

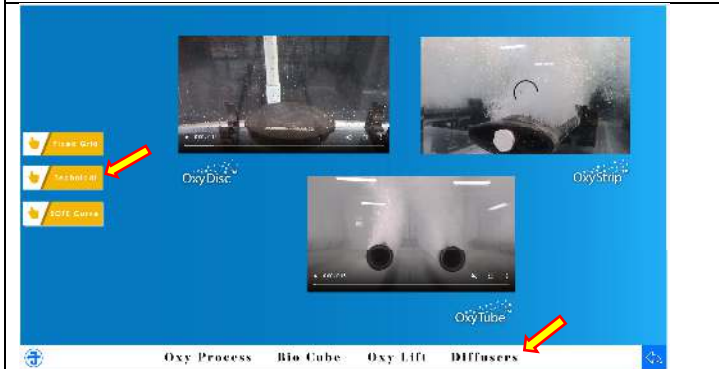
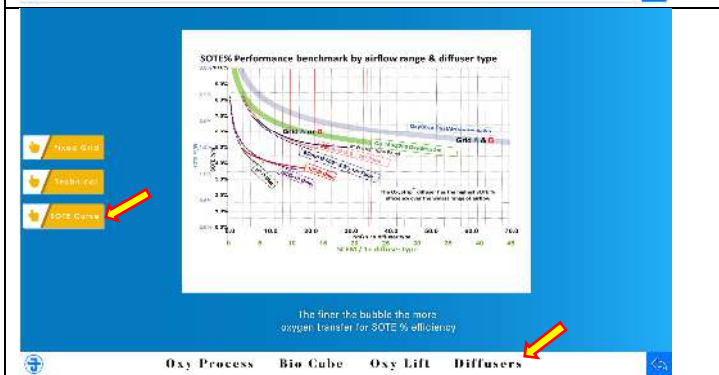
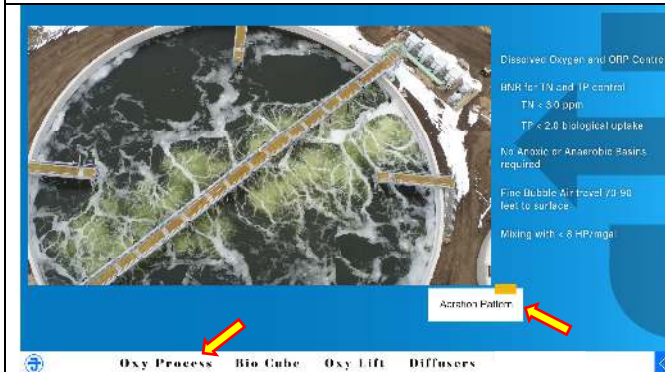
 <p style="text-align: center;">Oxy Process Bio Cube Oxy Lift Diffusers</p>	 <p>bottom right – return button to upper level slide & home position.</p> <p>Diffuser technology & utility: Klick – Diffusers</p>
 <p style="text-align: center;">Oxy Process Bio Cube Oxy Lift Diffusers</p>	<p>Klick – Diffusers - Fixed Grid – auto run video – 1st sequence: Grand Island, NE - May, 2015; 1,040 x JAEGER OxyStripTM OS 160/ 2200 FF (2m long) Diffusers, piping – plant retrofit; Fixed Grid retrofit – see LITERATURE page – case study – FIXD GRID RETROFIT for detail 2nd sequence: Groningen, Netherlands, July 2018; 360x JAEGER OxyStripTM OS 160/ 2200 FF (2m long) Silicone Diffusers - diffuser replacing Ovivo Aqua Consult – AeroStrip T4.0-180x Strip PU Membranes Strip Diffuser 4m; Industrial sugar beet factory 3rd sequence: PEDREIRA, Brazil, Aquamec Indústria e Comércio Ltda , Nov 2016; 96 x JAEGER OxyStripTM OS 160/ 2200 FF (2m long) Diffusers 4th sequence: Arthur, IL July, 2018; 72x JAEGER OxyStripTM OS 160/ 2200 FF (2m long) Diffusers, Drop Pipes, piping Vs. City of Sao Paulo, Sabesp, Brazil; Aquamec Indústria e Comércio Ltda; Oct. 2016; 18,000 x ECO-10 10” Disc Diffusers</p>
 <p style="text-align: center;">Oxy Process Bio Cube Oxy Lift Diffusers</p>	<p>Klick – Diffusers – Technical – auto run videos –</p> <p>For reference: Buyer's guide disc, tubular, & strip diffuser systems: The today's fine bubble membrane diffuser marketplace offers WWTP plant owners & operators, infrastructure planners, & engineers many choices of diffuser models, designs, & manufactures. The are 3 main product categories:</p> <ol style="list-style-type: none"> 1. Disc Diffusers 2. Tubular diffusers 3. Strip Diffuser & Plate Aerators <p>BENCHMARK page - topics: 1; 2; 3; 13; 14; 4; 5; 6; 7; 8; 9; 10; 19</p>
 <p style="text-align: center;">Oxy Process Bio Cube Oxy Lift Diffusers</p>	<p>Klick – Diffusers – SOTE Curve –</p> <p>For reference: History of continual SOTE testing and product enhancement since 1985:</p> <ol style="list-style-type: none"> 1. Disc Diffusers 2. Tubular diffusers 3. Strip Diffuser & Plate Aerators <p>BENCHMARK page - topics: 14; 13; 1; 2; 3;</p>



