

*While tunnel washers have come a long way, the proper application of ozone in the wash process can improve efficiency, performance and quality.*

# Ozone — Applications & Benefits of Ozone in Tunnel Washers

*Mechanical basis for tunnel wash and ozone use*

By Jack Reiff

**T**he pace of change in design and advances in technology in the development of tunnel washers have, in my opinion, been as fast and furious as those of flight in the aircraft industry. Flight has “taken off,” as have the design and development of tunnel washers.

My fond memories of and relationship with tunnel washers began in the mid-'70s when I was a chemical sales technician for Diamond Alkali Co. I was asked to set up the new Poensgen continuous wash system being installed in New Jersey at a joint hospital laundering facility. This was the first time I or most people I knew in the industry had ever heard of such a machine.

**Then-new technology heralded new era**

Arriving on the scene with my titration kit and the confidence of

knowing washroom technology, I approached this task with a lot of enthusiasm. What I saw when I entered the laundry was six long pipes with large, aircraft-type inner tubes at the outlet of each pipe. The inner tubes were the extractors or press modules for the processed linen. The tunnel washer was designed as a tube (pipe) into which the linen was fed in a rope-like fashion. In this way, the leading piece of linen pulled the linen behind it, forming a rope-like continuous source. The unit was able to wash items that could be linked together like threads. One can sense the problem that would be caused if the feed line parted. The feed process had to be restarted to get the line going again.

The line passed through several treatment baths in the wash process, which was similar to what we see in modern tunnel systems. Sheets, towels and pillowcases moved along nicely and this proved to be a perfect match for the central hospital laundry, with many pounds of like items.

The water moved in a counterflow arrangement to the linen and chemicals were added through a hollow tube with a cup on the dip end. The feed water was interrupted at certain locations so that soil

could be drained off or water could be introduced to optimize the wash, bleach, rinse and finishing of linen.

The hollow tube that delivered chemicals in this system was attached to a rotating cam with a measuring cup at the end. The measuring cup and arm moved to allow the cup to move into and out of the chemical supply tank. The range of dip and lift determined the amount of chemical used. The cup lifted to allow chemicals to flow through the hollow tube in to the specified area. Chemical concentrations were adjusted during the mixing process, where they were converted from powder to liquid.

We established a titration system for almost all chemicals, including for the sour, to guarantee performance (the sour titration was a reversal of the break titration, which used a known standard concentration of alkali solution). Based on the cam-to-arm configuration, which was changeable, the dip and amount of chemical being used was adjusted for the wash formula.

As stated earlier, there was a large, rotating inner tube configuration at the finishing end of the tunnel washer similar to that of an airplane inner tube. This tube rotated, pressing and pulling the linen feed line through the Poensgen tunnel, pressing out water so the linen could be collected in baskets and brought to ironers for finishing.

This was the dawn of a new day for me and for the laundry industry. The next phase of tunnel development I was exposed to was in the form of the Voss Archimidia, a bottom-transfer tunnel installed at the Consolidated Laundry facility on Eagle Street in Brooklyn, NY, followed by one that went into the laundry plant in Norwalk Hospital, Norwalk, CT.

### Designs and vendors multiply

These units, based on the Archimidia screw, had chemical supply tanks with dosers to get the chemicals, which were under pressure, into the washer. The chemicals were injected into a central hub that served several supply tubes and ran the length of the tunnel to an opening at the proper location for that chemical's use. The chemical volume and strength could both be adjusted at the doser. The feed location could be changed within specified parameters so that chemicals could be added per the supplier's requirements.

The Voss Archimidia washer had a control card that moved up and down to regulate the formula. Chemical technicians cut the cards to regulate the wash formula. When formulas were to be changed, such as when going from sheets to OR linens, a new card had to be installed, much like the programs of earlier conventional washing machines. It was at the Norwalk Hospital, with the consent of laundry manager Jim Bauman, that I designed an electrical switching device that could activate different control tracks so that the program could be changed without removing the program card. This sped things up for Jim and opened a door for Voss.

As the technology matured, so did equipment design. The basic counterflow remained the same but wash transfer concepts changed. The bottom-transfer screw led to the top transfer and many other designs.

As time passed, greater technological sophistication improved wash times and quality, press performance and load transfers. Efficiencies improved and the tunnel washer came to be seen as an industry fixture. Designers incorporated double shells, zoned compartments, full compartments, splitter tanks, boosting systems and

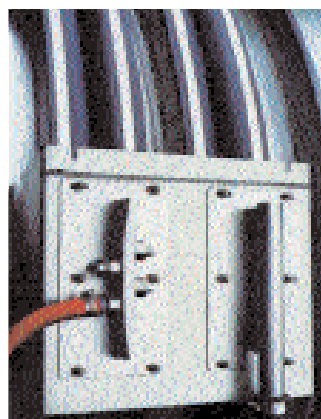
quick water drain/replacement transfers. So much has been done to improve each approach and technique that the customer can now choose from a vast array of tunnel washers.

