



# Upgrading Conventional Activated Sludge with Innovative MABR

Simple, low-energy nutrient removal in a small footprint

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Imagination at work.

# ZeeLung MABR value proposition

Intensify nutrient removal  
more treatment from existing tank volumes

Reduce aeration energy  
30% lower than CAS, 50% lower than IFAS

Simple solution  
no civil works

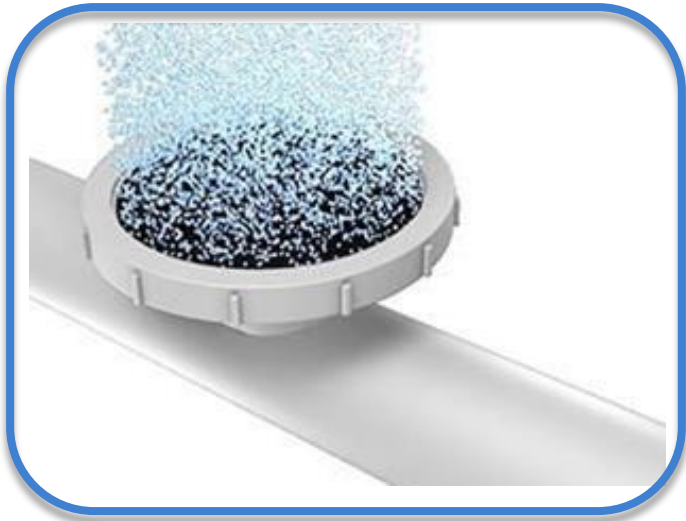
MABR uses a biomass carrier to support the growth of a biofilm

The carrier material “breathes” and transfers oxygen to the biofilm at very high efficiency without the use of bubbles

MABR is not...



