

Full-Scale MABR Experience – Case Studies of Process Intensification

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Agenda

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ZeeLung MABR Technology Overview



ZeeLung* MABR

Simple, sustainable, process intensification

» Process intensification

Up to 50% more treatment capacity in existing tank volumes

» Process resilience

Resilience to upset conditions

» Simple solution

Installed in existing tanks, no civil works, fast implementation

» Energy Savings

Up to 50% less energy



MABR Value

Process intensification

1

Upgrade for capacity expansion and/or NH_4 /TN removal

2

Footprint-constrained or expensive construction

3

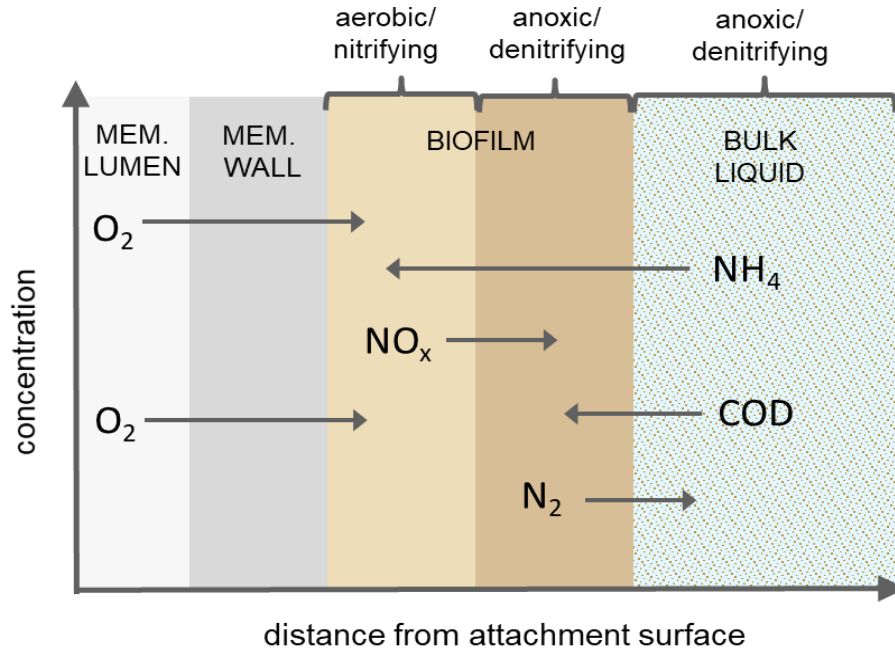
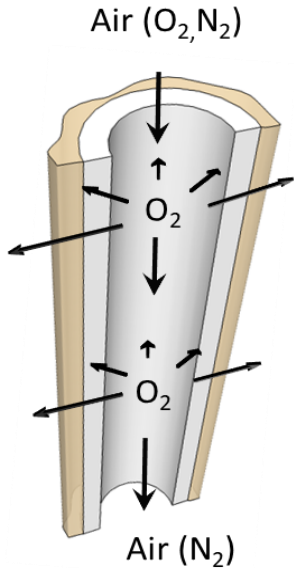
Fast or phased implementation

VP Amplifiers

- a) High energy cost ($> \$0.15$ kWh)
- b) GHG monetization
- c) Tank geometry (L:W ratio > 2 , shallow)



What is MABR?