It is not my intent to endorse or recommend a particular tunnel washer. There are many manufacturers that have a tradition and history of excellent design, manufacturing and performance that speak for themselves.

### Ozone breaks Sinner's Circle paradigm

Tunnel washers have come a long way. What is lacking now is the proper application of ozone in the wash process to improve the efficiency, performance and quality of tunnel washers.

The application of ozone as a chemical enhancer encompasses



*The injection and drain system (at left) provides effective control of water and chemicals. Any liquid chemicals may be used, either from stock solutions or concentrates. Waterway seals are maintenance free, and—after years of service—can be changed in minutes.*

many critical aspects of washroom formulas. An understanding of washroom technology is needed to facilitate good washroom procedures. Anyone can wash lightly soiled items quite effectively and somewhat efficiently with low levels of ozone. The challenge is to take full advantage of the synergy developed when ozone is used to enhance washroom chemistry for all levels of soil.

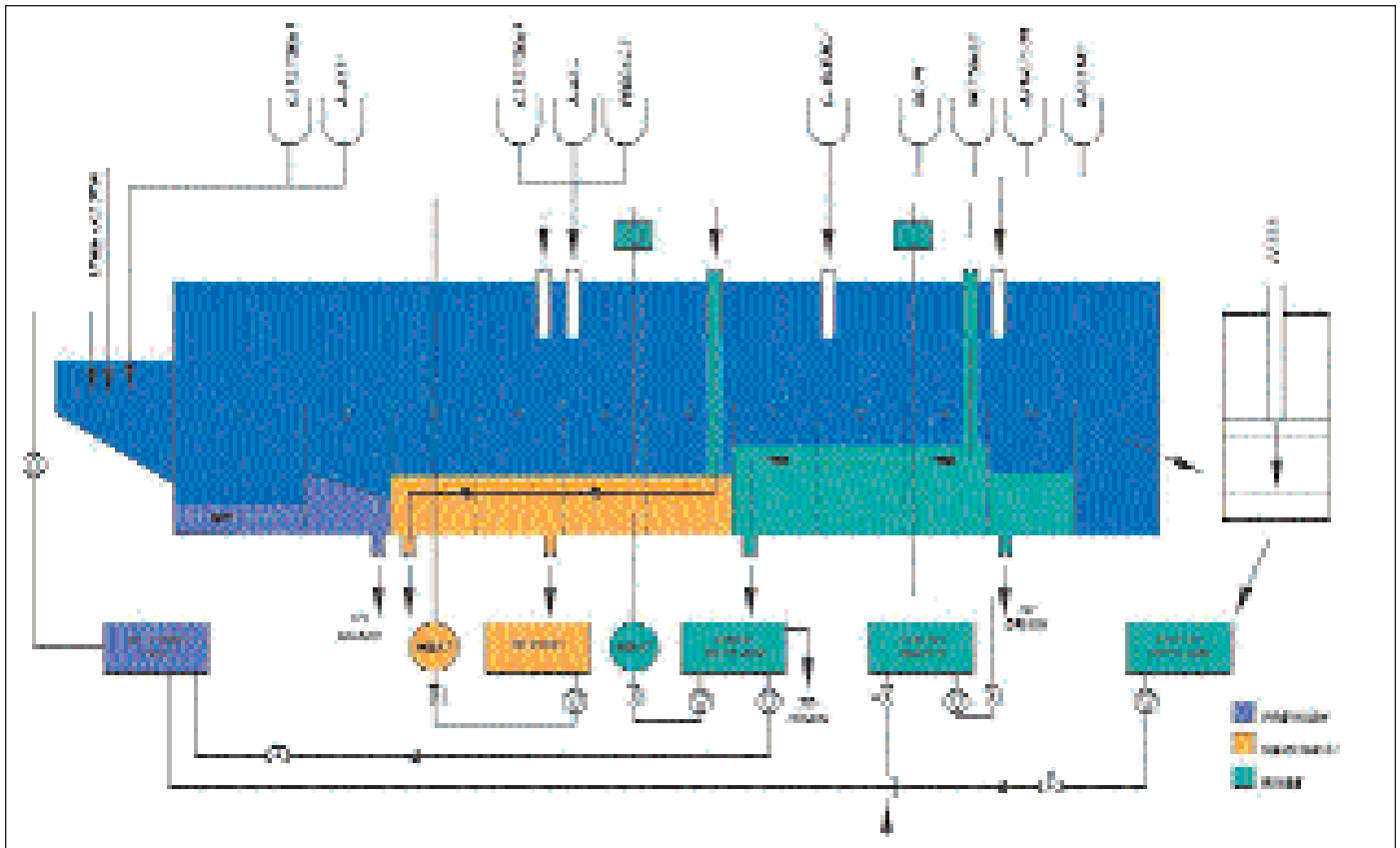
Consider a scenario in which ozone is used with cold water when hot water is turned off. What effect does this have on the removal of body soil, food, beverage or other soils that flow at body temperatures of at least 98°F? Would the use of cold water require the use of more chemicals or more time?

