



UNOX Process Upgrades

Background

Over the years, Linde has had an extensive history of innovation in the wastewater treatment process. In the 1960's, Linde wastewater engineers developed the UNOX process. At the time, it was a revolutionary concept. Today, with aging equipment and changes in treatment requirements, Linde can provide a wide range of technologies for UNOX upgrades. These enhancements can help UNOX facilities achieve reduced operating costs and improved reliability through the upgrade of oxygen generation and dissolution equipment.

Oxygen Generation Systems

Oxygen Supply: A critical UNOX wastewater treatment system component

Many of the oxygen generation systems installed at UNOX facilities were put in place in the 1970's and 1980's. These oxygen generation systems use either PSA (pressure swing adsorption) or cryogenic technology. Today, Linde offers a newer generation of on-site air separation technology that can produce oxygen much more efficiently.

The Linde VPSA (vacuum pressure swing adsorption) system offers the following benefits:

- Reduction in power requirements of up to 70%
- Reduced maintenance
- Full service oxygen plant operation and maintenance from Linde
- Improved power turndown
- Faster startup
- Improved operability

Linde has an extensive network and varied oxygen supply option to ensure that your oxygen needs are met. Our world class International Monitoring and Production Assistance Center (IMPAC) provides added value to our customers by continuously monitoring product levels at your back up liquid oxygen facility.

In situations where a UNOX facility is located near a Linde pipeline, we can enable the facility and avoid all of the energy and operational challenges associated with onsite oxygen generation altogether. At the City of Detroit, this 650 million gallon per day facility was able to close its onsite oxygen generation system completely, and rely exclusively on oxygen supplied from a Linde pipeline.

Table 1: Oxygen Supply Systems for UNOX Plants

	LOX	PSA	VPSA	Cryogenic
Typical Gas Flow Rate (tpd)	1-20	1-20	>20	>20
kWh/ton	n/a	724	185	257
Max Turndown	100%	20%	45%	20%
Startup	~10 min	~10 min	~10 min	>2 days
Pressure	10-20	80-90	2-3	10-20
Purity	99%	90%	90%	99%

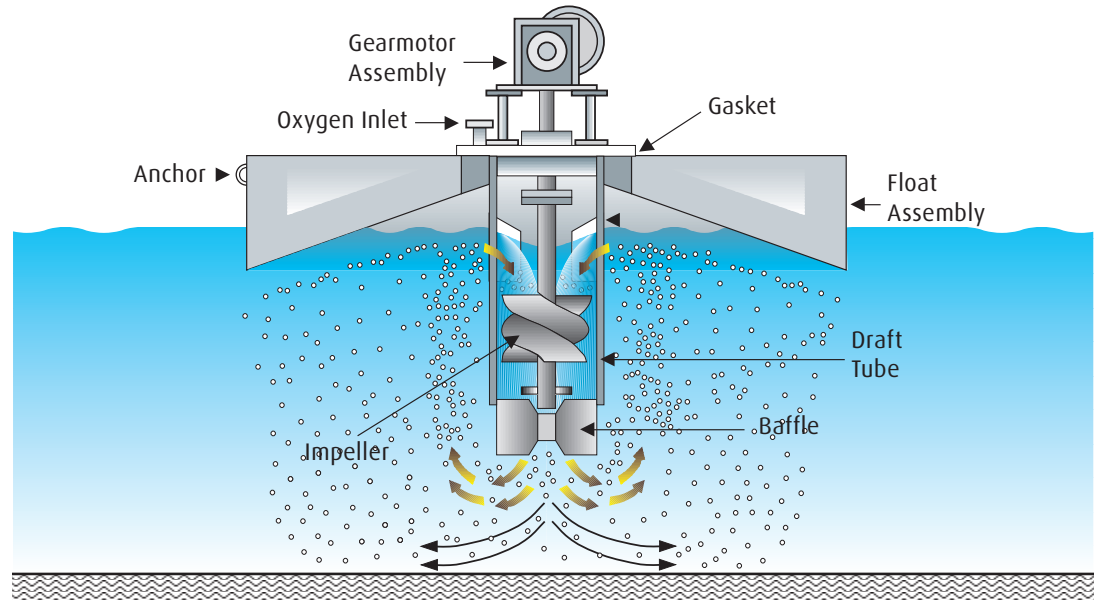
Oxygen Dissolution Systems

The original covered basin mixers found on the UNOX systems can be replaced with Linde's In-Situ Oxygenation (I-SO™) system. This system is designed to dissolve oxygen into wastewater with a high transfer efficiency. The I-SO™ also offers automated and manual dissolved oxygen (DO) control. Controlled oxygen flow can be used to optimize oxygen usage, operate swing aeration zones, or establish anoxic cells for total-nitrogen removal.

Biological Nutrient Removal

Since their original construction, many UNOX facilities have new regulations that require either nitrification or total removal of reduced nitrogen (TKN or NH3-N). As the UNOX aeration basins are closed, CO₂ tends to accumulate in the head space, which reduces the pH and can lead to upsets in nitrification. Linde offers a retrofit to promote nitrification or total nitrogen removal. The mixer for each UNOX stage is removed, so that the aeration tank is open to the atmosphere. Once this step has been complete, Linde's I-SO™ systems are installed in the open tank, which allows the CO₂ to be vented during aeration.

In-Situ Oxygenation (I-SO™) Unit



Linde has provided upgrades at multiple UNOX facilities in the United States. These upgrades have included both oxygen generation systems as well as I-SO™ installations.

Table 2: Linde Upgrades at UNOX Facilities

Facility	Year	O ₂ /TPD	Upgrade	Benefit
Euclid, OH	2001	15	Switch from PSA to VPSA	Power Savings
Detroit, MI	2004	600	Switch from Cryogenic to Pipeline Oxygen	Life Cycle Cost Savings
Ocean City, MD	2005	12	Switch from Cryogenic to VPSA	Power Savings
Holyoke, MA	2007	8	Switch from PSA to Liquid Oxygen and installation of six I-SO™ systems	Lower maintenance, better dissolved oxygen control, total nitrogen removal
Louisville, KY	2014	135	Switch from Cryogenic to VPSA	Power Savings
Holland, MI	2015	12	Switch from PSA to liquid oxygen and installation of four I-SO™ systems	Increase capacity with I-SO™ system addition

Summary As UNOX wastewater treatment facilities strive to improve their environmental performance, Linde offers oxygenation generation and dissolution applications that will help you to meet your goals. Whether your interest is in energy reduction, improved reliability and maintenance, or nitrogen removal, Linde offers systems that will meet your needs.

To learn more about Linde's wastewater treatment options and how we can help you improve your productivity, call us at **1-844-44LINDE** or visit us at www.lindeus.com.

Linde
 10 Riverview Drive
 Danbury, CT 06810
 Phone 1.844.44LINDE (1.844.445.4633), Fax 1.800.772.9985; 716.879.2040
www.linde.com

The Linde logo and the Linde wordmark are trademarks or registered trademarks of Linde plc or its affiliates. The information contained herein is offered for use by technically qualified personnel at their discretion and risk without warranty of any kind.

Copyright © 2020, Linde plc. 6/2020 P-40-4635