PRAXAIR®

Making our planet more productive℠

Ozonation and Sludge Reduction

Sludge and Today's Modern World

The issue of sludge disposal is becoming nationally and internationally more critical.

Excess biosolids generated in the activated sludge process are currently disposed of using methods that include agricultural reuse, incineration or landfill disposal. Sludge disposal costs have however continued to rise due to a number of factors that includes more stringent regulations and limits, high input costs, and public safety concerns. For these reasons, it is necessary to re-analyze the available sludge management strategies with the objective of minimizing costs. Sludge management can reach 40% of the total management costs for a wastewater plant.

Technology Addresses a Need

An effective sludge management strategy is to resolve the problem at its origin by controlling excess sludge production in the activated sludge process. This new approach has been developed by Praxair, a global leader in industrial gas production.

Praxair's patent pending sludge ozonation process has been successfully applied to reduce sludge in wastewater treatment plants that handle municipal and industrial wastewater. The following results have been obtained:

- Significant sludge reduction
- Elimination of foaming problems
- Improvement in process stability
- Improvement of dewatering
- Improvement of settling
- Improvement of effluent quality (de-colorization)
- Effective chemical oxygen demand (COD) removal

The Praxair Process

Praxair's sludge ozonation process provides a cost effective means for reducing the quantity of excess solids generated in wastewater treatment. The process achieves as much as 80% solids reduction with ozone consumption values of approximately 0.05 – 0.10 kgs O_3/kg suspended solids (SS) removed. The sludge ozonation process takes advantage of the strong oxidative potential of ozone to effect the lysis of bacterial cells. In this process, a portion of the return sludge (RAS) is passed through the Praxair ozone contact system. When the ozone and sludge are brought into contact, the strong oxidizing action of the ozone causes the bacterial cell walls to be lysed (i.e. to rupture).

These lysed cells are now delivered back to the basin, where the ruptured cells leak out their contents. This cellular content comprises proteins, polysaccharides, lipids, and other organic compounds which serve as 'food' for the bacteria in the basin.

Through sludge ozonation it is possible to convert the solid waste (the excess biosolids) to COD through ozone induced lysis.

Ozonation allows a consistent reduction in the quantity of return sludge, exploiting the oxidizing capacity of ozone, through a

process which integrates directly in the wastewater treatment cycle, thereby radically changing the approach to the sludge management challenge. Because the excess sludge generation is significantly reduced by as much as 80%, downstream sludge handling processes like thickening and digestion are easier to handle leading to more savings than just the avoidance of final biosolids disposal costs.

The Praxair sludge ozonation technology is the result of extensive research, testing and process development by Praxair and draws on our extensive expertise with gas-liquid mixing as well as with ozone applications. The technology has been designed to be easily integrated into existing wastewater treatment processes without the need for additional basin requirements.

Sludge Ozonation in Action

Praxair's sludge ozonation technology has been successfully deployed at Lariana Depur's Bulgarograsso wastewater treatment plant since May 2006. The Lariana group manages a number of wastewater treatment plants across Italy.

The influent to the Bulgarograsso plant is comprised of 50% industrial (textile) waste and 50% domestic wastewater.

The plant treats about 23,000 lbs of COD daily, generating as much as 4 Dry tons of sludge. In the Bulgarograsso plant, the wastewater treatment process consists of five process operations. The first step involves the physical separation of particles and thin sands from the wastewater. Next, the influent wastewater is passed through an anoxic basin.

Following the denitrification step in the anoxic basin, the wastewater is cycled through through an aerobic process in the biological reactor.

	Pre-Ozonation	Post-Ozonation
Sludge Generated	2 Dry Tons/Day	0.4 Dry Tons/Day
% Dry Solids	18%	22%
SVI (ml/L)	80-100	50-60
O_3 Dosage	0	0.05-0.10 kgs O_3/kgs SS Removed
Foaming	20 cm above liquid	None
Treatment Capacity	80% COD Removal 60% TN Removal	80% COD Removal 60% TN Removal

Results from the Lariana test. The Praxair process was scaled to treat half of the sludge generated.

Other chemical and physical treatments such as clarification followed by sand filtration are then used to eliminate micro-organisms, residual suspended solids and non-biodegradable dissolved substances. Because of the high textile content of the wastewater, an ozone treatment step is used for de-colorization of the effluent prior to discharge.

Following the implementation of Praxair's sludge ozonation technology, significant results were observed in addition to the sludge reduction benefit. A general improvement in the overall wastewater treatment process was observed with improvements to sludge settling and dewatering characteristics. A long standing foaming problem was also brought under control within two weeks of implementing the Praxair sludge ozonation process.

