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"Ozone Testing Turns Heads, Looks Too Good To Be True"

Industrial and linen trials show that this type of oxidation fights pollution and increases wash efficiency. It's early in the game,but the power of ozone looks like it could hit home runs for the laundry industry.

Producing ozone on-site and using it in washer/extractors to reduce contaminant levels and wash more efficiently: Is it an idea whose time has come?

PureWater Corp., Kansas City, Kan., has run a number of recent experiments, particularly in linen laundries. There have also been industrial tests. These pilot programs have found that ozone can be effective in oxidizing the organics Including greases, fats, and oils) that plague most commercial laundries.

Ozone, the triatomic form of oxygen, is a powerful oxidizer that leaves no residuals or by-products except oxygen and a minimal amount of carbon dioxide. It's widely used as a disinfectant for swimming pools, municipal water treatment, aquaculture, and air purification in food processing and other industries.

When organics in wash water and on laundry come into contact with ozone, their degradation increases as they become oxidized. Such degradation can play a key role in reducing detergent, water, heat, and cycle time requirements, PureWater says. Organics are usually rich in electrons; ozone is electron-deficient. Thus, the reaction is rapid, creating an oxide form of the organic that releases more easily from laundry material.

Working with Detergents

Surfactants and alkalis abound in most laundry detergents. The latter contribute to pH and alkalinity of wash water; they also combine with calcium and magnesium ions. This allows the surfactants (organic release agents) to react with the organics much more effectively.

Wash water with high pH is needed to remove organic fats from fabrics. The higher the fat content in those materials, the higher the alkalinity and pH required. Trouble is, once the alkali combines with the calcium and magnesium (which naturally occur in water), it's tied up. It can't contribute any more to alkalinity or pH.

That's where ozone helps. When it comes into contact with the expended or consumed alkaline, the ozone will oxidize or release the calcium and magnesium ion, allowing the formation of a precipitate. This frees up the alkaline to react again. Ozone aids the surfactant, too. The hydroxyl developed from the ozone at high pH improves the surfactant's ability to remove the organic by oxidizing the organic to a much more soluble state, allowing precipitation of the organic oxide.

"Consequently, a faster, more effective wash cycle is accomplished as the ozone allows a dramatically reduced amount of detergents to last longer and react more effectively," PureWater President Dan Katz says.

Comments like that put detergent suppliers on the defensive. If you install ozone, you'll need less detergent. But ozone is corrosive. So wouldn't you effectively trade equipment life for savings on supplies?

"This is absolutely not the case," Katz. "Ozone breaks down very rapidly in the wash liquor due to the pH and high alkalinity. By that time, it has already done its job. Once it comes out of solution, it is merely air. Besides, your washers are designed to survive high caustic environments that are more corrosive than ozone."

If you ask him which chemicals to use with ozone, you'll get this response: "We will leave this up to you for now. The chemical companies who we have come in contact with so far are starting to investigate types and blends of surfactants that will best utilize the additional wash activity supplied by ozone.

"We have experienced different results with different manufacturers. Your Percarbonates and Perborates work very well with the ozone process, especially from a wastewater perspective."

The greatest declines in chemical expense have come in the washing of Visa and polycottons, he says. There's been an average minimum 10 percent temperature reduction with "significant time reductions per formula."

However, "every laundry is different. We suggest that you immediately assume a chemical reduction of 30 percent per hundred weight. Additional savings are available once you fine-tune your formulas."

Reducing Wastewater Expense

"Without question, we are reducing biochemical oxygen demand (BOD) and chemical oxygen demand (COD) by 50 percent leaving the washer," Katz says. "Consequently, the expense related to wastewater quality and treatment are reduced linearly."

Here's what PureWater says about its process' effect on other contaminants:

Suspended solids and turbidity. Most suspended solids or colloidal matter are usually negatively charged. Ozone, which often acts as a positive charge, reacts synergistically to the colloidal suspension and neutralizes the matter. Organics found on the colloidal sphere are oxidized, allowing better precipitation and/or solubility.

Heavy metals. As a powerful oxidizer, ozone is capable of increasing the oxidation state of metal ions. Therefore, it's effective for the removal of metal ions through the resulting precipitation. Metal ions that can be removed this way include lead, iron, zinc, cadmium, and nickel. Other inorganics very reactive to ozone are cyanide, thiocyanate, sulfite, bromide, nitrite, and iodide.

Volatile organic compounds (VOCs). Ozone destroys many VOCs. Its oxidation involves a variety of standard procedures used for removing VOCs in water, gas absorption, gas desorption (stripping), and chemical reaction (oxidation).

Not all VOCs react the same and many parameters exist for efficient destruction. Laundry wastewater's high alkalinity is a major advantage to the mass transfer of the ozone in the water and subsequent reactions. At a pH of 9, decomposition of some ozone produces a variety of a number of highly reactive oxidizing species. Even faster oxidation of the organics occurs.

Fats, oils, and greases (FOG). Katz admits, "We are not experiencing the reductions as anticipated on oils and grease due to the physical mechanics of the facilities in which we have installed equipment."

Aeration or dissolved air flotation remains the most consistent method of reducing FOG, he says, but it's not perfect. Ozone helps here because its more soluble in water than oxygen, causing an increase in floating grease and oil.

