



WWTP UPGRADE : TECHNOLOGIES FOR NITROGEN REMOVAL

Mathieu Delahaye

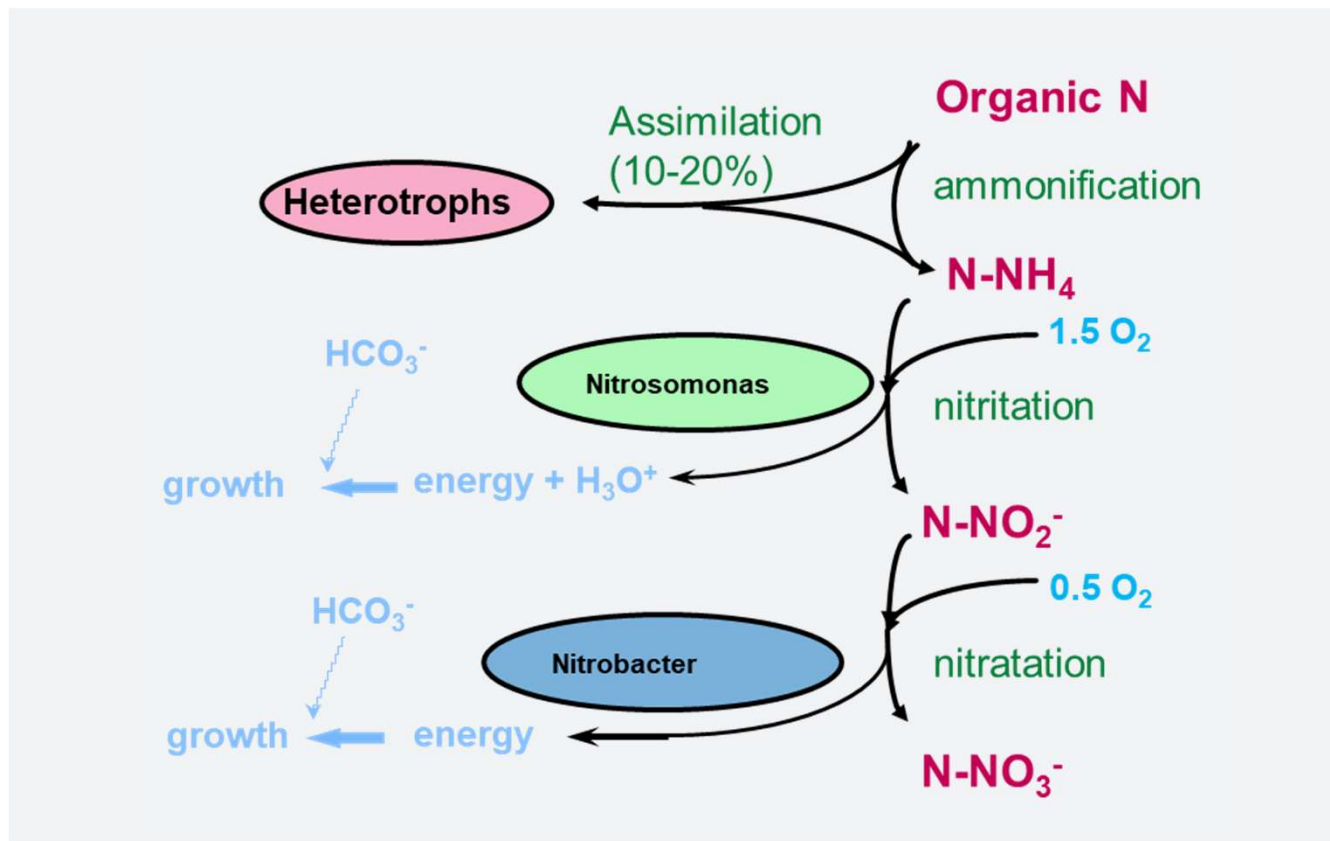
Strategic Development Deputy Director
SUEZ Treatment Infrastructure