Klick – Oxy Process
Actual nutrient loading driven process control & WWT process design – OxyProcess™
 Modern WWT plant / Aeration diffuser system designs require diffuser products and systems which provide on a yr. 1 to yr. 20+ planning scheme, meet the challenges of rising average temperatures, & an increasing volatile operating environment:

- Supplying sufficient oxygen [O₂] to meet the biological oxygen process demand [BOD] at all times and operation conditions
- Minimum diffuser system turndown range of 8:1, 16:1 or better
- Optimizing blower air / minimizing power consumption driven by process oxygen uptake
- Provide low energy consumption mixing during low O₂ uptake cycles, anoxic, or anaerobic phases
- Dissolved oxygen [DO] process control
- Variable frequency drive [VFD] control on blower and mixer system
- Multi-level diffuser system redundancy, ideally retrievability for 100% system uptime / resilience

System flexibility, & scalability for continual WWT process optimization
 JAEGER explains OxyProcess™ in sections PRODUCTS, MEDIA, & PROJECTS how current and future WWT plant / Aeration diffuser system demands are met, how the energy consumption of the WWT activated sludge phase can be reduced by up to 40%, and how the WWT process can be continually improved by employing actual nutrient loading driven process control – OxyProcess™.



Klick – Oxy Process – Aeration Pattern

- See notes on slide

For reference:

- see **LITERATURE page** – case study – SINGLE BASIN BNR WWTP - for detail

Hays, KS; Burns & McDonnell, Design & Build; November 2018; On line January 2019; New Basin, WWTP – retrievable; 624x JAEGER OxyStrip™ OS 160 / 2150 FF Silicone diffusers on 26 retrievable racks including blowers, walk bridge, Rack Traverse System for Cleaning/Maintaining Diffusers; Engineers: Burns & McDonnell, HDR



Klick – Oxy Process – Aeration Pattern

- See notes on slide

For reference:

See - **LITERATURE page** – case study – SINGLE BASIN BNR WWTP - for detail

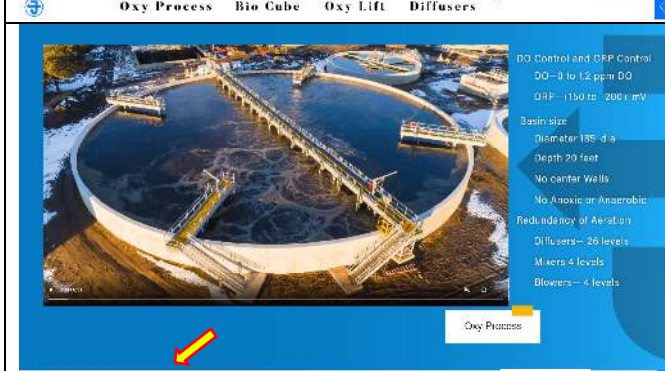
See - **PRODUCT page** – OxyProcess

Low speed high efficiency submerged mechanical mixing
 85% power reduction:

