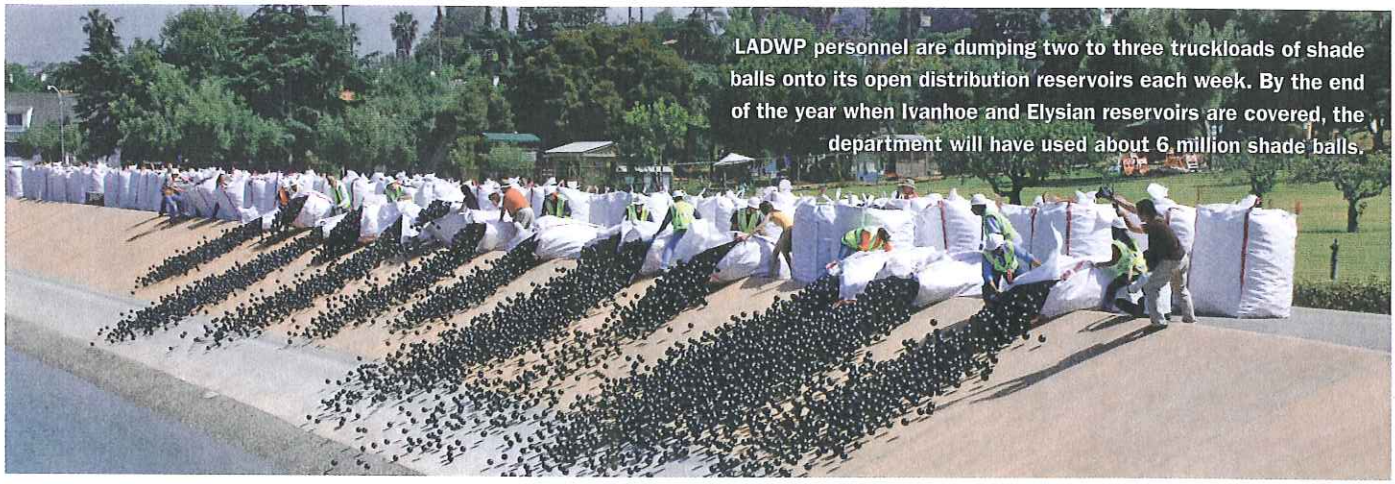
Bromate is a disinfection by-product that forms when three elements—bromide, chlorine, and sunlight—are present. When the US Environmental Protection Agency formulated guidelines for bromate levels in drinking water, however, it wasn't known that bromate could form as a disinfection by-product in an open distribution system. The federal limit for bromate is a running annual average of 10 ppb.

Because LADWP's treatment facility always measured bromate at less than 5 ppb, it was a surprise when bromate levels in its open posttreatment reservoirs were registering much higher. One seasonal measurement exceeded 100 ppb. The department was confident that, with careful monitoring and shutting off the supplies from groundwater wells that have high naturally occurring bromide, it could temporarily meet the 10 ppb annual average. LADWP had to remedy the problem further though, because it would need the well supply to meet elevated water demands during hotter months of the year.

PHOTOGRAPHS: LOS ANGELES DEPARTMENT OF WATER AND POWER



LADWP is using 4-in. high-density polyethylene vapor control balls, also known as shade balls (inset), to mitigate bromate formation by blocking sunlight in its open distribution reservoirs. Bromate forms when bromide, chlorine, and sunlight interact.



LADWP personnel are dumping two to three truckloads of shade balls onto its open distribution reservoirs each week. By the end of the year when Ivanhoe and Elysian reservoirs are covered, the department will have used about 6 million shade balls.

Vapor control balls, also known as "shade balls," are providing an economical way to mitigate bromate formation by blocking sunlight in LADWP's reservoirs. Less expensive and more easily acquired than other remedies, the shade balls don't require elaborate construction, parts, labor, or maintenance.