Nitrification

NITRIFICATION IS ACHIEVED BY AUTOTROPHIC BACTERIA

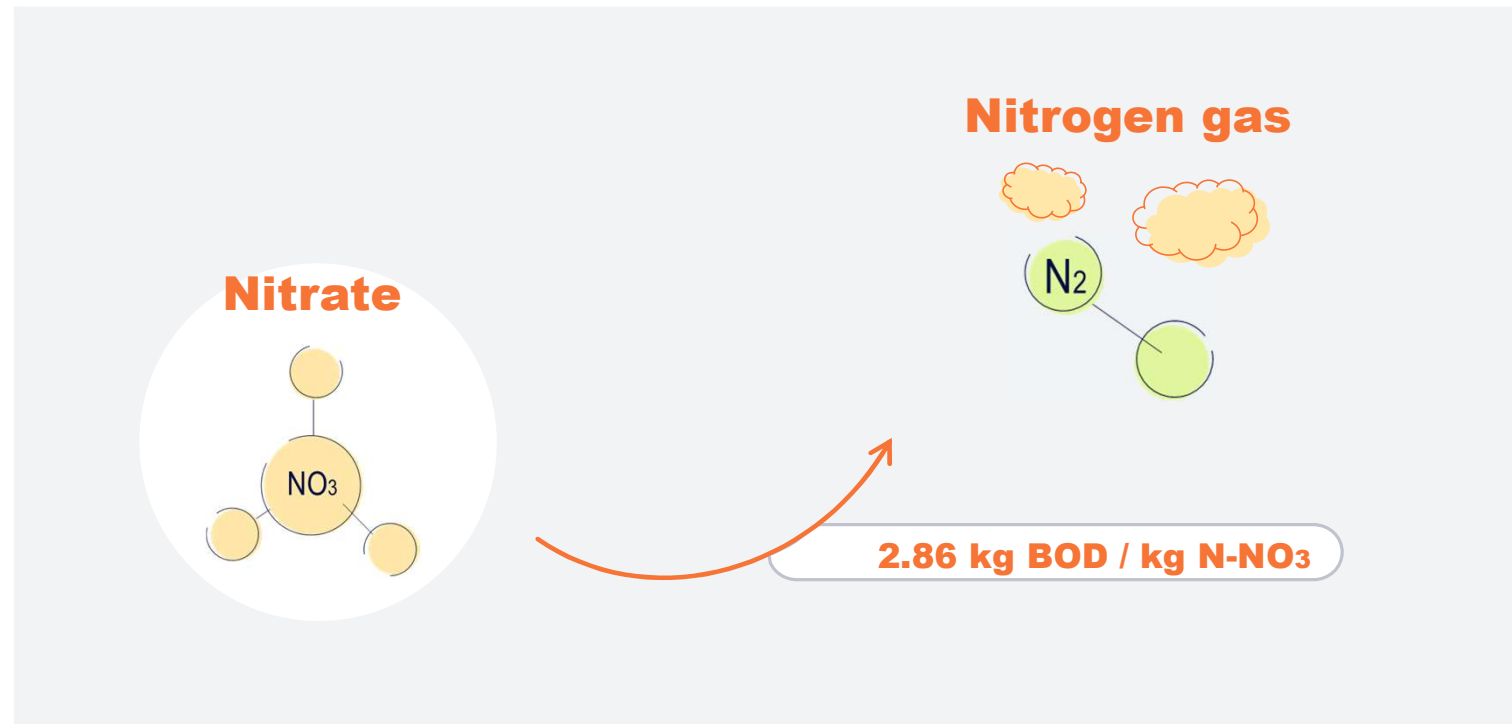
- **Slow growth (4 days @ 20°C)**
- **Need O₂**
- **Limited by the presence of organic carbon**
(competition with heterotrophic bacteria)



Denitrification

DENITRIFICATION IS ACHIEVED BY HETEROTROPHIC BACTERIA

- Need anoxic conditions
- Consumes organic carbon



How to do complete nitrogen treatment ?

