WATER ONLINE

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Case Studies Make A Strong Case For Ozone Sidestream Injection

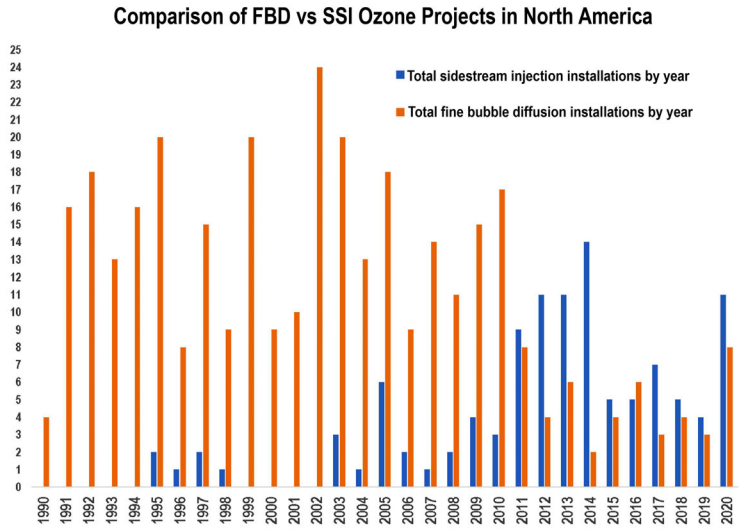
Source: Mazzei Injector Company, LLC

By Jim Lauria

A year ago, the Mazzei team dove deep into a wide range of resources to examine the trends in the North American ozone industry. We scoured our files on customers and competitors' installations, analyzed trends in the municipal water treatment market, studied our computational fluid dynamics (CFD) modeling archives, and tapped the International Ozone Association (IOA) installation database. The result was a *Water Online* article titled "Deep Dive Into Data Reveals Powerful Ozone Story."

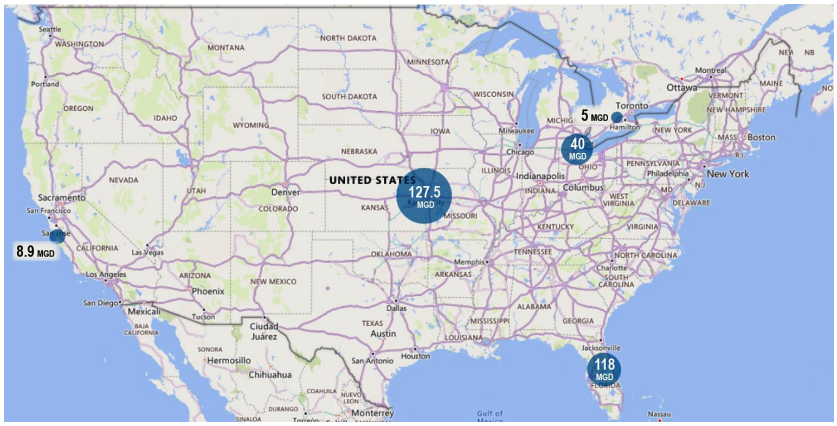
Since then, we have closely watched presentation trends at conferences, including the recent IOA meeting. And here is what we found...

One of the highlights of the 2022 IOA conference — beyond seeing old friends and meeting new people in person after way too many Zoom meetings — was hearing so much customer feedback about the benefits of sidestream injection (SSI) for mixing ozone in a wide variety of applications. In fact, a majority of the projects presented there included Mazzei sidestream equipment, and each one seemed to highlight a different benefit of the technology in SSI ozone systems.



A dive into International Ozone Association data showed a clear shift to sidestream injection from fine bubble diffusion projects over the past two decades

In sidestream injection, a percentage of the total flow, typically less than 10%, is diverted through venturi injectors, which are carefully engineered to create a vacuum as the flow is constricted, then allowed to expand. The vacuum draws in ozone and mixes it thoroughly with the sidestream. The ozonated sidestream is then returned to the main flow through a Pipeline Flash Reactor™ (PFR) that features an array of specially designed and placed mixing nozzles to thoroughly mix the ozonated water into the full volume in just a few feet of pipeline, or a basin nozzle manifold that mixes the treated sidestream into a contact basin that can be much shallower and smaller than those required for passive diffusion.