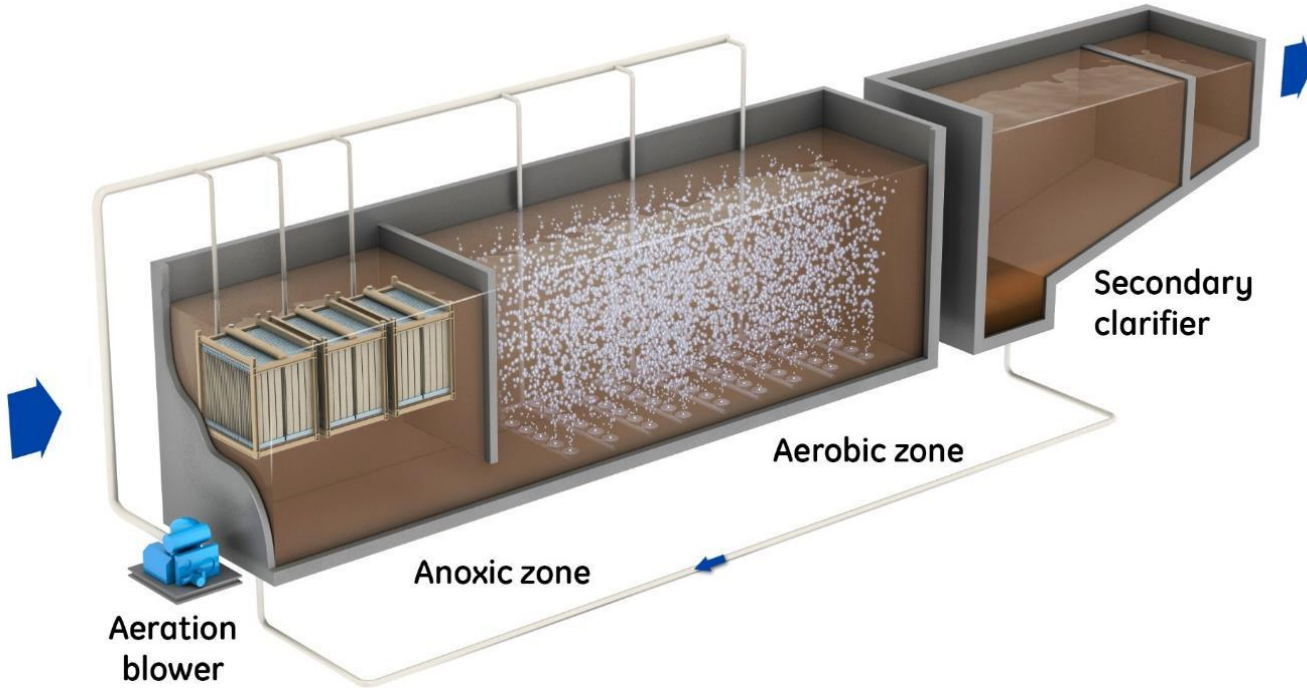


» Media-supported biofilm with built-in O_2 supply.

» Counter-diffusional biofilm with “magical” properties



ZeeLung cassettes are installed in the bioreactor



Increased biomass inventory in existing volume enables nutrient removal & capacity expansion

MABR Application Guidelines

Good Fit	Evaluate	Not a Good Fit
Capacity increase up to 50%	Capacity increase > 50%	Greenfield
Nitrogen removal		Only BOD removal
Create room for Bio-P		Water reuse
Alternatives require new construction	Alternatives don't require new construction	
Project implementation in phases		
Energy/GHG driver		
Resilience – ammonia load variations, peak trimming		
Tank geometry		



ZeeLung MABR Case Studies



Innovative & Proven

18

Full-scale plants in operation,
3 in operation for >2 years

>30

Technology demonstrations



North Toronto WWTP City of Toronto

North Toronto, Ontario, Canada Capacity Upgrade

- » Existing CAS plant
- » 45.5 MLD rated capacity, currently operates at 18.5 MLD
- » Restore treatment capacity, provide high level of nitrification
- » Evaluate innovative technologies for energy consumption and enhanced treatment



North Toronto ZeeLung Business Case



MABR Expansion to 45.5 MLD

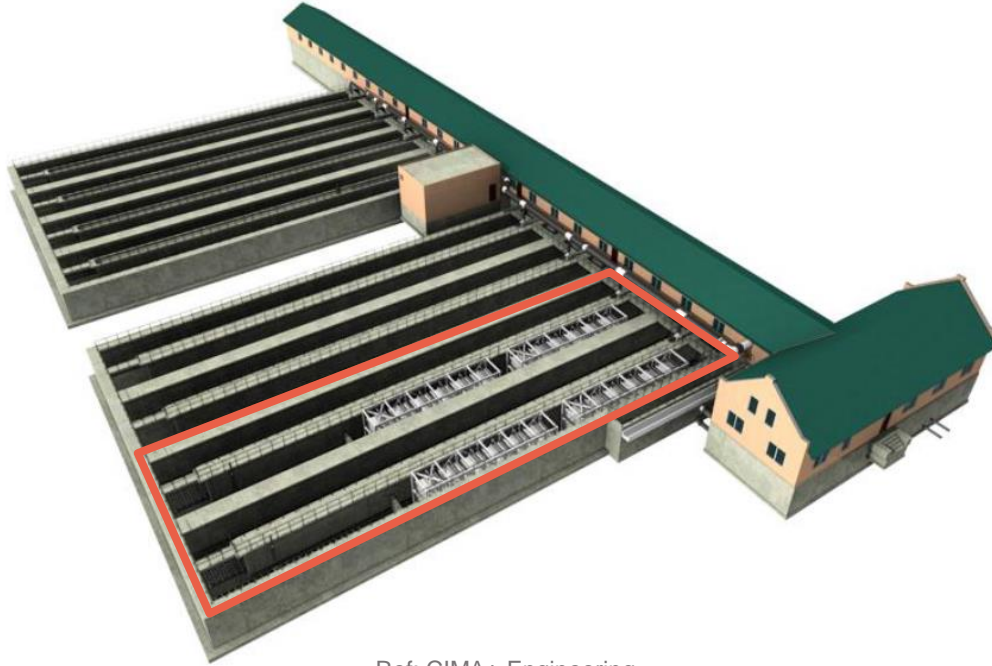
- Capital cost of \$10.3 M
- Annual energy cost (\$0.14/kWh) of \$500k
- 20-year NPV \$17.4 M