OPPOSITE CONDITIONS FOR NITRIFICATION AND DENITRIFICATION

TECHNOLOGIES USED FOR N REMOVAL :

⇒ SUSPENDED BIOMASS :

- Low load activated sludge (often < 0,1 kg BOD5/kg VM.d)
- Sequenced aeration or aerobic + anoxic zone
- Long sludge age (for nitrifiers growth)

⇒ FIXED FILM (MBBR AND BIOFILTERS)

- Specific reactors for nitrification and denitrification
- Stability of nitrification at low temperature

⇒ MIXED CULTURES :

- IFAS (integrated Fixed Film Activated Sludge)
- MABR (Membrane Aerated BioReactor)

⇒ OTHER PROCESSES NOT USING NITRIFICATION / DENITRIFICATION :

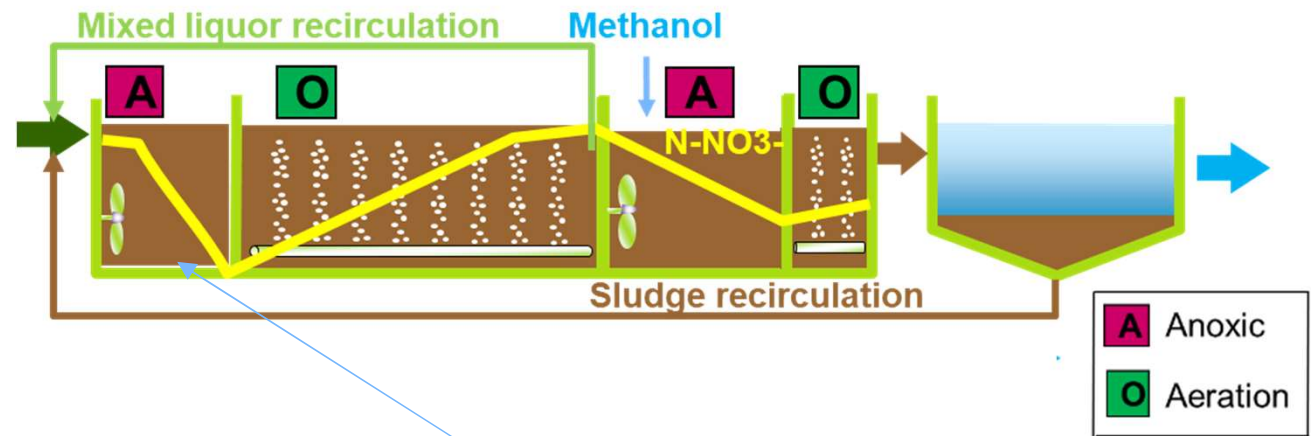
- Nitrate Shunt / Anammox

How to upgrade activated sludge (CAS) to achieve N removal?

CREATE SPECIFIC ZONE FOR N REMOVAL

1. From high load AS to low load AS

- Need Pre-DN and Post-DN for low N requirements (extra volume)
- Need external carbon source for Post-DN (and reduce BOD removal from primary step)
- Need extra aeration



– Alternative :

- Use MABR in the Pre-DN tank (to achieve 30 % of Nitrification)

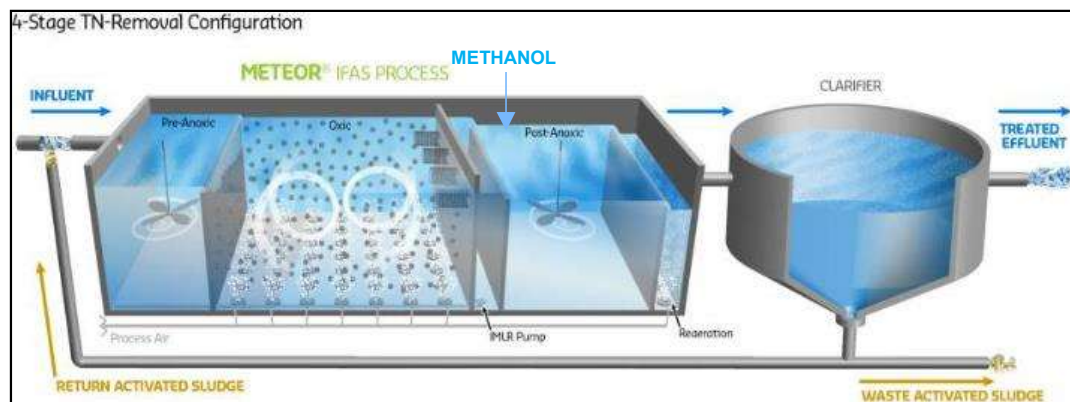


How to upgrade activated sludge to achieve N removal?

