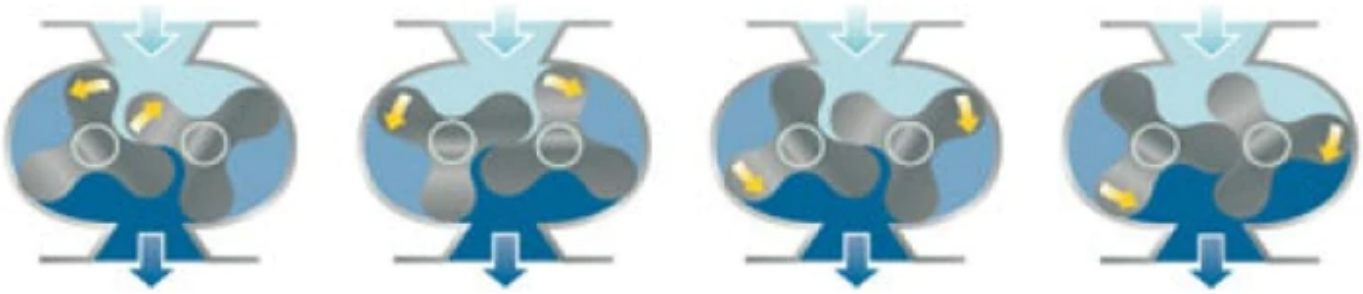
Blower Technology Advances Squeeze Energy Costs

With air blowers representing a large proportion of electricity costs in wastewater treatment plants, the race is on to find more efficient aeration methods.

Jul 1st, 2010



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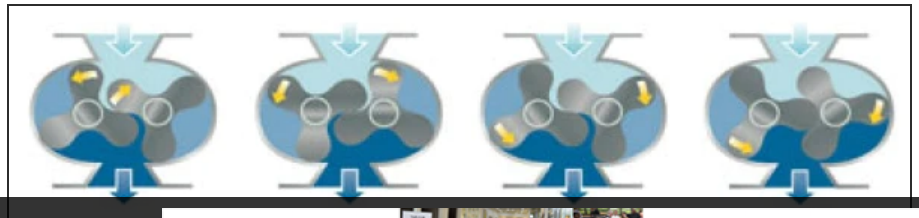
With air blowers representing a large proportion of electricity costs in wastewater treatment plants, the race is on to find more efficient aeration methods. What will the arrival of screw technology mean for rotary lobe designs? Peter Lattaway discusses laboratory tests that compared the two.

Low pressure air is the backbone of many production processes and is a vital element in the aeration operations of wastewater treatment plants. However, the technical evolution in blower design for small volume flows (300 to 5,000m³/h) has not advanced for the past 50 years. While Roots-type lobe blowers have been developed from 2-lobe to 3-lobe blowers, mainly to reduce the pulsation level, lobe blowers have not achieved significant improvements in terms of energy efficiency.

In order to achieve that energy efficiency goal, a major advance in the design principle was needed.



Working prin

achieved resulting from improved energy efficiency and lower air outlet temperatures.

Lobe blowers

Roots-type blowers are positive displacement machines consisting of a pair of two lobed or three lobed rotors, rotating inside an oval shaped casing. One rotor is driven by external power while the other rotor is driven by synchronisation gears.

As the rotors rotate, air is drawn into inlet side and forced out the outlet side against the system pressure. There is no change in the volume of the air within the machine but it only displaces the air from the suction end to the discharge end against the discharge system resistance.

At the lobe-type blower delivery side, air at a higher pressure is present. When the rotor lobes uncover the exit port, air from the delivery side flows back into the flute space between rotor and casing. This back flow of air equalises pressure and compresses the entrapped air externally at constant volume. Furthermore, the air is forced to the discharge line against the full system pressure.

Due to dynamic losses at the inlet and discharge side and from leakages and friction, the real compression work is increased and, subsequently, the adiabatic efficiency of the blower will be reduced.

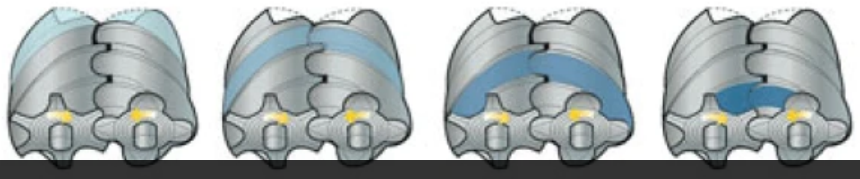
Delivering a stable flow is a key consideration for aeration systems. The theoretical maximum efficiency in the case of Roots-type blowers is 76.5% at a pressure ratio of 2, while a tuned screw blower can achieve 100%.