RESEARCH SPECIFICS

LADWP's primary treatment facility, the Los Angeles Aqueduct Filtration Plant, is a 600-mgd plant that uses ozone and direct filtration. Six posttreatment open-air reservoirs within the city contain chlorinated water with varying levels of natural bromide. The three reservoirs most affected—the 795-mil-gal Silver Lake Reservoir, 58-mil-gal Ivanhoe Reservoir, and 64-mil-gal Elysian Reservoir—combine to serve 600,000 customers in downtown, central, and south Los Angeles. Because the water traversing Ivanhoe and Elysian reservoirs, at least seasonally, has high bromide water that's chlorinated, those reservoirs are being covered with shade balls to mitigate bromate formation. Silver Lake Reservoir, which is too large to cover with shade balls, will be filled seasonally with low-bromide water that won't be treated with chlorine until after it leaves the reservoir, away from solar exposure. This constitutes a major change of LADWP's operation policy but guarantees the water is safe from bromate formation.

The decision leading LADWP to its shade ball solution began in fall 2007 with extensive monitoring and a close working relationship with the community and regulatory authorities. LADWP personnel monitored bromate levels at Ivanhoe Reservoir several times each day. Testing on a cloudy mid-October day when the sunshine was about 15–20 percent of what it would have been on a bright summer day revealed no net bromate formation. However, levels nearly quadrupled the next day, which was sunny and clear. These monitoring results confirmed LADWP's suspicion that light was a component of the bromate formation.

"If light was a driving factor, this field data suggested that, if you wanted to control bromate with a cover, the cover didn't have to be completely, absolutely light tight," says Brian White, water quality operations biologist with LADWP's water quality compliance department. "We realized that we'd have to block only about 80–85 percent of the light to get no-net bromate formation."

A remote electrical optical sensor (REOS) system helped White and his team analyze the relationship between light intensity and bromate formation and measure light intensity and light decay at various depths. They suspended plastic drinking water bottles filled with bromate-containing reservoir water at depths in the reservoir thought to represent 10 percent variants of light decay, ranging from 90 percent to 10 percent. "It looked like bromate formation was negligible below the 5–10 percent light level," says White.

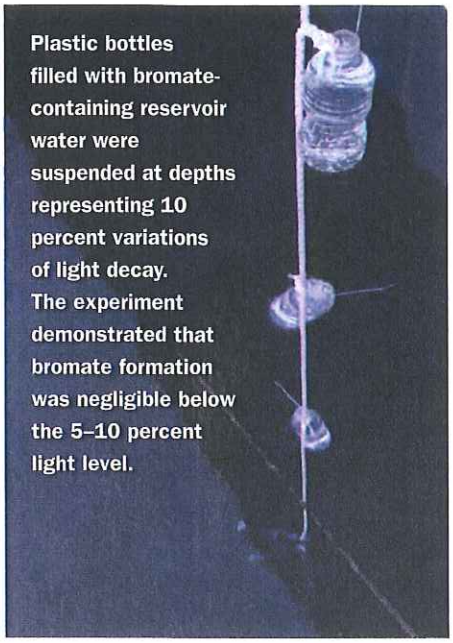
The experiment confirmed that light decay diminished bromate formation.

SHADE BALLS BY THE NUMBERS*

2,000	Number of balls manufactured per hr, 24 hr/day
300,000	Number of balls delivered/wk in 2–3 truckloads
6 million	Total number of balls used for project completion
10	Number of balls/ft^2
14	Approximate number of reservoir acres to be covered
34¢	Cost per ball
$2 million	Project cost
$100 million	Cost to cover reservoirs with traditional methods
6 mo	Time to mitigate bromate with shade balls
3–5 yr	Time to mitigate bromate with traditional covers