Ozone, described chemically as O<sub>3</sub>, is the triatomic form of oxygen. It is very unstable and highly corrosive. Ozone has a short life cycle and decomposes to oxygen (O<sub>2</sub>) without leaving a residue. This high oxidation power with a chemical valence slightly on the acid side is the basis for various applications in the wash. This super oxygen enhancer does special things for washroom chemistry. However, an enhancement is not a replacement for chemical applications.

To date, ozone is the one product that can be utilized in a wash formula that will reduce—but not eliminate—all other factors in washing. A chemist by the name of Sinner developed the Sinner's Circle theory of washing in which time, temperature, mechanical action and chemicals controlled the wash formula. It was thought that if you increased one factor, you could decrease the others, as depicted by a simplified pie chart.

We know from experience that this is not true. We need dilution in the wash formula to rinse down and eliminate soil from the fabric. We need the same dilution to reduce residual chemicals in the

# Wastewater Treatment



The counterflow system in tunnel washers starts in the rinse zone, where fresh water is introduced. Rinse water is usually drained into a transfer area, where it may then be divided between the bleach zone and the prewash area.

fabric. We know that if we increase chemical use, we must increase dilution to reach the desired effect on the fabric without increasing the neutralized salts that might be left after treatment. This all must be taken into consideration when working with a counterflow system as well as with a conventional washer.

## Corona discharge more popular than UV

Ozone, the super oxygen enhancer, is the chemical enhancer that accomplishes the tasks noted above and reduces all aspects of the wash criteria as depicted in the Sinner's Circle pie chart. Ozone is unique in another way. Through a process called cell lysing, ozone molecularly ruptures and disperses microorganisms.

In this way, microorganisms such as bacteria, viruses, mold, fungi, and algae are dealt with more effectively than by other biocides such as chlorine. They are not just dead; they are destroyed, preventing reactivation or the development of a resistant strain of the microorganism. The sanitizing ability of ozone, 3,000 times more effective than chlorine, makes it the chemical of choice in water treatment.

Not all ozones are the same. The percentage of concentration, the flow rate, the air source, the application and many other aspects of ozone use will yield different results. It is important to remember that ozone is highly corrosive and is an aggressive oxidizer that attacks most materials. Steel, brass, bronze, petroleum hydrocarbons, plastics, cotton, polyester, chlorine and many other materials will break down in the presence of ozone. It is therefore important to know the levels of ozone being used, the concentration, the makeup

of the air source and the life cycle of the ozone because these are critical to its performance (Note that EPA Bulletin #832-F-99-063 states that the dew point of the feed gas must be -60°C [-76° F] or lower to manufacture ozone without a by-product of nitrogen oxides such as nitric acid.).

The two methods I know of for creating ozone are ultraviolet (UV) light or corona discharge. These methods excite oxygen molecules so that they jump around and attach themselves to other oxygen molecules, making O<sub>3</sub>. The O<sub>3</sub> is not too happy and looks to go back to its more stable form of O<sub>2</sub>, so its life cycle is very short. The ozone life cycle is dependent on the concentration of the ozone, the temperature of its surroundings, whether there is a vacuum, where it is to be used and the level of soil.

It appears that the life cycle of ozone is very short when exposed to high temperatures because the gas becomes excited. The ozone life cycle is extended for a brief time in cold water but when used in a vacuum, ozone dissipates rather quickly because it expands to fill the vacuum. How one answers the questions of how and where to use ozone are critical to developing an efficient and effective wash formula.

Most laundry applications utilize corona discharge technology because it is easier to control, has a smaller footprint and starts when electric current crosses the feed air system. This is much like a bolt of lightning passing through the atmosphere in a rainstorm, generating ozone. You can sense a crispness in the air and a clean, fresh smell. ☞

# Wastewater Treatment

## Cold-water rinse sustains O<sub>3</sub> levels

When developing a wash procedure for cleaning soiled fabrics in a tunnel washer, one must consider the operating conditions of the tunnel. All the tunnels I have come across operate with the main water flow coming through the rinse chamber. This flow determines the speed and fullness of the rinse and starts to reduce the wash bath temperature for treatment. Most units have two or three compartments for the rinse operation and an incoming flow of about 55 gallons per minute.