- Diffused Air Mixing 176 hp [132 kWh]
- vs. Mixer 22.5 hp [17 kWh]

(Example @ 15 ft. [4.6m] SWD; 2.64 mil. Gallons [1,000m³])

Variable frequency drive [VFD] control mixer system



Klick – Oxy Process – Hays

- See notes on slide

For reference:

See - **LITERATURE page** – case study – SINGLE BASIN BNR WWTP - for detail

See - **PRODUCT page** – OxyProcess

Low speed high efficiency submerged mechanical mixing
 85% power reduction:

- Diffused Air Mixing 176 hp [132 kWh]
- vs. Mixer 22.5 hp [17 kWh]

(Example @ 15 ft. [4.6m] SWD; 2.64 mil. Gallons [1,000m³])

Variable frequency drive [VFD] control mixer system

Effluent Performance of OxyProcess Design

	Influent	Effluent	% removal
BOD	300-500	10-20 ppm	95%
TSS	100-150 ppm	10-20 ppm	80%
Turb	35-75 ppm	10%	
Ammonia	30-50 ppm	0-10 ppm	95-98%
Nitrate	n/a	15 ppm	
Total Phos	8-10 ppm	<0.2 ppm biological	40-70%
Phos (Chem)		<0.2 ppm chemical	80-95%
			30-40-50% ea

OxyProcess Design

- Signal to new filter & Denite for 4-NR performance. Monitor as needed with DO and ORP.
- Mixing Energy Separate from Aeration Energy
- Cycle Air On/Off based on Loading to plant, to save energy

Consistent Effluent Perf. In 1st Year. Performance for 1st Year. Influent 15000 ppm. Influent 15000 ppm.

Performance

Oxy Process Bio Cube Oxy Lift Diffusers

Klick – Oxy Process – Performance

- See notes on slide

For reference:

See - **LITERATURE page** – case study – SINGLE BASIN BNR WWTP - for detail

Dixon

- Dixon ms screen
- Upgraded as compared to new plant. Saved 35 million
- BNR Performance to c. 1-NR and 1-P-2
- No Anoxic & Anaerobic Basins
- Blowers operate only 4 hours/day
- Save \$10,000/yr power vs Dolus
- One Mixe Two Blows
- 3 levels of Diffusers for redundancy
- 1 week construction time on-site

Oxy Process Bio Cube Oxy Lift Diffusers

Klick – Oxy Process – Dixon

- See notes on slide

For reference:

See - **LITERATURE page** – case study – OXIDATION DITCH RETROFIT - for detail

OxyLift

120-1800 ft² per diffuser rack (100-1500 ft² per tank)

10-15 ft high. 10-15 ft wide. 10-15 ft deep. 10-15 ft long. 10-15 ft high. 10-15 ft wide. 10-15 ft deep. 10-15 ft long.

Oxy Process Bio Cube Oxy Lift Diffusers

Klick – Oxy LIFT

WWT systems resilience – Retrievable OxyLift diffuser systems:

Water sanitation / wastewater treatment infrastructure, its continual / non-interrupted operation are critical factors to human health and habitation. System redundancy, & resilience to rising average temperatures, & possible system upsets like extreme weather events of the WWT activated sludge phase are mandatory.

JAEGER demonstrates in sections PRODUCTS, MEDIA, & PROJECTS how OxyLift™ – the retrievable OxyStrip™ diffuser rack systems – can provide a piece of mind to all WWT plant owners & operators, infrastructure planners, & engineers. Any basin geometry or plant size can be made retrievable by employing OxyLift™ technology for as little as 1% to 2% of the initial total investment of a modern wastewater treatment plant.