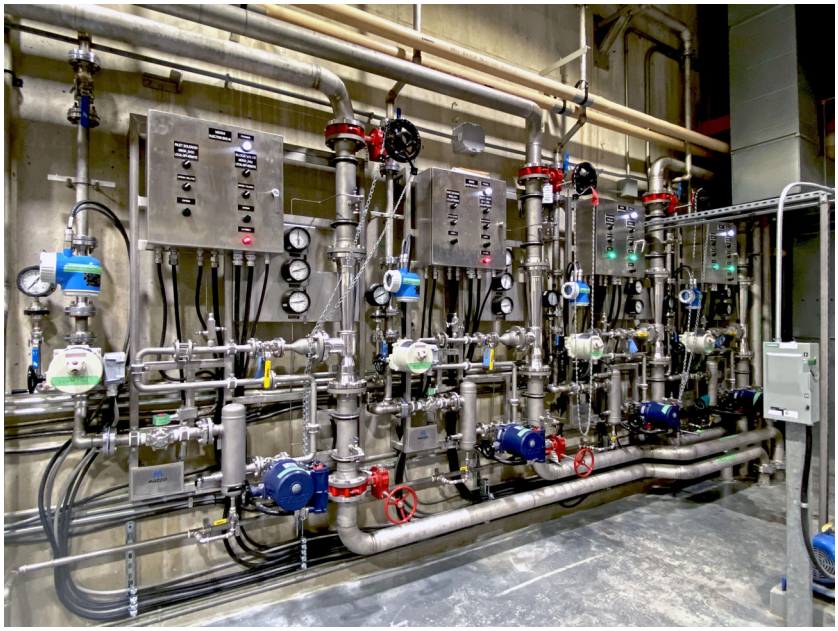


This article covers SSI ozone systems across North America.

The IOA presentations were a perfect follow-up to last year's project from our own files and the IOA's archives. Through that deep dive, we charted trends that showed more utilities choosing SSI systems for ozone, away from older, less efficient technologies like fine bubble diffusion. What we and the rest of the crowd at the IOA meeting heard was a deep dive into the many reasons why they are choosing sidestream injection — and the enthusiasm that reinforces those decisions.

In this article, I will explore the SSI systems presented at the meeting, organized by the principal benefit each setup delivers.

Greater Efficiency (River Water in Kitchener, Ontario)


Four sidestream injection systems reduced the Mannheim Water Treatment Plant's maintenance downtime days by a week a year and reduced projected O&M costs by 43%

The Mannheim Water Treatment Plant in Kitchener, Ontario, replaced its twin fine bubble diffuser contact systems with four wall-mounted venturi injector assemblies followed by four basin nozzle manifolds to return ozonated sidestream to the 19-MGD main flow of the plant. The ozone removes taste, odor and color compounds from the source water, which is then directed to GAC (granular activated carbon) filtration, UV and chlorine before being stored or distributed to residents.

In making the decision to switch to SSI, the Region of Waterloo (Ontario) team penciled out the 25-year operations and maintenance costs of fine bubble diffuser and sidestream injection systems. By the end of the 25-year period, they determined, the total O&M costs of the sidestream injection system were 43% lower than those of the fine bubble diffuser system — just $190,000 for SSI vs. $332,500 projected for the diffusers. SSI systems require dramatically less maintenance, cutting the number of facility downtime days over 25 years from 175 for fine bubble diffusers to 50 for SSI. That's just 2 maintenance days per year with SSI, freeing up an extra week per year that would otherwise be spent cleaning and maintaining diffusers and gaskets.

Plant managers also reported 10 to 18% improvements in downstream filter performance compared to their previous fine bubble diffusion system, as well as lower chlorine doses.

Switching to SSI is projected to save 40,000 kWh in electricity per year and reduce annual LOX demand by 7,000 kg. With today's spiking energy prices, the team's cost savings are likely to far surpass the current savings figures.