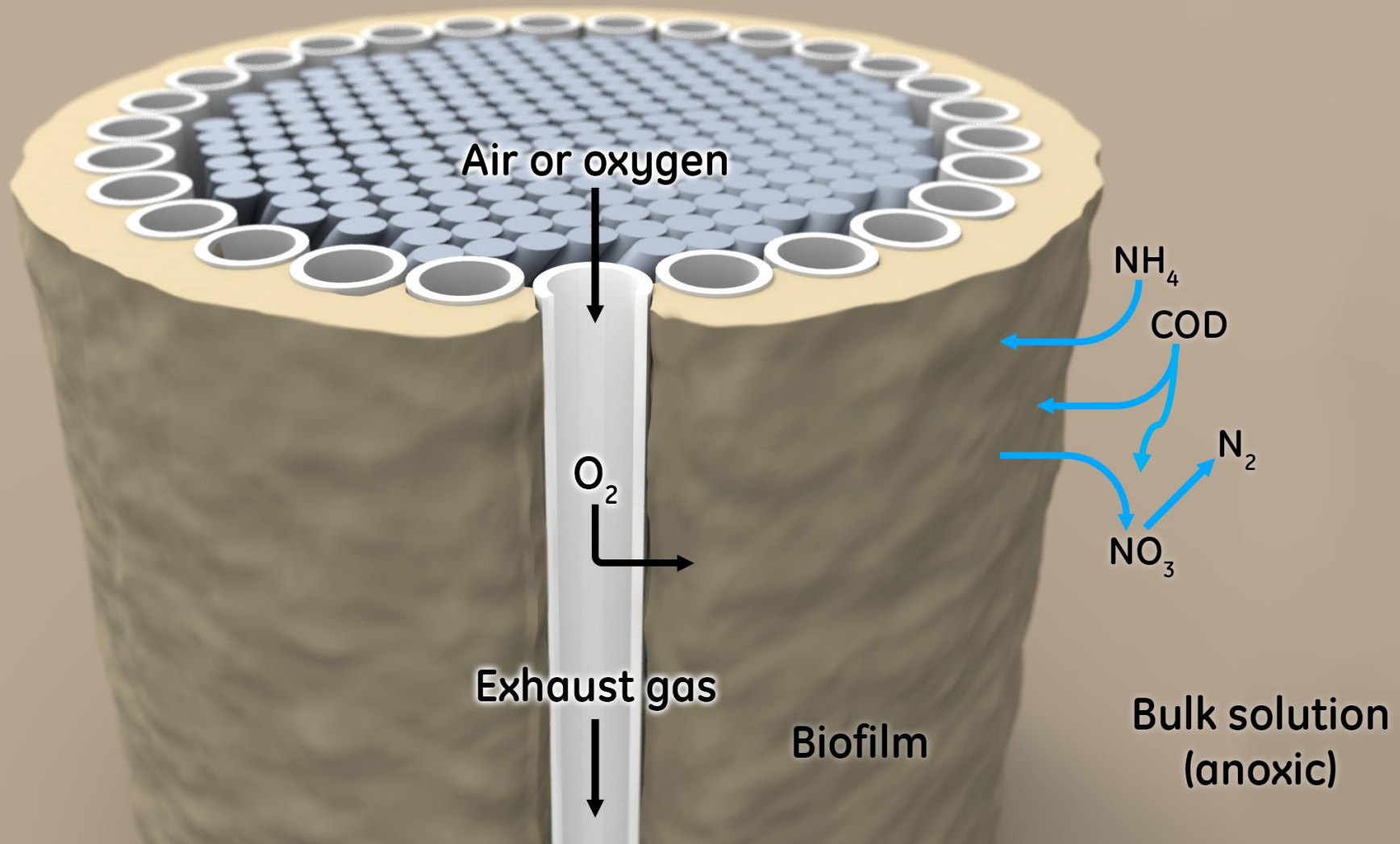
a filter



a diffuser

# *Technology overview*