A basic wash formula will start with a transfer cycle of about 1.5 minutes, comprised of one minute for washing and 30 seconds for transfer to the next chamber. This process is variable and can be adjusted to deal with high soil levels. All equipment fits this format in the introduction of the main supply of water.

Most tunnel washers are broken into sections or operation zones. Starting at the soiled linen inlet, there is usually a pre-wash zone, which drains to the sewer. The next section would be a wash zone made up of several chambers that transfer to the bleaching zone. The water counterflows from the last bleach section, down through the wash zone and into the drain.

The wash is then transferred to the rinse zone, which is also made up of several chambers. This water drains into a split or redirect supply tank. From the rinse zone, linen is transferred to treatment compartments for final chemical finishing before going to the press.

To summarize, we have a prewash area, a wash area, a bleach area, a rinse area and a final treatment area before going to the press. The uniqueness of the counterflow system in making full use of water starts in the rinse zone. This is the point at which fresh water is introduced into the tunnel to rinse linen. This is the cleanest that the water will be. This rinse water is usually drained into a transfer area where the water is then divided between the bleach zone and the pre-wash area.

In the bleach zone, where ozone use is eliminated, the process is similar to bleaching in the clear due to the counterflow characteristics of the wash. The prewash area is usually where rinsing and chemistry begin removing soil from the fabric. Steam is typically injected to raise the temperature for the desired soil removal. Although dirty water drains from this section, a good portion of the water is transferred with the linen into the next compartment, where the washing begins in earnest. More chemicals are added and temperatures are increased for effective soil removal. This load is transferred along from several wash pockets through several bleach pockets. In the wash zone, ozone helps reduce the soil level of the wash liquor by oxidation, thus improving wash quality.

## Ozone cuts post-bleaching chlorine levels

After going through the rinse cycle, the load is transferred to the treatment zone, which can also be made of one or more compartments. At this point the sour, bacteria treatment, starch or other desired finishing agents may be added. This last compartment drains to a small tank around the press or to other collection areas.

With this brief description and understanding of tunnel-washing concepts, you can see that the application of ozone raises many questions. The use of standard or other chemicals does not keep ozone from providing its many beneficial properties, but raises the bar on chemical applications.

Some ozone companies that use a supply tank of water infused

with a high concentration of ozone will inject the ozonated water into the machine at the rinse water inlets. We don't recommend this method for reasons outlined above. To maintain a decent level of ozone for this wash process, the water must be cold and the ozone concentration high. This allows ozone to move forward for washing and maintain some level of ozone in the system. As the water carries forward, the temperature increases due to the bleach and wash processes. Ozone is depleted during the rinse cycle and very little gets to the soil area. In most cases, rinse water drains to a transfer tank from which the water is directed to other tunnel compartments. Some will go to the bleach bath and transfer down through the wash. In other cases, some rinse water will go to wash and bleach inlets while also feeding prewash compartments. At these locations, the use of ozone will enhance the wash operation.

Ozone enhances the wash process by means of oxidation. Ozone may also allow an operator to reduce wash temperatures in the pre-wash and wash cycles and reduce operation times as well. In this case, ozone reactivates wash chemicals for continued soil removal. Ozone also works as an anti-chlor in the rinse, which can reduce rinse and/or transfer times and enhance the final bath by contributing to the sanitizing and anti-chlor requirements in the final operation. For ozone to accomplish these tasks, it must be active at a low level so as to avoid destroying fabrics, and be maintained for the duration of the operation.

### Questions that arise:

- What is the composition of the feed gas?
- What concentration of ozone is to be used?
- How long will concentrations be maintained in the wash cycle?
- At what location(s) will ozone be infused into the wash cycle?
- What can be done in terms of reduced washing temperatures?
- What can be accomplished in terms of reduced chemistry?
- What effect can ozone have on transfer times?
- Will the change in transfer time reduce water consumption?
- Will ozone move into the bleach bath, affecting stain removal?
- What is the footprint of a typical ozone system?
- Can you quickly revert to non-ozone operation if ozone equipment fails?

The textile rental industry has entered a new millennium of ozone packages. Operators now have access to multi-level, multi-capacity, modular ozone systems that deal positively with all the issues noted above and more. Among these options are treatments for light, medium or heavy soil along with industrial-grade waste. Questions on operational specifics are welcome. In our next article,

we will explore the means of producing ozone and how it interacts with other chemicals in your tunnel washer. **TR**



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