Due to dynamic losses at the inlet and discharge side, as well as leakages and friction, the real compression work is increased and, subsequently, the adiabatic efficiency will be reduced.

All of these effects are taken into account when defining levels of energy efficiency. The oil-free screw blower is a positive displacement machine consisting of male and female rotor elements which move towards each other while the volume between them and the housing decreases.

The rotors do not make contact and are synchronised by timing gears. Each screw blower has a fixed, integrated internal pressure ratio. To attain optimum efficiency, the internal pressure ratio must be adapted to the required working pressure.

At the beginning of the compression cycle, air at suction pressure fills the flute spaces as the rotors unmesh under the suction flange. Air continues to fill the flute spaces, until the trailing lobe crosses the inlet port and the air is trapped inside the flute space. As the lobe meshes, the flute volume is reduced, causing the pressure to increase. Air is discharged from the flute space when the leading lobe crosses the discharge port. Further rotation and meshing of the rotors forces this air to the discharge line.



Working principle of a screw blower

ability to change the delivered air flow.

Laboratory tests

Neither product information data nor test data from different technologies can be used to analyse blowers' energy efficiency accurately. The only way to compare the performance of machines is with a laboratory test in which different technologies work in the same environment under equal operating conditions, while using the same measurement equipment.

The screw blower comprises male and female rotor elements that move towards each other while the volume between them is reduced

In the test procedures, performed on different power ratings of a Roots-type blower, the consumed energy taken from the terminals at the power supply at the installed blower was measured together with the volume flow at the outlet flange of the blower system, according to ISO1217 ed.3 full acceptance test (Ppack). The test results are expressed in the specific energy requirement (SER in J/l), which shows the relation of the consumed power (in kW) divided by the free air delivery (FAD in m^3/h). In the first test set-up, a tri-lobe roots blower driven by a 110 kW motor and connected to a separately installed frequency converter was compared to a screw blower using a 75 kW motor with integrated variable frequency drive. The result, at maximum volume flow of the Roots-type blower (2,145 m^3/h), showed a 32.1% higher specific energy consumption (roots: 141.0 kW, screw 106.7 kW).At minimum volume flow (984 m^3/h), the difference in the specific energy requirement was 64.4% (roots: 191.7 kW, screw 117.2 kW).

In addition to these tests it was decided to invite the independent Technische Überwachungs-Verein (German Technical Monitoring Association, or TÜV) to witness the performance testing of an Atlas Copco ZS screw blower against a tri-lobe blower, according to the international standard ISO 1217, edition4. In these tests it was proven that the ZS screw blower is 23.8% more energy-efficient than a tri-lobe blower at 0.5 bar (e)/7 psig, and 39.7% at 0.9 bar (e)/13 psig.

ENERGY SAVINGS

Water industry statistics from the USA put the need for energy efficiency into perspective. According to the Environmental Protection Agency (EPA): "...approximately 56 billion kilowatt hours (kWh) is used for drinking water

about $400 million annually" (US Environmental Protection Agency, "Energy and Water/Wastewater Infrastructure").

Author's note:*Peter Lattaway is the product support manager of Atlas Copco Compressors. For more information on the EPA's Energy and Water/Wastewater Infrastructure report, please visit: http://www.epa.gov/ne/eco/energy/ew-infrastructure.html*