CAS Expansion to 45.5 MLD

- Capital cost of \$25.8 M
- Annual energy cost (\$0.14/kWh) of \$860k
- 20-year NPV \$37.8 M

ZeeLung Technology Demonstration



Ref: CIMA+ Engineering

- » 20 ZeeLung cassettes installed in bioreactors 1 and 2
- » 11.4 MLD – $\frac{1}{4}$ of full plant rated capacity
- » Independent MLSS – Can compare with adjacent conventional sludge lines
- » Demonstrate nitrification and energy savings



Hespeler WWTP Region of Waterloo



Hespeler WWTP Ontario, Canada

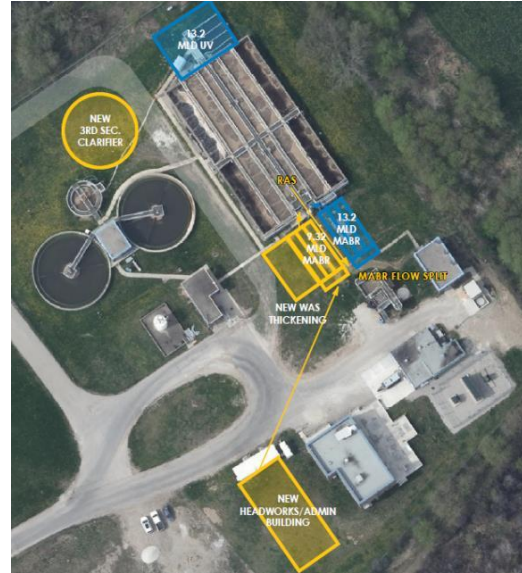
- » Existing CAS plant
- » Requires upgrade to treat more load and nitrify year-round

Hespeler ZeeLung Business Case



Extended Aeration Expansion

Vs.



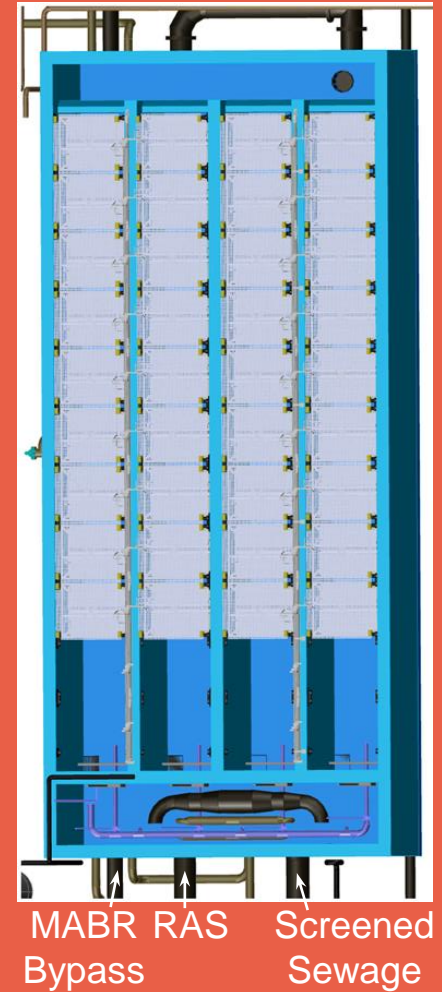
MABR Expansion

- » CAPEX half of CAS (\$12 M vs. \$25 M for 13.5 MLD)
- » Footprint savings
- » > 30% aeration energy savings

