Innovative Circular Technologies for Harmful Nitrogen Compounds/ To Solve Planetary Boundary Issues

Theme 2. Recycling nitrogen compounds in wastewater to ammonia resource
Theme 2-1. R&D on microbial conversion of nitrogen compounds to ammonia
R&D of anaerobic membrane bioreactor (AnMBR) capable of efficient treatment under high ammonium concentrations

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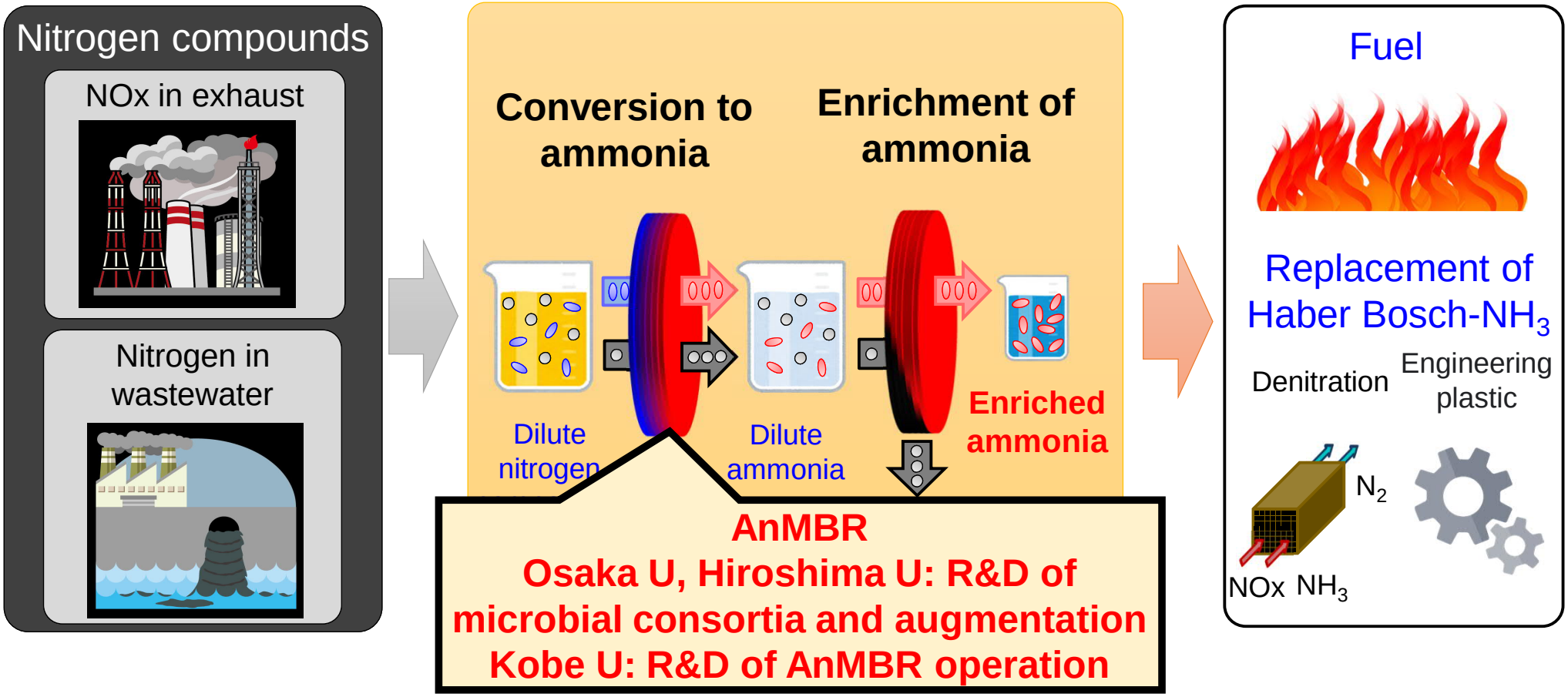
Implementing organizations : National Institute of Advanced Industrial Science and Technology (AIST),
The University of Tokyo, Waseda University,
Tokyo University of Agriculture and Technology, Kobe University,
Osaka University, Yamaguchi University, Kyowa,Hakko Bio Co., Ltd.,
ASTOM Corporation, Toyobo Co., Ltd., FUSO Corporation, Ube Industries, Ltd,

Position in the Project



Target of Theme 2 for FY2029 : Pilot-scale demonstration(5～15 m^3/d) of recovery and condensation of ammonium from wastewater.