CREATE SPECIFIC ZONE FOR N REMOVAL

2. Add biomedica to turn it into IFAS

- Need specific zone for N removal (extra volume)
- Requires addition of sieve
- Need external carbon source for Post-DN
- Requires extra mixing and aeration



INNOVATIONS

New biomedica with high specific surface area: 800 m²/m³ validated by lab tests (biological and mechanical tests)

Use of recycled material for plastic media

Optimization of aeration and mixing through fluid dynamics

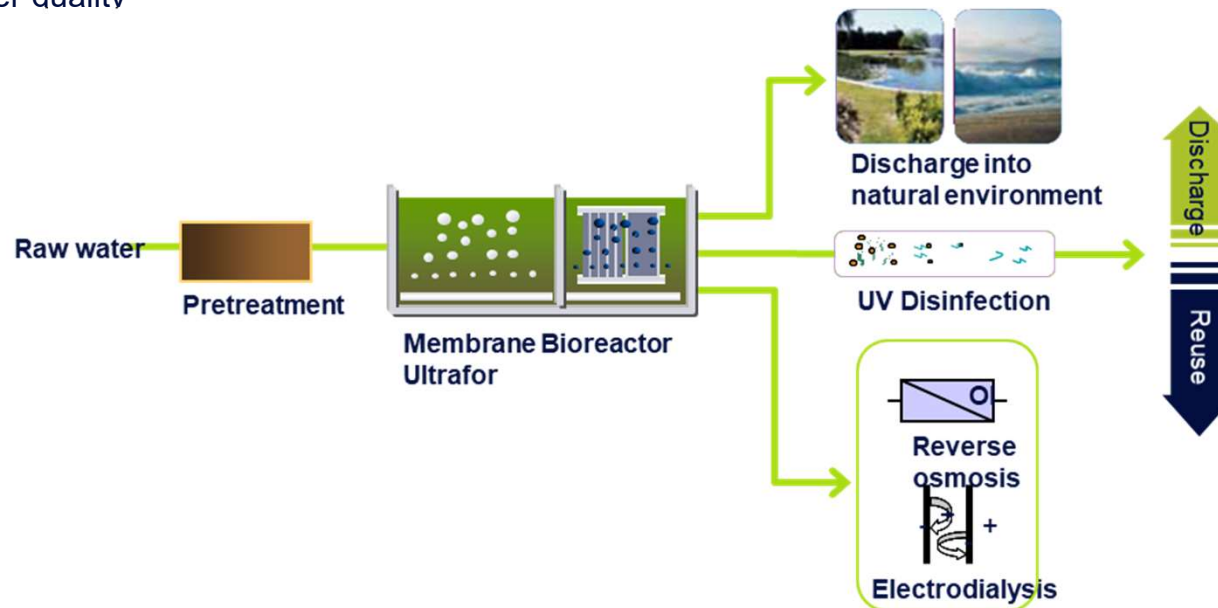


How to upgrade activated sludge to achieve N removal?

INCREASE BIOMASS CONTENT

3. Increase biomass content : Membrane BioReactor

- Up to 6 to 12 g/L in the aeration tank.
- Need extra volume to set up nitrification
- Need extra aeration
- Very high treated water quality