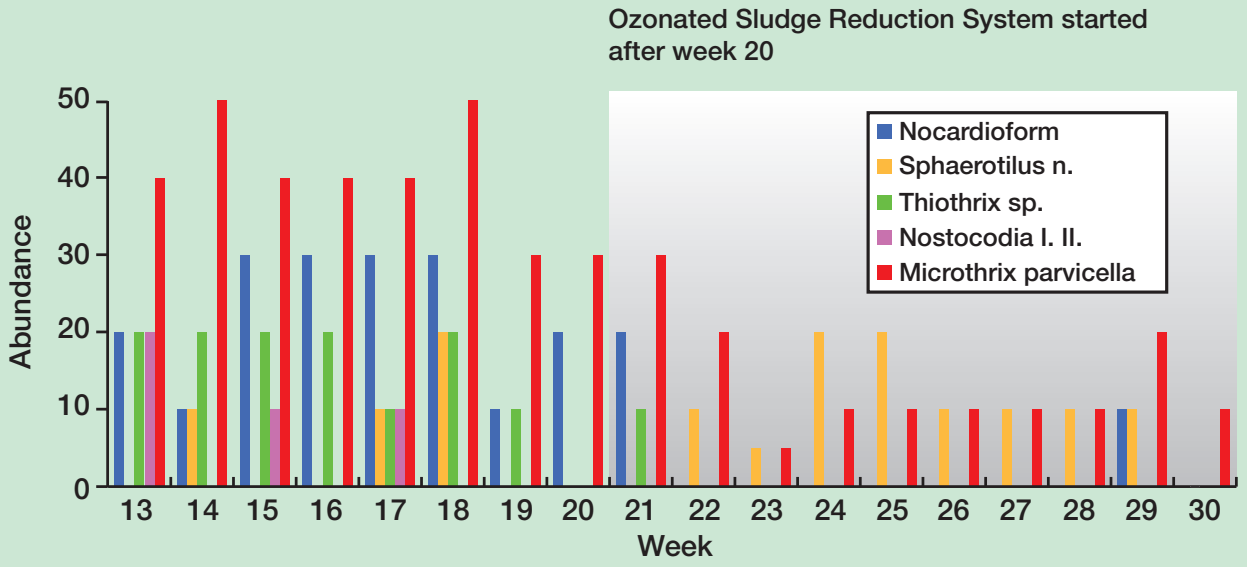
How Sludge Ozonation Works

Two things happen to influent COD in a basin. A portion is used by the cells for maintaining cellular processes (metabolism) while the other portion is used to generate new cells. In a wastewater treatment operation, the sludge yield (kgs SS generated/kg COD removed) provides a good sense of the fraction of COD that is converted into new cells.

Most conventional wastewater treatment processes have sludge yields in the range of 0.2-0.4 kgs SS/kg COD. This means that as much as 20%-40% of the influent COD is converted into excess sludge.

When ozone is used to lyse the cells, causing the conversion of the volatile suspended solids (VSS) to COD, a portion of the lysis products (the COD released by the ruptured cells) are used for maintaining metabolic processes while the remainder is used to generate new cells. This leads to an overall reduction in the quantity of excess sludge generated.

The Praxair sludge ozonation process provides excellent control of the kinetics of sludge growth by acting directly on the specific coefficients of sludge production as they relate to COD removal. A significant part of the COD released after cellular lysis is eliminated in the form of energy, through the catabolic processes of the bacteria. The ozonation process does not interfere with the wastewater treatment capability of the plant, and has a positive effect on bulking and sedimentation problems, due to ozone's selective action on



Sludge ozonation has a significant effect on the production of filamentous organisms, allowing foaming problems to be brought under control.

the filamentous bacteria. Detailed microbiological studies indicate that the ozonation process reduces foam causing species such as *Nocardia*, *Parvicella* and *Thiotrix* (See Chart).

Summary

The ozonation system has many advantages. In addition to a reduction of the excess sludge by up to 80%, Praxair's system allows a significant reduction of cost both for sludge disposal and for sludge treatment (e.g., aerobic and anaerobic digestion, thickening and dewatering), as well as an improvement in the settling and dewatering characteristics of the sludge. The Praxair system is also able to effectively utilize the oxygen stream associated with the ozone thereby providing all the oxygen required to treat the lysis COD product. Other competitive systems are not able to take advantage of the accompanying oxygen stream.

The Praxair sludge ozonation process is fully automated, and it is possible to remotely monitor and control the process.

The plant had historical foaming problems. A 20 cm foam board was a permanent feature.

Picture taken two weeks after commencing sludge ozonation. The foam is gone and the liquid level in the basin is visible.

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Praxair, Inc.
39 Old Ridgebury Road
Danbury, CT 06810-5113
USA

www.praxair.com
info@praxair.com

Telephone:
1-800-PRAXAIR (1-800-772-9247)
(716) 879-4077

Fax:
1-800-772-9985
(716) 879-2040