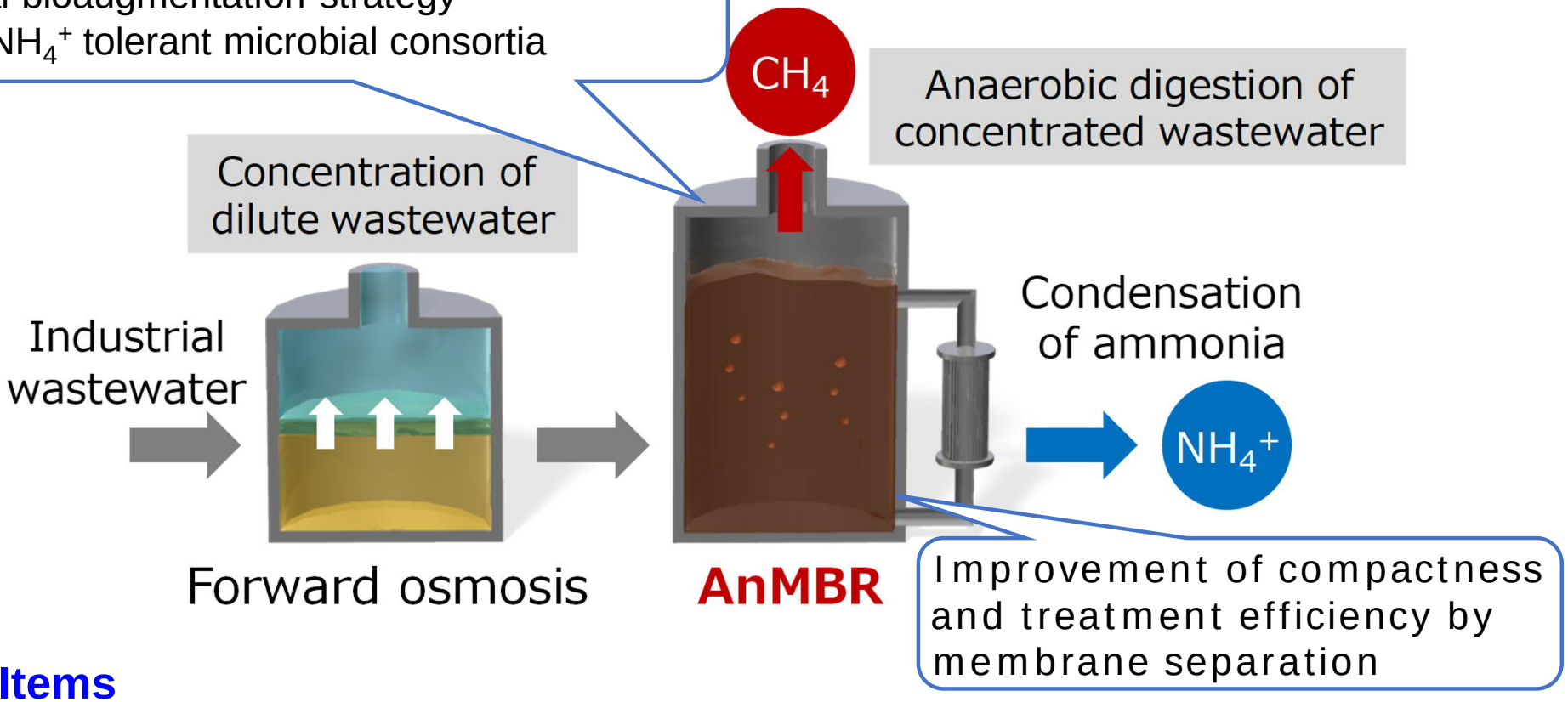
Position of Osaka, Hiroshima and Kobe Univ. : R&D of AnMBR capable of efficient treatment under high ammonium concentrations.

Target of Osaka, Hiroshima and Kobe Univ. for FY2029 : Construction and demonstration of a pilot-scale AnMBR for ammonium recovery using actual wastewater.