**Numbers are approximate*

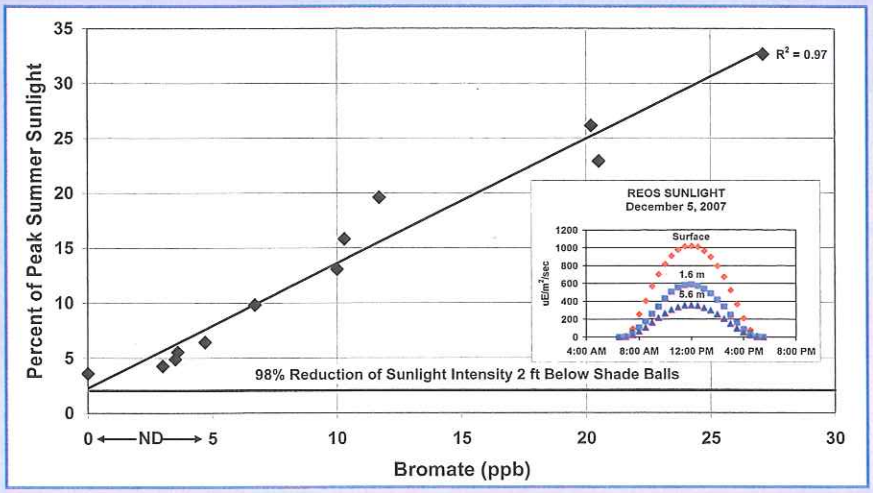
White knew that shade balls were effective in creating shade in bodies of water for the prevention of algae growth, so why wouldn't they be effective for bromate prevention?



Plastic bottles filled with bromate-containing reservoir water were suspended at depths representing 10 percent variations of light decay. The experiment demonstrated that bromate formation was negligible below the 5–10 percent light level.

Bromate Formation vs. Sunlight Intensity

An experiment to determine how much light the shade balls could block revealed a 98 percent reduction of light intensity at a depth of 2 ft below the balls.



"So we realized that we wanted to block 95 percent of the light to get to zero bromate formation, or to a level so low that our lab couldn't measure it," explains White.

Then LADWP directed its attention to the shade balls, sometimes referred to as "bird balls" for their use in keeping birds off water bodies near airport runways. White knew that shade balls were effective in creating shade in bodies of water for the prevention of algae growth, so why wouldn't they be effective for bromate prevention?

To find shade balls that were certified safe for coming into contact with drinking water, LADWP personnel contacted NSF International, an independent, not-for-profit organization that certifies products and writing standards for food, water, and consumer goods. NSF advised that only one manufacturer made such a product. Various colors of shade balls have been tested for safety, but only black is NSF-certified as safe because its color won't leech into the water.

With an acceptable product available to reduce light penetration into the reservoirs, LADWP personnel needed to determine how much light must be blocked to control the bromate formation and if shade balls could block that amount of light. White and his team spread shade balls in pools 8-ft across and 2–3 ft deep. By monitoring the amount of current coming from a solar panel and from a light meter placed under the water, they measured a 98 percent reduction in light intensity 2 ft beneath the shade balls.

WORKING WITH OTHERS

During the bromate discovery and mitigation process, LADWP worked closely with the California Department of Public Health and the Los Angeles community to ensure regulatory compliance and citizen approval.

"The first issue with all of this was that we don't currently have federal or state regulations for managing bromates in an open distribution reservoir, because it was not known or anticipated when the bromate regulation was created," says Pankaj Parekh, LADWP water quality compliance director. "So all of those things had to be worked out with the CDPH."

Parekh stressed the importance of involving regulators early in the process. In addition, CDPH scrutiny encouraged LADWP to do more substantial work and monitoring.

However, the idea of looking at a sea of black shade balls floating on a reservoir didn't appeal to many area residents. City council members met with their respective constituents to discuss the problem and why they needed to solve it with shade balls within a limited timeframe. With assurances that they'll get their open-water surface back in 4–5 yr, most citizens have put aside their personal preference in favor of good public health for the people who drink the water downstream. Regardless, a small group of dissenters still exists.

SHADE BALL DROP

In early June 2008, LADWP began dumping shade balls on the reservoirs. LADWP is receiving two to three truckloads of shade balls per wk, with each load containing 100,000 balls. By the time the 7.5-acre Ivanhoe and 6.5-acre Elysian reservoirs are covered later this year, about 6 million shade balls will be floating in the reservoirs. When an underground storage facility is completed in 2013 and the balls are no longer needed for bromate mitigation, the shade balls will be shredded or otherwise recycled.