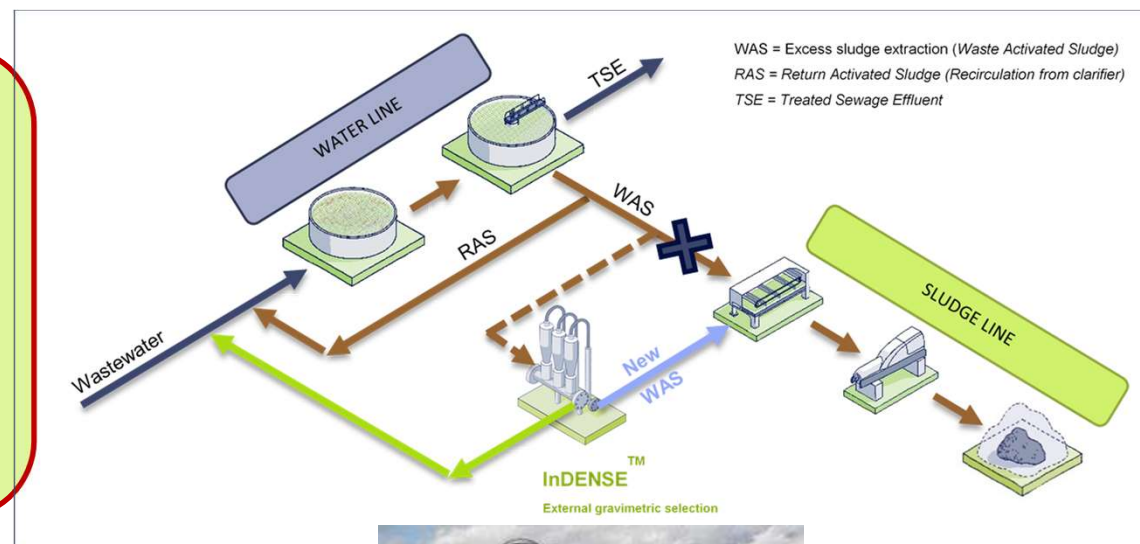
How to upgrade activated sludge to achieve N removal?

INCREASE BIOMASS CONTENT

INNOVATIONS

4. Increase biomass content via densification (INDENSE)

- Up to 4 to 8 g/L of biomass
- Need extra volume to set up nitrification
- Need extra aeration
- Requires an anaerobic zone



➡ Indense can be coupled with MABR to boost nitrification and save even more footprint

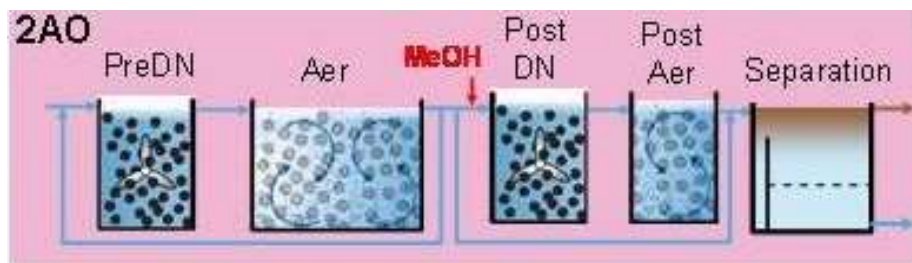


How to upgrade fixed film WWTP to achieve N removal?

CREATE SPECIFIC ZONE FOR N REMOVAL

1. Pre-DN & Post-DN (MBBR or Biofilters)

- Need extra volume for denitrification
- Need sieves and extra mixing (MBBR)
- Need backwashing equipments (biofilters)
- Need external Carbon



More energy and chemicals needed than CAS

INNOVATIONS



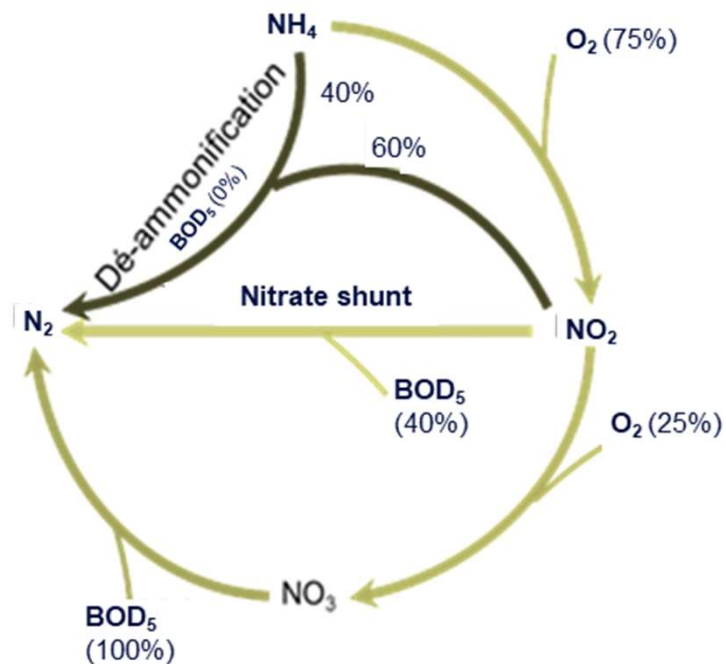
New biomedias with high specific surface area: 800 m²/m³ validated by lab tests