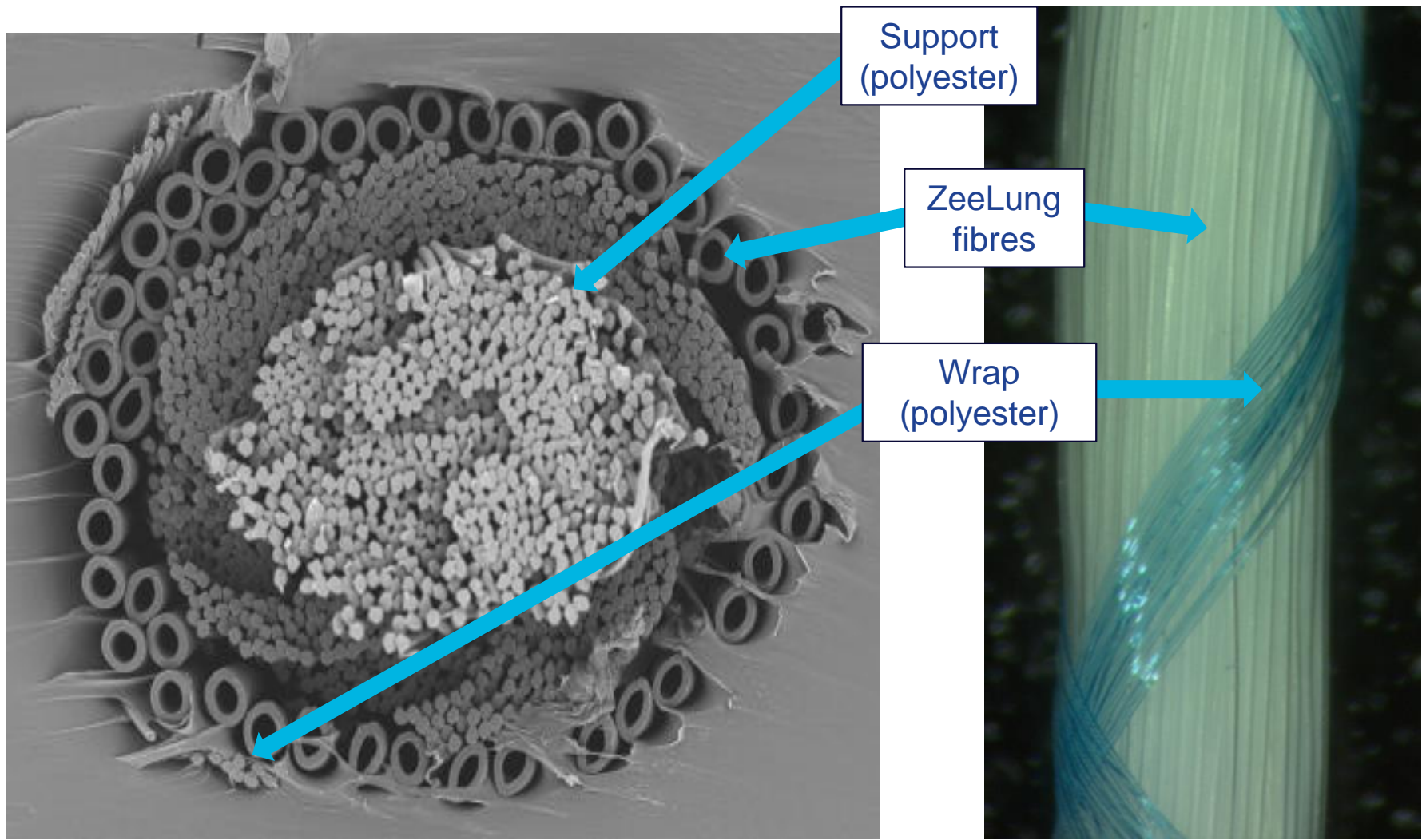
# Membrane Aerated Biofilm Reactor process