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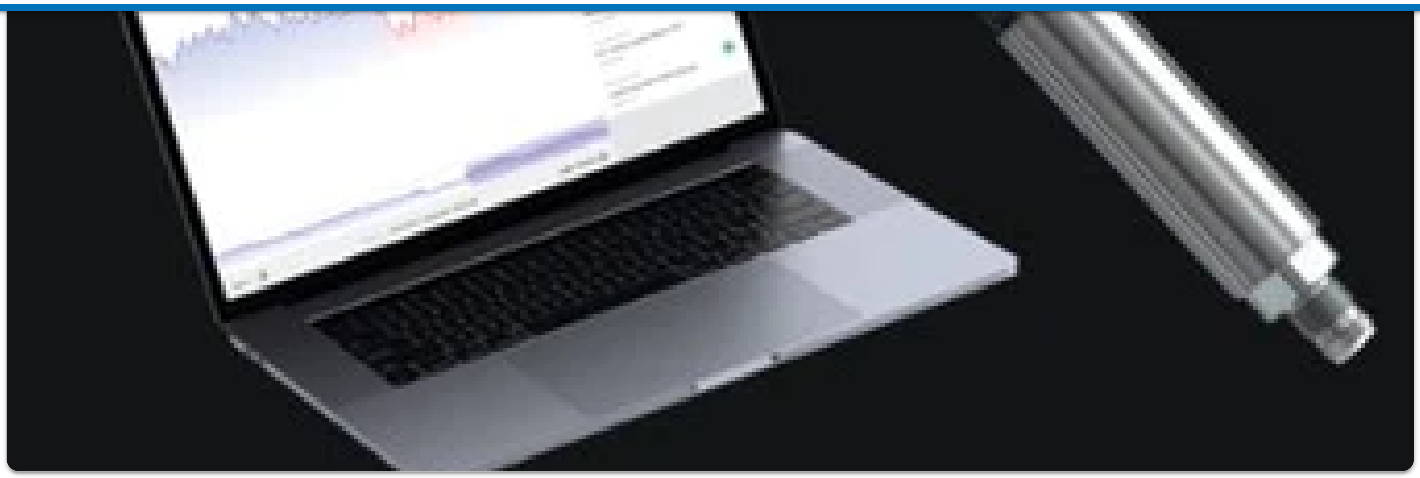

Treatment

Lahti Aqua selects UROS for sanitation safety planning in Finland

The regional water supply company deploys UROS Sense liquid quality monitoring solution to systematically identify and manage risk along sanitation chain.

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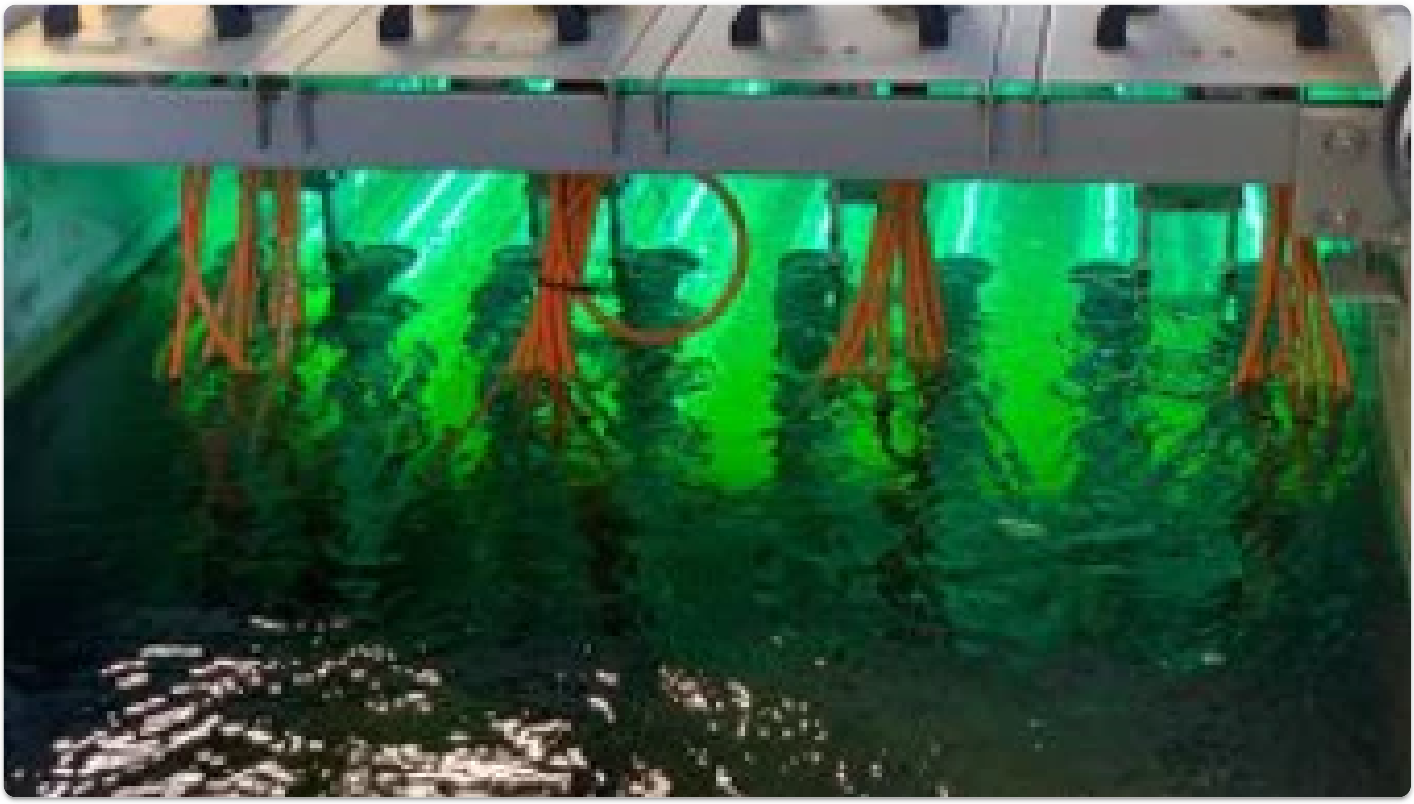