**Example :
VEAS plant**

Treat Nitrogen in anaerobic digestion's centrate

ANAEROBIC DIGESTION'S CENTRATE ARE HIGHLY LOADED IN NH_4 AND WITH HIGH TEMPERATURE
NITRATE SHUNT + ANAMMOX CAN BE PUT IN PLACE



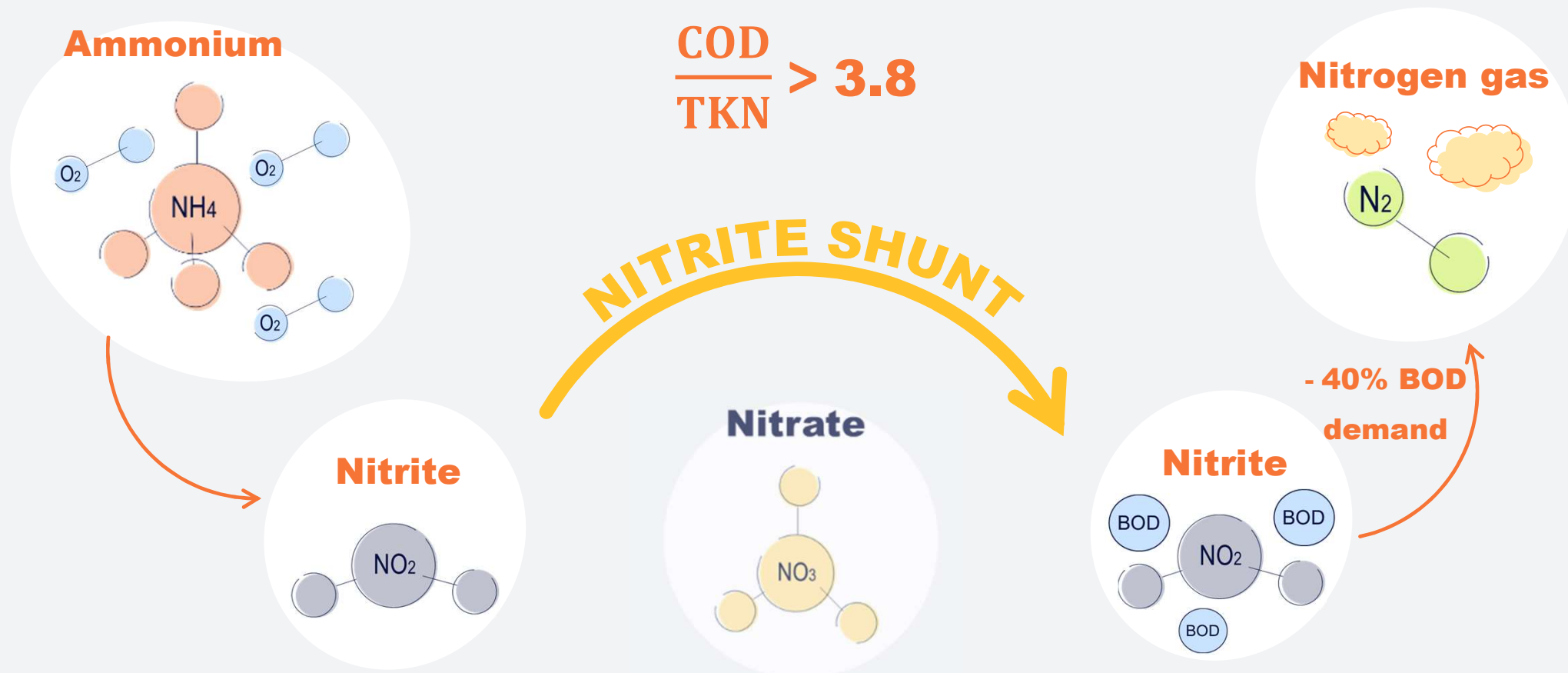
CLEARGREEN SIDESTREAM

- SBR type of reactor (Cyclor)
- Partial nitritation followed by deammonification by selection of anammox bacteria
- No external carbon needed
- Reduced consumption of oxygen (- 55 %)
- 10 % gain on nitrogen load in main biological tank
- 4 references worldwide