Highest efficiency of oxygen transfer by diffusion of  $O_2$  into a biofilm

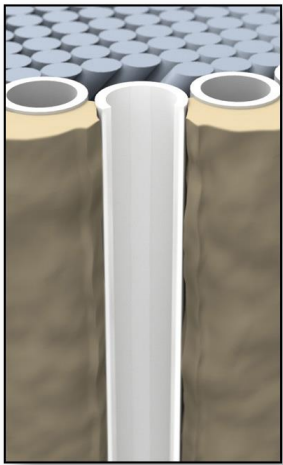


# ZeeLung membrane cord

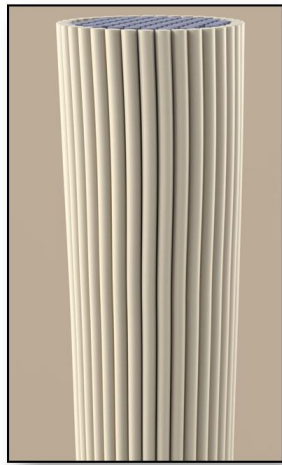


*Cord construction ensures product robustness*

# ZeeLung product



ZeeLung filament



ZeeLung cord



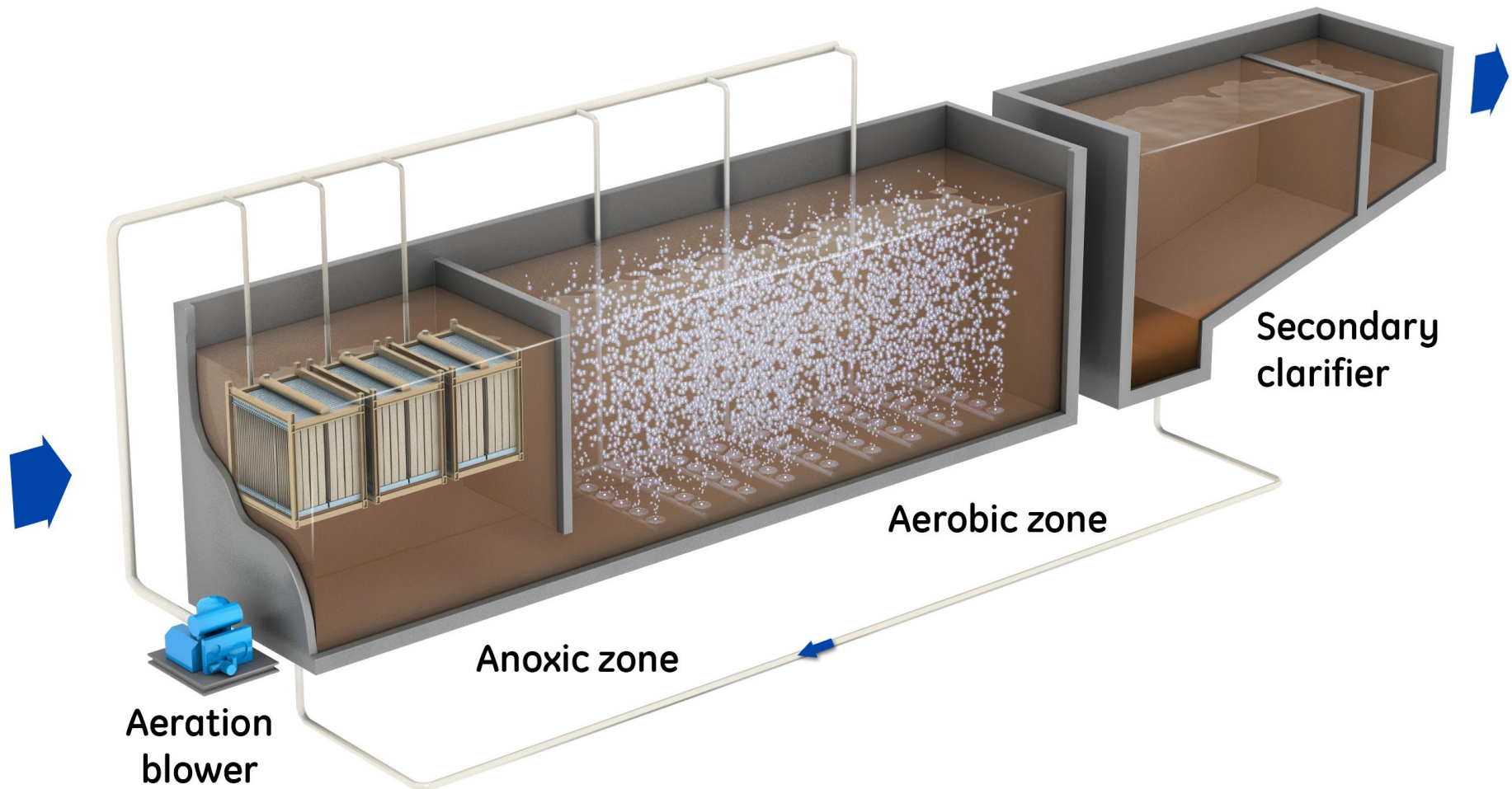
ZeeLung module



ZeeLung cassette



# ZeeLung cassettes are installed in the bioreactor



Increase biomass inventory in existing volume  
Enables nutrient removal & capacity expansion

# Benefits of MABR

1 Treat more flow/load in existing tank volume

2 Implement nitrogen removal in existing tank volume

3 Optimize management of carbon

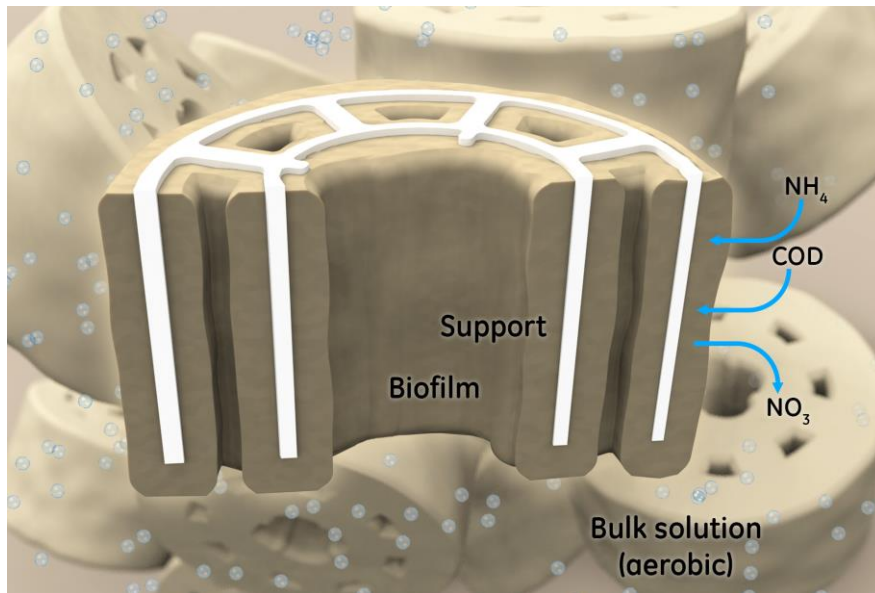
- Lower SRT increases energy recovery
- Simultaneous nitrification/denitrification improves efficiency of carbon for nutrient removal