Wastewater

Spanish researchers develop method to detect coronavirus by analyzing wastewater

The analysis system, which could be used as a method for epidemiologic monitoring, has been tested in Murcia, Spain, and in three treatment plants of the metropolitan area of Valencia.

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Treatment

Thames wastewater treatment plant employs Microvi MNE technology

The fully automated MNE demonstration plant was configured as a tertiary nitrification system for ammonia removal.

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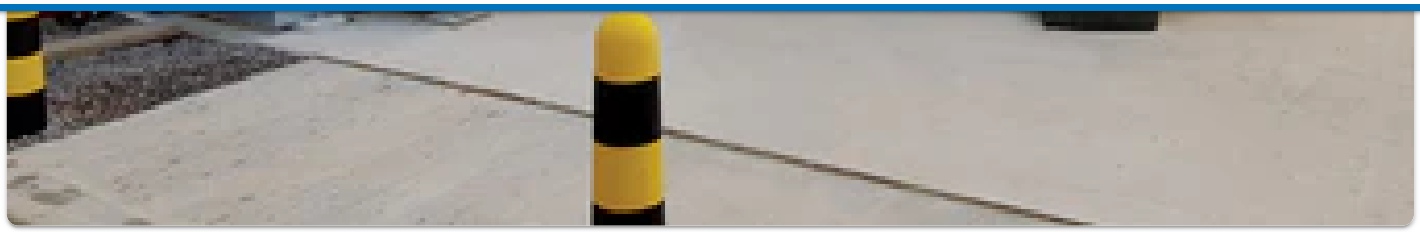

Wastewater

Wessex Water awards Bluewater Bio three phosphorus removal contracts

FilterClear offers a proven and reliable method to tackle increasingly stringent discharge consents across the country.

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Wastewater

European Commission greenlights large international water project

WATER MINING is a 17 million euro project aimed at demonstrating innovative water resource solutions.

Apr 21st, 2020

Wastewater

Scottish Water awards WPL contracts for expansion, refurbishment projects

Modular WPL Hybrid-SAF wastewater treatment units will be installed on the Winchburgh expansion project.

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Reuse / Recycling

Sewage-enhanced steel slag makes stronger concrete

RMIT University research shows byproduct of steel making can be used to both treat wastewater and make stronger concrete.

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Wastewater

Effluent Sewers Down Under

Innovative wastewater treatment system allowed Australia's Yarra Valley Water to provide a feasible, long-term solution to its customers in Kinglake West soon after a major crisis.

Bill Hensley Apr 7th, 2020

HKU researchers develop a novel wastewater treatment process to effectively remove hazardous chemical contaminants.

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Wastewater

PUB Singapore awards $433M biosolids treatment contract to Sembcorp Design and Construction

Company will construct Tuas WRP's biosolids building, digesters, waste receiving facility.

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Wastewater

Danish wastewater plant opts for actuator automation

The Rotork CKc electric actuators have been installed at the wastewater treatment plant in place of manual alternatives.

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Treatment

Sludge Pumping for Optimum Efficiency

Efficient sludge pumping has an important role to play as water companies gear up for zero carbon, says Mick Dawson, consultancy director, BHR Group, who urges designers and operators to better understand their sludge systems.

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Smart Water Utility

Ruhrverband uses shredding solution from Vogelsang in large sewer

The modified shredding solution is now being used in the inlet of the pumping station in Witten.

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Energy Management

Energy Management on the Rhine

A German wastewater utility uses a decanter centrifuge to thicken excess sludge, which allows the plant to extend the time spent in the digesters. This means less water is pumped into the digesters, requiring less heat.

Daniel Lakovic Mar 9th, 2020

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