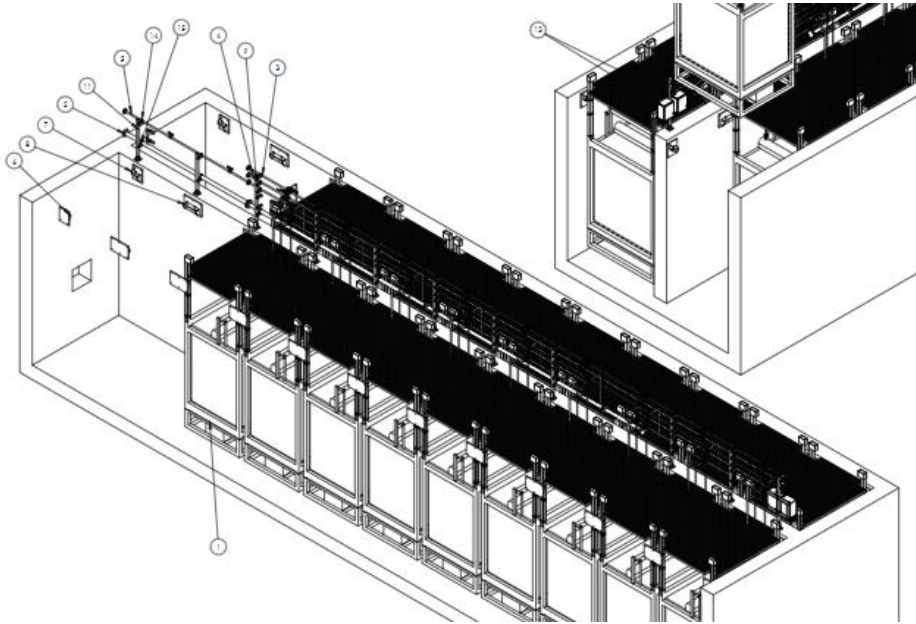
Hespeler MABR Design

Unique Aspects

- » Scale – Largest full-scale MABR plant in North America w/ 36 cassettes
- » Process Design – Ammonia removal by ZeeLung; No MLSS nitrification credit in winter
- » Implementation – Purpose-built tanks to minimize disruption during construction
- » Procurement – Competitively bid pre-selection
- » Design Considerations:
 - Headloss
 - Supplemental mixing
 - Testing flexibility – flow routing, instrumentation
 - Future expansions



Purpose-built MABR Tanks





Spernal WWTP

Severn Trent Water

Spernal Severn Trent Water, UK

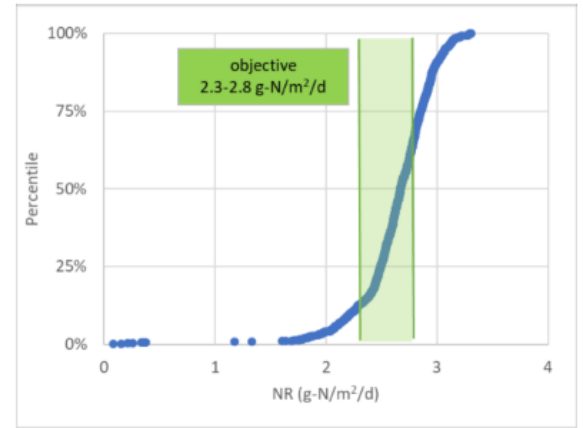
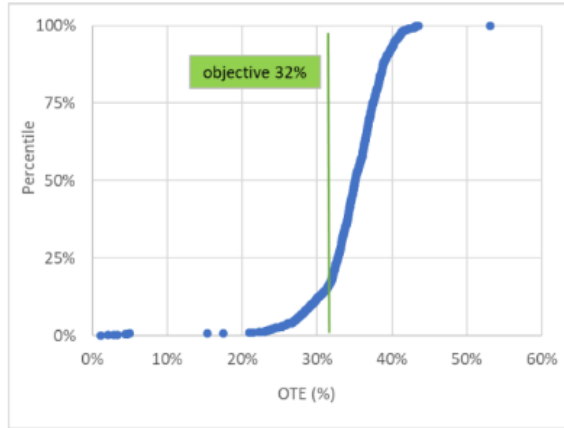
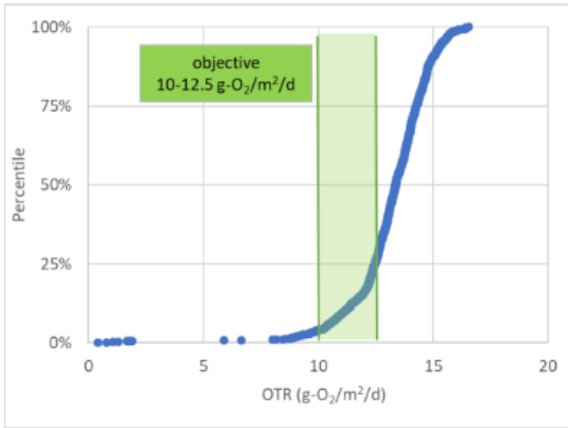
- » 5,800 m³/d, 10,500 PE_{COD-120}
- » Start-up: Nov. 2020
- » Project drivers:
 - Test MABR technology for enhanced ammonia and TN removal
- » 5x ZeeLung cassettes
- » All ancillaries in a 10 ft container
- » 3 days for installation