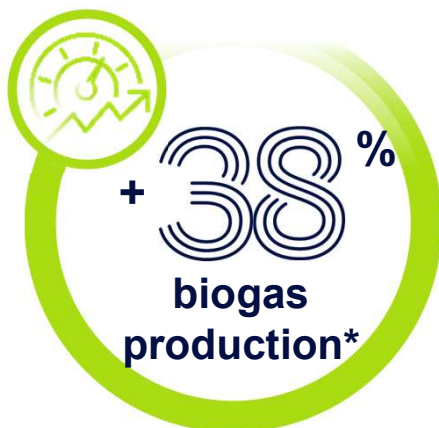
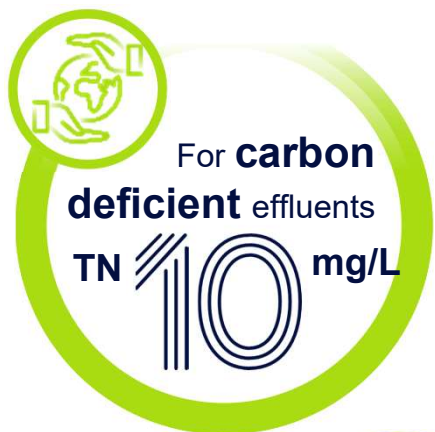
Cleargreen Mainstream / Nitrate Shunt : an innovative solution saving carbon

Aerobic

Anoxic



Value Proposition



(*) Vs a WWTP with conventional
NDN, and equipped with digestion
+ biomethane injection

| SUEZ - Technologies for Nitrogen Removal - 09/01/2023

Cleargreen™ Mainstream



RECOMMANDATIONS

LIMIT CARBON ADDITION WITH :

- Pre-DN
- Reduced removal yield at primary step (Sedipac)
- Increased nitrate recirculation

UPGRADE OF HIGH LOAD CAS :

Upgrade with Indense and MABR

UPGRADE OF FIXED FILM SOLUTIONS

Pre-DN biofilter + MBBR C + Post-DN Biofilter

TREAT NH₄ FROM ANAEROBIC DIGESTION CENTRATE VIA ANAMMOX REACTOR

Cleargreen Sidestream : Low energy, zero Chemicals

FLEXIBLE SOLUTIONS / CIRCULAR ECONOMY

- Integration of micropollutant removal technology (ozonation, activated carbon)
- Use of MBR for production of reclaimed wastewater

SUEZ references

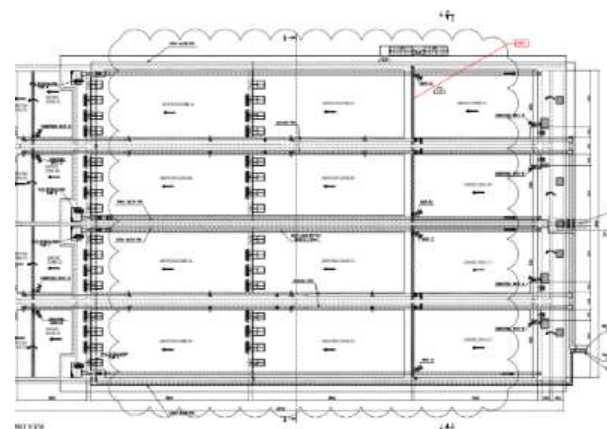


**PARIS – LA MOREE
(FRANCE)**

MBR

50 000 m³/d

**NH₄-N < 1.3 mg/L
and NGL < 10 mg/L**



**AGLIPAY
(PHILIPPINES)**

MBBR

60 000 m³/d

**NH₄-N < 0.5 mg/L
NO₃-N < 14 mg/L**

**SOPHIA
ANTIPOLIS
(FRANCE)**
Biofilters
50 000 m³/d
NGL < 3 mg/L



**TOULOUSE
(FRANCE)**
MBBR
31 000 m³/d
NH₄-N < 0,5 mg/L



THANK YOU



Mathieu Delahaye

Deputy Director Strategic Development
SUEZ TI

mathieu.delahaye@suez.com