"This is a major advantage to those of you who are experiencing bad results from your DAF systems. Through the use of a very economical inclined plate clarifier, the use of ozone will increase the

effectiveness of oil removal dramatically." The company continues to study FOG in two installations in food processing plants.

Might ozone accomplish all wastewater treatment requirements? "We would like to say, 'Yes, it's a done deal.' Many times it may be a perfect fit and will bring you into compliance. Unfortunately, this is directly related to your wastewater quality leaving the plant.

"For BOD, COD, and suspended solids, the process is providing a very serious reduction. There's no question the ozone will enhance treatment system efficiency and reduce physical chemical costs. You may need to incorporate additional ozonization in your DAFsystem, or at lease provide another method for chemical reaction."

Industrial Case Study

To demonstrate wastewater benefits, PureWater installed an ozone generator on a 400-pound washer-extractor at a Midwest industrial laundry. The test protocol was developed to determine the efficiency of removing BOD, COD, FOG, and additional contaminants. Other expenses associated with wet wash chemicals, equipment operation, temperature, and water consumption were "reduced dramatically," PureWater's Steve Montgomery says.

The system included a PWC ozone generator and ozone injections system designed for the wash room. A secondary recirculation system pulled the wash liquor from the wash wheel for injection of ozone before returning it to the wash wheel in a closed loop system.

The washer/extractor was modified by wielding a 1 1/2-inch coupling in the vicinity of the dump valve, and a second half coupling to the bottom of the outer shell as far as possible from the first. These connections served as the outlet and inlet points for the recirculation system.

A 1/2-horsepower open impeller pump, specifically designed filter back tank, and venturi injector were used. Compressed air, necessary for ozone production, was delivered by a small 100 PSI air compressor at a rate of 4 cfms.

Fabric test pieces, supplied by an independent source, were run on "regular" pant and shirt loads as well as ozone loads. These test pieces were used to determine soil removal, whiteness retention, and tensile strength loss.

Wastewater analyses were run on shop towel, shirt, and pant loads. These included COD, total petroleum hydrocarbon (TPH), and turbidity. The latter tests were used to indicate soil levels remaining in the final rinse that may or may not lead to redeposition.

To determine soil removal, the amount of light reflected from fabric test pieces was compared with standard unwashed pieces. For redeposition, the measurement was a general whiteness index from standard. The higher the number, the better, for both tests. (Results, Table 1).

Wastewater tests reflect COD loading from the last rinse, sour, and certain break operations, as well as turbidity measured in NTU units. The reason tests were run on the last rinse and sour operations: If soils are being removed as demonstrated by the test piece data, then there would be a reduction of effluent loading at these points. Also, this would indicate any potential problem with long-term redeposition using shorter formulas. (Results, Tables 2-4).

Table 4: COD & Turbidity in Final Sour, Last Rinse

Formula	Sample Description	Test Piece Number	COD	Turbidity/ NTU
Pants Regular	Final Sour	None	70	15(2)
	Final sour	116	127	39
Ozone	Final Sour	115	118	72
	Last Rinse	115	245	100 (2) 72
Shirts Regular	Final Sour	118	295	96
	Final Rinse	118	857	196
Ozone	Final Sour	120	74	76 (1)
	Last Rinse	120	308	84 (1)
	Final Sour	120	61	32 (1)
	Last Rinse	120	4	96 (1)

(1) Shirt formula for test piece 120 used 1/2 the regular supply amounts and was run on a shorter formula than test piece 119.
(2) Pant formula for test piece 115 used 1/2 the supply amounts than formula with no test piece.
Formula the same.

Two other tests and their results:

Gray scale comparison. This is subjective: a judgment is made as to how far from the unprocessed color that a processed piece appears. Technicians conducting the test aren't aware of the difference in wash processes.

In this test, color loss from ozone was comparable to or better than standard washing, Montgomery says. One reason for the diminished color loss might be the tendency for color to crock in a high alkali condition, something ozone reduces.

Silkweave tear standard. Tear tests indicate there appears to be no significant deterioration in fabric strength as a result of using ozone in the was process. All tests were conducted in the warp direction.

The test piece and wastewater data show that ozone improves soil removal, Montgomery concluded. Ozone shortens the wash process to remove soil in a shorter period of time with less supplies. "There appears to be a negative effect on soil removal if more product is used than necessary," he said.

Results of wastewater tests show a "definite" reduction in TPH, COD, and FOG in shop towel loads. Data from garment loads indicate that such a reduction can take place even with reduced formula time.

Ozone and Solids

Oxidation of organics using ozone does result, however, in a formation of solids known as "microfloc." These would need to be removed through a prescreening device; they might settle in an equalization basin.

Ozone also enhances floc precipitate formulation in conjunction with a coagulating or flocculating agent such as Alum.Research shows a 50 percent reduction of Alum consumption when ozone is used with it.

As a result, discharge contaminates could be reduced, effluent loading could be less, and surcharges and pretreatment capital and operating costs could be lower. Effluent treatment would be greatly simplified - it would be a simpler physical chemical treatment process in which solids are created and then removed from the waste stream.