See topics / questions #:

FAQ	PLANET	BENCHMARK	PRODUCTS	PROJECTS
8; 12; 16; 11; 10;	13; 14; 15; 16;	5;	OxyStrip; OxyLift; OxyProcess	Retrievable: 1, 2, 3, & 4; Lagoon:

Transporting Diffusers

Project Design Requirements:

- Can and maintain diffusers over aeration basin. Needed to provide 10-15 ft of transport diffusers to edge of tank.
- Provide 25 levels of redundancy for inspection of a diffuser rack.
- Allow for additional air diffusers up to 8-10% additional air without devoting tank.

Oxy Process Bio Cube Oxy Lift Diffusers

Klick – Oxy LIFT – Transporting Diffusers

- See notes on slide

Single tank yr. 1 to yr. 20+ design

System redundancy, & resilience

Utility, Ingenuity, Quality, Diffuser Rack, OxyStrip, O&M, Superior Hardware,

<p>Project Requirement: Simple hoist to retrieve diffusers Two minutes from bottom of tank to top of water for inspection Able to inspect all 26 diffuser racks in a single day with two people</p> <p>JRE Oxy Process Bio Cube Oxy Lift Diffusers</p>	<p>Klick – Oxy LIFT – OxyLift</p> <ul style="list-style-type: none"> - See notes on slide <p>Single tank yr. 1 to yr. 20+ design</p> <p>System redundancy, & resilience</p> <p>Utility, Ingenuity, Quality, Diffuser Rack, OxyStrip, O&M, Superior Hardware,</p>
<p>Electric Crane to raise diffuser racks No Outside Crane required 2 minutes removal time 4 minute replacement time</p> <p>Oxy Process Bio Cube Oxy Lift Diffusers</p>	<p>Klick – Oxy LIFT – Raising Diffusers</p> <ul style="list-style-type: none"> - See notes on slide <p>Single tank yr. 1 to yr. 20+ design</p> <p>System redundancy, & resilience</p> <p>Utility, Ingenuity, Quality, Diffuser Rack, OxyStrip, O&M, Superior Hardware,</p>
<p>Project requirement: No outside cranes allowed to retrieve diffuser rack. If you cant carry it on your tool belt—you cant use it! Therm hoist is transportable along the bridge with a single person</p> <p>Oxy Process Bio Cube Oxy Lift Diffusers</p>	<p>Klick – Oxy LIFT – Transferring Crane</p> <ul style="list-style-type: none"> - See notes on slide <p>Single tank yr. 1 to yr. 20+ design</p> <p>System redundancy, & resilience</p> <p>Utility, Ingenuity, Quality, Diffuser Rack, OxyStrip, O&M, Superior Hardware,</p>
<p>Cleaning diffusers annually maintains efficiency and wwp performance. After 9 months of service diffusers are in excellent condition. Silicone (whip) diffusers provide longer service and easier to clean than EPDM.</p> <p>Oxy Process Bio Cube Oxy Lift Diffusers</p>	<p>Klick – Oxy LIFT – Clean Diffusers</p> <ul style="list-style-type: none"> - See notes on slide <p>Single tank yr. 1 to yr. 20+ design</p> <p>System redundancy, & resilience</p> <p>Utility, Ingenuity, Quality, Diffuser Rack, OxyStrip, O&M, Superior Hardware,</p>