Worker Safety (Well water in Orlando, Florida)

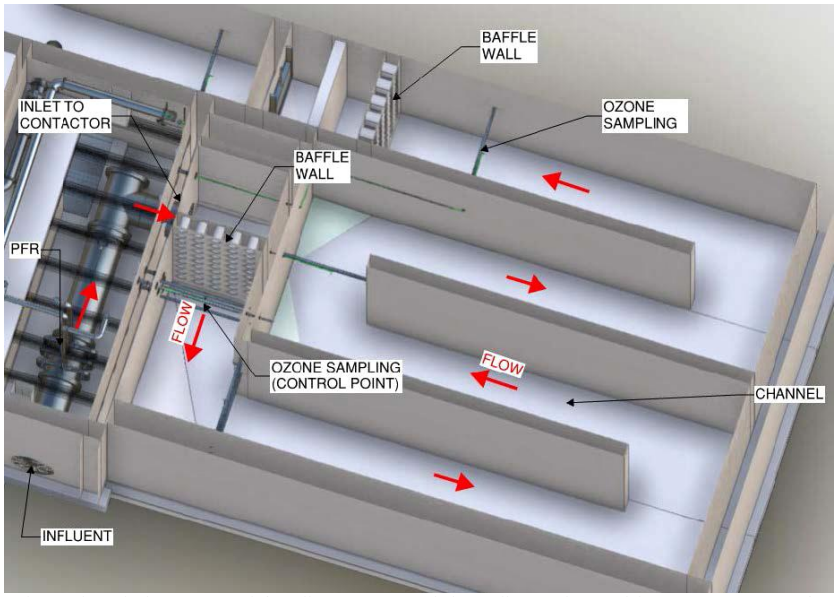
Maintenance on the Orlando Utilities Commission's Pipeline Flash Reactor is quick and easy compared to draining fine bubble diffusers and working in enclosed spaces.

The Orlando Utilities Commission (OUC) in Orlando, Florida, enjoys similar reductions in energy and ozone generation costs as their colleagues in Canada, as well as the advantage of the high turndown capacity of their SSI/Pipeline Flash Reactor system to help optimize for fluctuating demand. Ozone is an ideal treatment for the hydrogen sulfide in Orlando's source water, and the improved process control of sidestream injection allows precise and effective dosing.

Orlando also experienced an unexpected and potentially dangerous disruption during the Summer 2021 COVID wave: a shortage of LOX due to the need to divert LOX to area hospitals and away from OUC's drinking water plants. Shaken by the need to deal with reduced local supply, Orlando water managers have an extra appreciation for the efficiency of SSI.

Another benefit Chris Schultz reported about the OUC system is a boost in worker safety. With the SSI/PFR system, OUC workers no longer have to spend days each year in enclosed spaces to clean, test and replace fine bubble diffusers. Even the latest generation of fine bubble diffusers, made of ceramic disks and stainless steel connections, are still prone to gasket failure and still demand cleaning. Because venturi injectors are flushed by constant sidestream flow and the sidestream system has no moving parts beyond its pumps, there are nearly no maintenance demands, and any checks or repairs can be conducted in the open.

Battling Cyanotoxins (Lake water in Toledo, Ohio)



The Pipeline Flash Reactor (at left in illustration) at Toledo's Collins Park WTP delivers 95% mass transfer efficiency in a compact footprint.

With Lake Erie algal blooms in the news for the past decade or so, water treatment professionals at the 120-MGD Collins Park Water Treatment Plant in Toledo, Ohio are under immense pressure to protect their ratepayers from microcystins, the toxic compounds produced by cyanobacteria blooms. Geosmin and 2-MIB are taste and odor compounds that are also disturbing contaminants when source water is home to harmful algal blooms (HABs). Fortunately, ozone is highly effective at controlling microcystins as well as geosmin and 2-MIB.