Spernal Performance - KPIs

Target KPI's
OTE: 32%
OTR: 10 – 12.5 g-O₂/d/m²



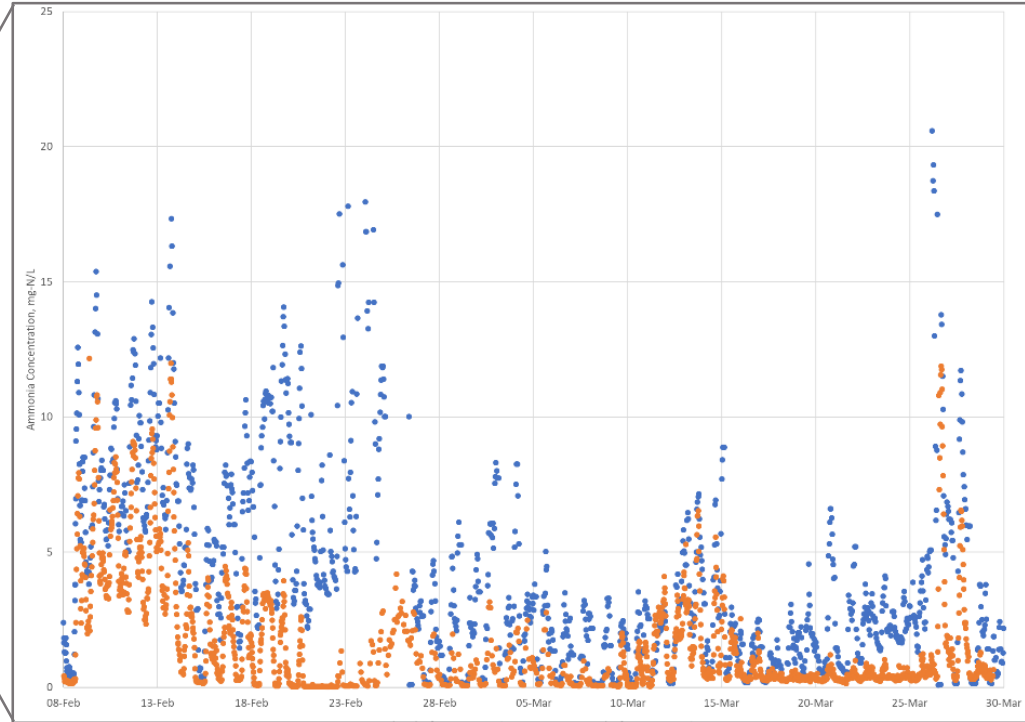
Avg. OTE since Mar, 2022: 38.4%
Avg. OTR since Mar, 2022: 14.7 g-O₂/d/m²
Avg. aeration energy: 3.84 kgO₂/kWh



Spernal Performance Overview

Peak «trimming» effect proven by comparing control lane and ZeeLung lane

Effluent Ammonia Concentration



ZeeLung treats roughly 9-13% of influent ammonia

Control lane ●
ZeeLung lane ●

THANK YOU!

QUESTIONS?

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