4 Eliminate or reduce recycle flow rates

5 Reduce energy consumption

# MABR intensifies nitrification compared to conventional biofilm processes

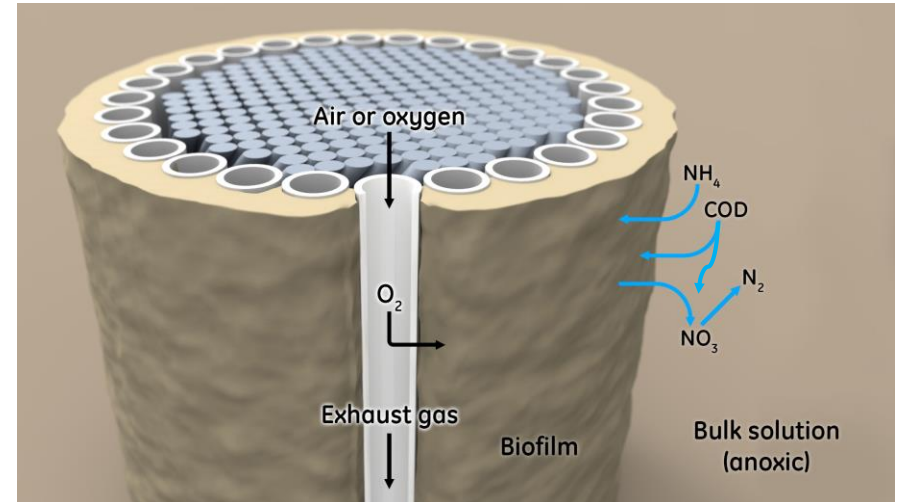
## Conventional



Reaction occurs at the surface

Competition for  $\text{O}_2$  between heterotrophs & autotrophs

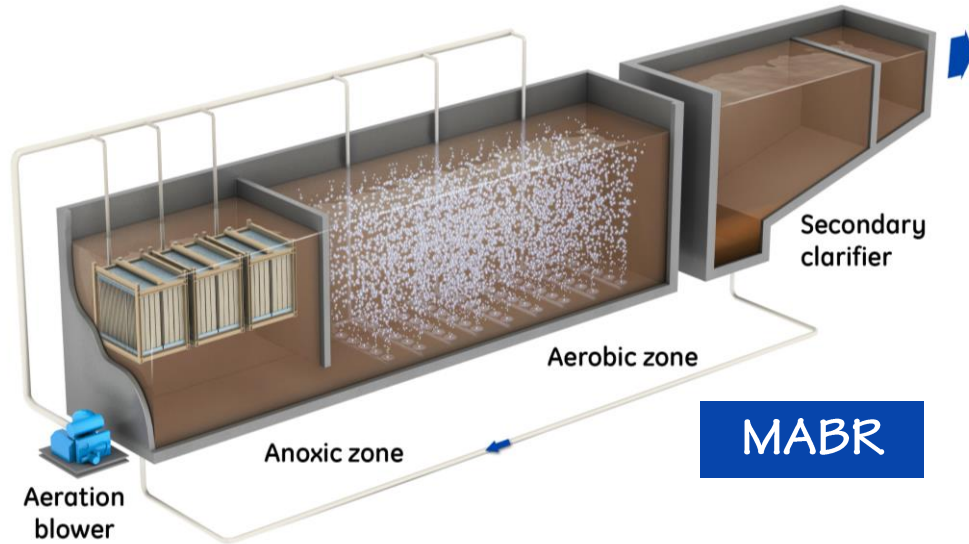
## MABR



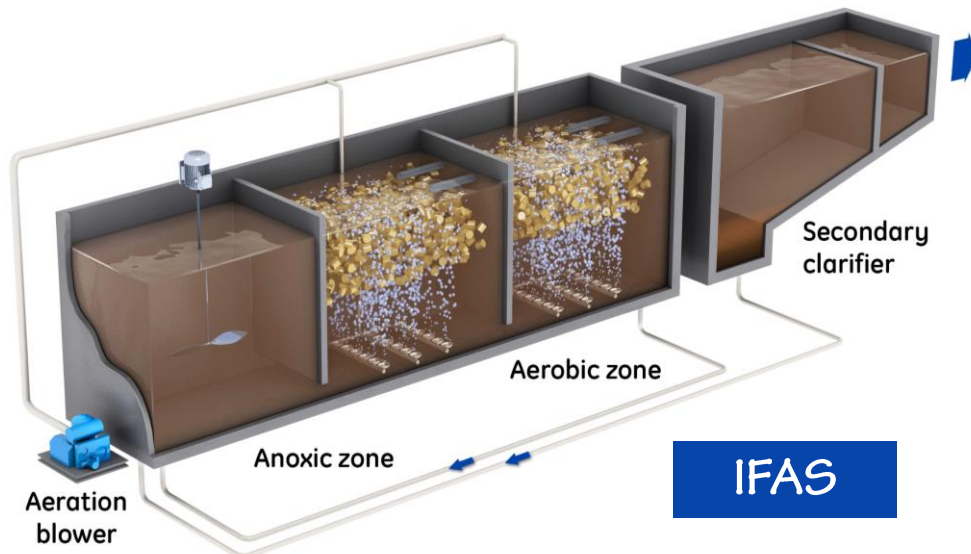
Reaction occurs in the biofilm

Favors the growth of autotrophs (nitrifiers) at media surface