The Collins Park Water Treatment Plant uses a multi-barrier approach to microcystins, teaming powdered activated carbon (PAC), ozone, and chlorine to remove a total of 99.7% of the toxins. Sidestream injection in the ozonation system is a vital component of the program, in part because it delivers a mass transfer efficiency of 95% or higher in very little space, a significant constraint at Collins Park (the ozone treatment system had to fit between an existing recarbonation basin and a bank of filters). Where fine bubble diffusers must be placed at least 18 to 20 feet deep in large contact basins — which rack up construction costs of $300 per square foot or more — SSI Pipeline Flash Reactors require just a few feet of pipeline for mixing. In Toledo's design, the sidestream diversion, Mazzei injectors, and Pipeline Flash Reactor were sited in a three-story stack that minimized the physical footprint.

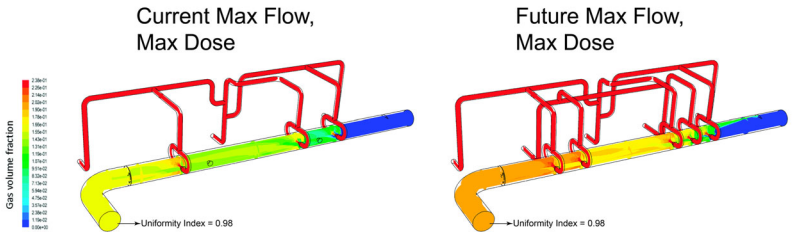
Less Bromate Formation (Groundwater and river water in Ontario, Canada)

The extraordinary mass transfer provided by venturi injectors and Pipeline Flash Reactors or basin nozzle manifolds requires minimal hydraulic retention time (HRT). Of course, that is great from the standpoint of treatment efficiency. But it also helps minimize the formation of bromates and other disinfection byproducts (DBPs) where precursors such as bromine are present in source water.

A 2016 study by the Water Research Foundation in Ontario demonstrated that "even with a high ozone dose in the sidestream flow (4.5-9.5 mg/L) there was insufficient time in the sidestream to produce high bromate concentrations."

With growing concerns about DPBs such as bromate, such findings are increasingly important when designing an ozone system.

More Efficient Filtration Downstream (Recycled Water in Monterey, California)



The Pure Water Monterey system was designed to double the injection nozzles in its Pipeline Flash Reactor to accommodate higher flows in the future.

As with the Mannheim SSI system, a sidestream injection ozonation train at the 30-MGD Pure Water Monterey water recycling plant in Monterey, California, increases the efficiency of filtration downstream. The result is reduced cost, less backflush water, and greater processing efficiency.

Pure Water Monterey draws source water from a wide range of flows, including wastewater, stormwater, vegetable processing lines, and agricultural irrigation return flows. The project will provide about 1/3 of the water needed in the Monterey Peninsula, reduce ocean discharge, and help residents fend off saltwater intrusion in the local aquifer.

Presenter John Kenny of Trussell Technologies noted at the IOA conference that by adding to the efficiency of ozonation and settling in the earliest stages of the Pure Water Monterey process, the Mazzei SSI system reduces pressure on downstream membrane filtration systems.

Great Taste! (River and well water in Johnson County, Kansas)

A set of sidestream injection systems enables WaterOne to adapt to a 12:1 turndown ratio.

WaterOne has been lauded by the American Water Works Association (AWWA) for its great-tasting water. A key step in turning Kansas River, Missouri River and well source water into award-winning tap water is ozone, which controls taste and odor compounds. In WaterOne's 180-MGD system, sidestream injection efficiently mixes ozone into a fraction of the flow utilizing several different venturi

injector models, and then mixes the treated water with the main flow through 84- and 54-inch Pipeline Flash Reactors. This combination approach allows WaterOne to operate proficiently even with a 12 to 1 flow turndown ratio and maintaining treatment goals.

As with the other systems profiled at the IOA conference, WaterOne's system is all about efficiency and efficacy — benefits sidestream injection contribute to ozone's success.

Tastes great, less (space-) filling — along with all the other benefits — sidestream injection is taking its place as the dominant delivery system in ozonation across a wide range of applications and geographies.