 <p>OxyProcess system supply from Jaeger Aeration incorporates all of the design bridge, platform or other equipment for diffuser retrievable with engineering stamp on structural design. Blower design with PD or Centrifugal type blowers for single source responsibility Diffuser rack for fixed grid or retrievable design based on project needs</p> <p>Oxy Process Bio Cube Oxy Lift Diffusers</p>	 <p>Klick – Oxy LIFT – - See notes on slide Single tank yr. 1 to yr. 20+ design System redundancy, & resilience Utility, Ingenuity, Quality, Diffuser Rack, OxyStrip, O&M, Superior Hardware,</p>
 <p>Oxy Process Bio Cube Oxy Lift Diffusers</p>	 <p>Klick – Oxy LIFT – Can the fine bubble diffuser system of circular or rectangular basin with a basin diameter or width > 20' to 35' [6m to 10.5m] be made retrieval? Yes, OxyLift TM has no retrievability limitation by basin geometry Rectangular, round, toroidal, and square Bridge or wall mounted FAQ – topic # 16</p>
 <p>Retrievable FBBR IFAS MBBR systems</p> <p>Increasing existing systems organic removal performance Ammonia nitrification Applications Retrievable modules – increased system redundancy</p> <p>Oxy Process Bio Cube Oxy Lift Diffusers</p>	<p>Klick – Bio Cube – auto run videos – Retrievable FBBR IFAS MBBR systems Increasing existing systems organic removal performance Ammonia nitrification applications Retrievable modules – increases system redundancy BioCube Process Biofilm attached growth systems for BOD and nitrogen removal from wastewater. Fixed film media units design options Single pass Return sludge IFAS systems Retrievable, drop-in FBBR modules Increasing the BOD removal performance / increase biomass (suspended & fixed) by up to 60% by tank volume For reference: See - PRODUCT page – OxyProcess</p>
 <p>Oxy Process Bio Cube Oxy Lift Diffusers</p>	<p>Klick – Bio Cube – Enlarge Video 1 upper left: Retrievable FBBR IFAS MBBR systems BioCube I – BOD & Ammonia removal – Ellisville, MS, municipal, 2017</p>



Klick – Bio Cube –

Enlarge Video 1 upper right:

Retrievable FBBR | IFAS | MBBR systems

Ammonia stripping (nitrification) & BOD removal application for effluent permit compliance

Industrial, Hurlock, MD; May, 2019; WWTP New retrievable FBBR – BOD & ammonia stripping; 40 x FBBR Units – JAEGER BioCube II units - 480 JAEGER OxyStrip™ OS 160/ 2150 FF (1.5m long) – 5 Blowers
 Mixing Tank – 40 JAEGER OxyStrip™ OS 160/ 2200 FF (2m long)
 -

Retrievable FBBR | IFAS | MBBR systems

BioCube™ - Applications

- FBBR Post treatment of trickling filter effluent**
 Trickling filters designed for BOD removal cannot easily be upgraded for nitrification. A downstream FBBR system provides ammonia removal. Moreover, a submerged FBBR removes the contribution of the bio-solids most cases. Since Trickling filters already have a diffuser, only the FBBR system needs to be integrated between the TF and the aeration tank.
- IFAS system**
 IFAS systems are commonly used for upgrade of existing activated sludge systems. Typically the aeration reactor is converted to an additional diffuser reactor with high biomass concentration, since biofilm and suspended biomass share the same reactor volume. Depending on the initial situation, significant upgrade in treatment efficiency can be accomplished.
- FBBR Post treatment of lagoon effluent**
 Typical Lagoon effluents are low in solids and BOD but cannot provide ammonia removal in most cases. A downstream FBBR system provides nitrification. The generated solids concentration is low and can be separated with tube settler or conventional clarifier.
- FBBR system as sole biological treatment**
 FBBR system may also be used as a sole biological treatment downstream of a primary settler. The first stage is designed for BOD removal. Subsequent nitrification tank.

Oxy Process Bio Cube Oxy Lift Diffusers

Klick – Bio Cube –

Enlarge Slide lower left:

Retrievable FBBR | IFAS | MBBR systems

BioCube – Application – description & process flow charts

In operation

After BOD removal the biofilm microorganisms facilitate the oxidation of Ammonium NH₄⁺ to Nitrite NO₂⁻

STEP 1:

$$\text{NH}_4^+ + \text{O}_2 \xrightarrow{\text{Facilitator}} \text{NO}_2^- + \text{H}^+ + \text{H}_2\text{O} + \text{ATP}$$

STEP 2:

$$\text{NO}_2^- + \text{O}_2 \xrightarrow{\text{Facilitator}} \text{NO}_3^- + \text{ATP}$$

Klick – Bio Cube –

Enlarge video lower right:

Retrievable FBBR | IFAS | MBBR systems

BioCube – Application – animated description & process