# MABR advantages compared to IFAS



- Fits any tank dimension, including long narrow tanks
- No impact on hydraulic grade line
- No risk of overflow during loss of power
- $\geq 50\%$  energy savings
- Easy access to diffusers
- Reduced recycle flows
- Not prone to foaming
- Biofilm control options
- Ability to adjust treatment levels



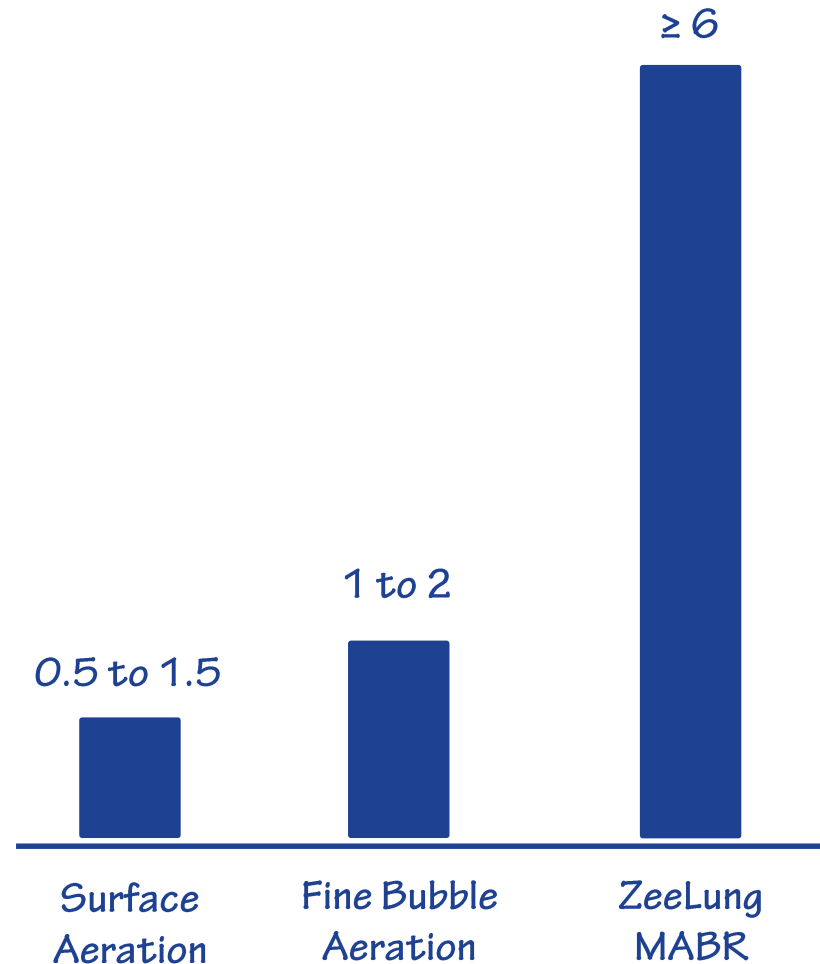
# ZeeLung reduces the energy for aeration by 4X

