

Pipeline Flash Reactor systems solve dissolved oxygen challenges

The growing scrutiny of low dissolved oxygen levels in surface water is increasing regulatory oversight and demands while plant operators are under pressure to reduce capital and operating costs. **Jim Lauria** of Mazzei Injector Company explains why these trends have made fast, efficient gas transfer systems more vital than ever.

Scrutiny of dissolved oxygen (DO) levels in surface waters has increased in response to widespread awareness of the vast hypoxic zones in the Baltic Sea and the Gulf of Mexico, dead zones in the Great Lakes of the United States and Canada, and myriad eutrophic water bodies around the world. In turn, pressure from regulators and the public has resulted in stringent discharge limits in order to ensure that water released to the environment meets strict DO criteria.

A wide range of technologies can be harnessed to oxygenate water including cascade aeration, spray aeration, bubble diffusers, and pure oxygen injectors. There exists an entire array of options for a variety of space, management, energy, and cost requirements.

With growing targets and shrinking budgets, an increasing number of wastewater treatment plant managers are opting to use Mazzei Injector Company's patented Pipeline Flash Reactor™ (PFR), which facilitates the most efficient inline gas transfer process possible.

Pipeline Flash Reactor technology

A Pipeline Flash Reactor is a chamber in which a length of pipe serves as an inline-mixing zone. A sidestream – which accounts for as little as three to five percent of the total flow volume of the system – is highly oxygenated or ozonated through the use of Mazzei's patented Venturi injectors. These injectors harness the pressure differential of flowing water to draw in atmospheric air or generated pure oxygen, which is then mixed into solution. The oxygenated sidestream flow then enters the Pipeline Flash Reactor where additional mixing and contacting is achieved via the PFR's precisely placed, specially designed nozzles (patented Mazzei Mass Transfer Multiplier™ (MTM) mixing nozzles). In the space of a few meters of pipe, the two streams mix thoroughly, with the nozzles effectively shearing entrained bubbles and maximizing the gas-liquid interface, thus enhancing oxygen transfer.

A key advantage of the Pipeline Flash Reactor is its small footprint and low infrastructure requirement, which essentially amounts to a flanged spool of pipe to replace or enhance an entire contact basin. An example of its best features in action can be found at the Hagerstown, Maryland, USA wastewater treatment plant, where a PFR system is attached to an oxygen generator along its 91-centimeter (cm) pipeline. In just a few meters downstream from the PFR, oxygen transfer efficiency reaches 80

percent, reaching and maintaining target DO levels of 10 to 11 milligrams per liter (mg/L). The system has also proved to be flexible, working just as well at low flows of 11 million liters per day (mld) as it does at peak flows of 113 mld.

Using computational fluid dynamics (CFD) modeling, Mazzei engineers design systems to optimize Pipeline Flash Reactors for specific project sites and conditions. Such optimization and customization is crucial for projects requiring retrofitting.

Efficiency in energy and space

Oxygen is drawn into a small fraction of the total water volume using fundamental fluid physics wherein water entering a restricted portion of the injector increases its velocity, creating a vacuum that pulls air into the stream. Therefore, the system's only energy demand is a pump large enough to push the sidestream through the injectors and PFR, since the PFR section of the pipe in itself has negligible head loss.

The PFR's energy demands stand in significant contrast to the high energy demands of blower systems or bubble diffusers in large ponds or lagoons as well as those of pump systems that must overcome the pressure drop often seen downstream of static mixers. Energy demands for the PFR may be further refined through the use of dissolved oxygen meters installed downstream, which can control the volume and pressure of the sidestream flow to match oxygen levels with system needs.

The PFR provides a controlled and stable mixing environment. In contrast, massive volumes of water in ponds, contact basins, or tanks are much less responsive and more difficult to control with precision. Furthermore, they must be maintained to much higher DO levels to accommodate for areas that experience high rates of loss and areas of poor mixing and dead zones.

Because all mixing takes place inside the Pipeline Flash Reactor, PFRs eliminate the need for mixing basins or tanks as well as the space and structures needed for blowers, diffuser grids, large pumps, and other infrastructure. In new projects, this advantage makes the technology an excellent option for reducing capital costs such as real estate, engineering, and construction materials. It also makes Pipeline Flash Reactors an extremely efficient option for retrofitting existing treatment facilities faced with the need to replace aging systems or comply with new DO standards.

Once installed, Pipeline Flash Reactors are



essentially maintenance-free. The fact that many PFRs are buried after installation offers evidence of confidence in their reliability, and such a practice provides an excellent way to further reduce their physical footprint. In the words of one wastewater treatment manager, the Pipeline Flash Reactor is “the most elegant, and probably the most cost-effective, solution out there.”

Author's Note

Jim Lauria, the vice president of sales and marketing for Mazzei Injector Company, LLC, holds a Bachelors of Chemical Engineering from Manhattan College and has more than twenty years of global water treatment experience in the agricultural, municipal, industrial, and commercial markets. Mazzei is a fluid design company that manufactures mixing and contacting systems. Jim can be contacted at jlauria@mazzei.net.

Above: Founder and Chairman/CEO of Mazzei Injector Company, Angelo Mazzei illustrates the scale of a massive system in southern California, which was designed to accommodate peak flows of up to 530 mld. This 183-cm Pipeline Flash Reactor replaced a large aeration tank/pond. PFRs can be sized down to 15 cm for more modest projects. Angelo Mazzei has been granted sixteen patents in the area of fluid processing and related equipment with emphasis in injection of gases and liquids into water streams and the removal of gases from water including patents for the PFR, MTM mixing nozzle, and the Mazzei injector.