Aeration efficiency, kg O<sub>2</sub>/kWh

Conventional aeration is inefficient and the largest energy consumer

ZeeLung aeration efficiency is 4X fine bubble aeration

Energy savings determined by % of oxygen demand supplied by ZeeLung

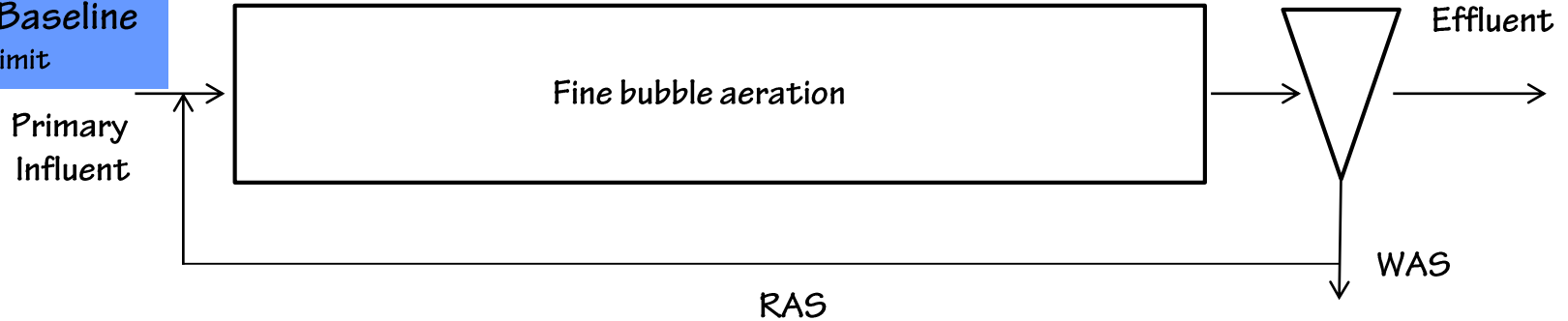


Potential applications

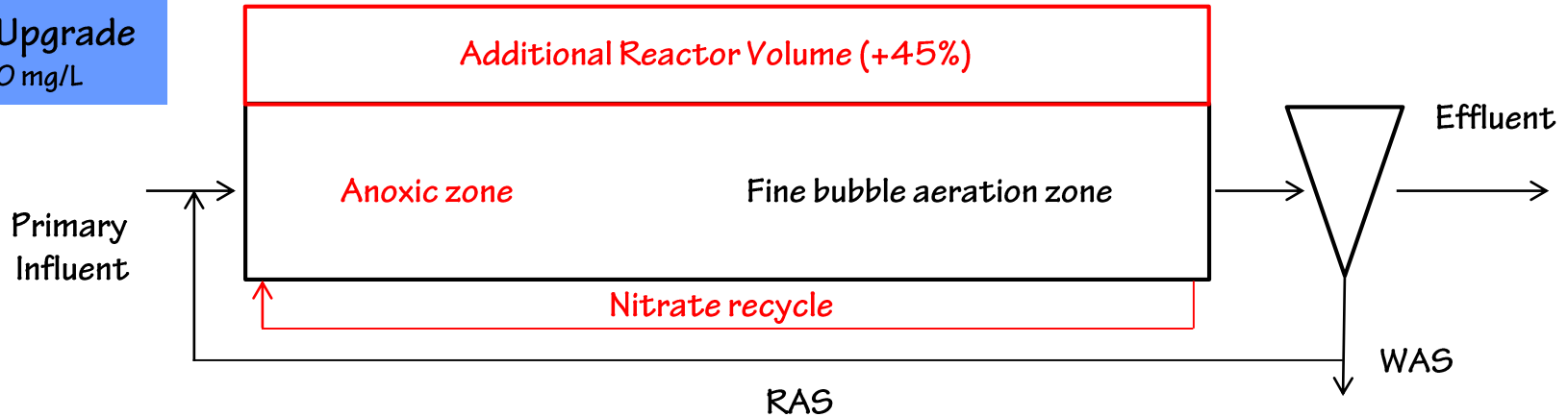


# Upgrade for nitrogen removal

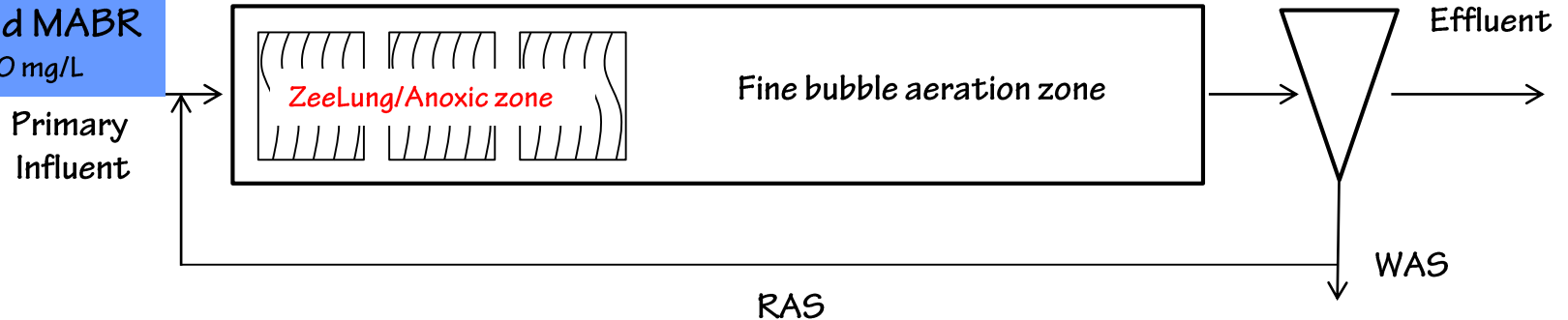
CAS Baseline  
No TN limit



CAS Upgrade  
TN = 10 mg/L



Hybrid MABR  
TN = 10 mg/L



*Experience*

# Chicago MWRD

## Terrence J. O'Brien Water Reclamation Plant

Began operation in 1928

Serves 1.3m people

333 MGD (1,260 MLD) capacity

PC + CAS + UV

New permit for phosphorous

Treatment performance challenged during cold temperature, peak conditions

MWRD target of energy neutrality



# Chicago O'Brien WRP ZeeLung benefits

Improve treatment  
performance under  
stressed conditions

Enable biological  
phosphorous removal

Increase capacity

Reduce energy  
consumption

Enable introduction of anaerobic  
zone in existing tank volume by  
intensifying nitrification process



0.5 MGD (2 MLD) demo  
Operated June 2015 – June 2016

# Chicago O'Brien demonstration conclusions

Biofilm established in 4 weeks

MABR intensifies N removal... potential to enable bio-P in existing tank volume

N removal not impacted by cold temperatures

Nitrification rate varies with ammonia loading and C:N ratio... important parameters for design

30% aeration energy reduction with potential to increase to 40%

MABR proved it could increase capacity, improve effluent quality and reduce energy





# ZeeLung enables increased wastewater treatment capacity in existing footprint for the Yorkville-Bristol Sanitary District

## Challenge

- 3.62 mgd plant near design load
- Increased organic load from new industries
- Future regulation for phosphorous
- CAS plant capex \$ 25m + opex \$ 0.5m per year

## Solution

- Install ZeeLung cassettes in existing activated sludge tanks
- Increased biomass inventory can treat more organic load
- Free-up volume to enable bio-P
- Reduce energy consumption

**Lowest-cost solution to expand capacity**





Belgian  
Wastewater  
Treatment  
Plant First in  
Europe to Use  
ZeeLung\*  
Technology

## Challenge

- 16 MLD plant
- Two parallel processes – CAS & MBR
- New regulations require 65% TN removal

## Solution

- Install ZeeLung cassettes in existing conventional activated sludge tanks
- Increased biomass inventory increases TN removal capacity
- Avoids the need to build new tanks

Increased nutrient  
removal in existing  
tanks

# ZeeLung MABR value proposition

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