Details & Items of R&D

R&D of AnMBR capable of efficiently converting organic carbon and nitrogen in the concentrated wastewater to CH_4 and NH_4^+ under high nitrogen concentrations

Reinforced NH_4^+ tolerance by bioaugmentation
- Rational bioaugmentation strategy
- Highly NH_4^+ tolerant microbial consortia



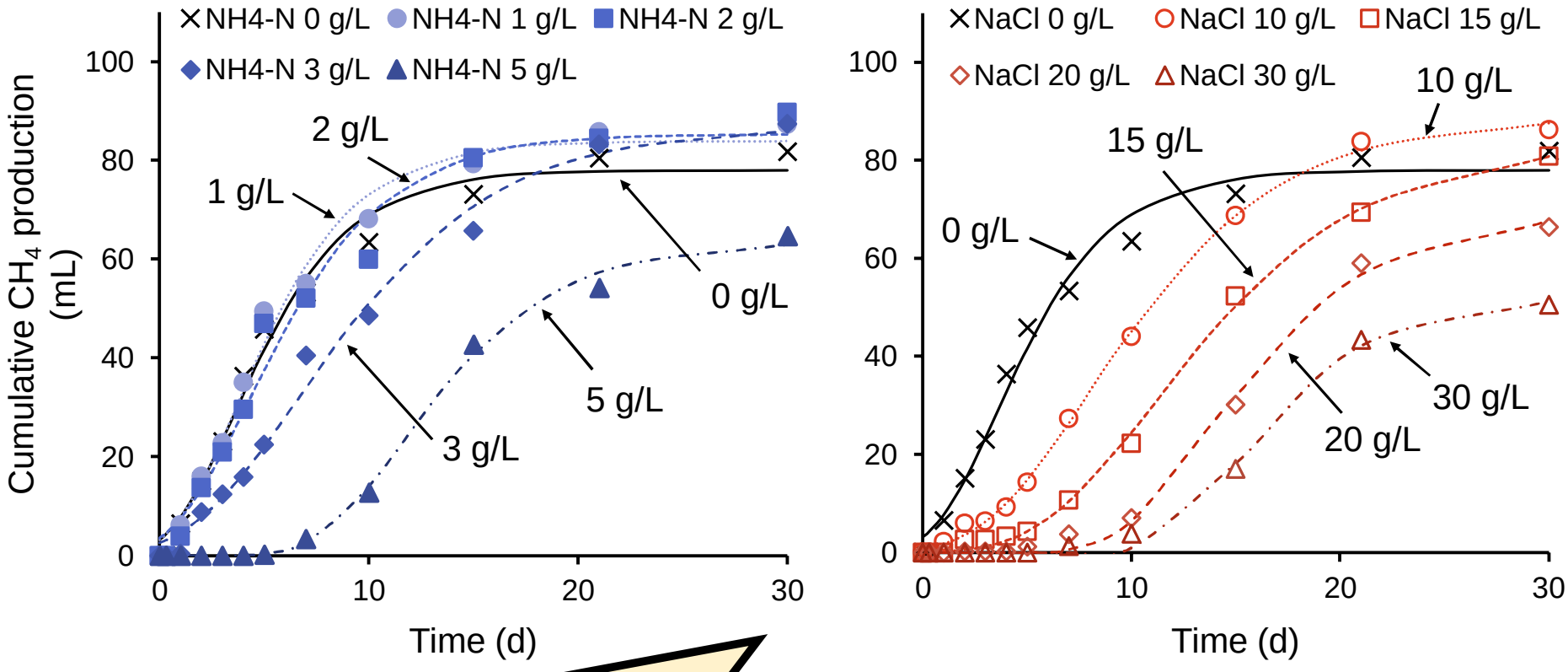
R&D Items

- Development of bioaugmentation technology of highly NH_4^+-tolerant microbial consortia (Osaka Univ.)
- Construction of highly NH_4^+-tolerant microbial consortia (Hiroshima Univ.)
- Establishment of efficient AnMBR operating methods (Kobe Univ.)

Achievement (1) Confirmation of NH_4^+/NaCl inhibition levels in anaerobic digestion (Osaka Univ.)

- Testing NH_4^+ and NaCl tolerance of mesophilic anaerobic digestion
  → Confirmation of inhibitory levels of NH_4^+ and NaCl to CH_4 production

Examples of the relationship between CH_4 production and NH_4^+ (left) or NaCl (right) concentration in mesophilic anaerobic digestion

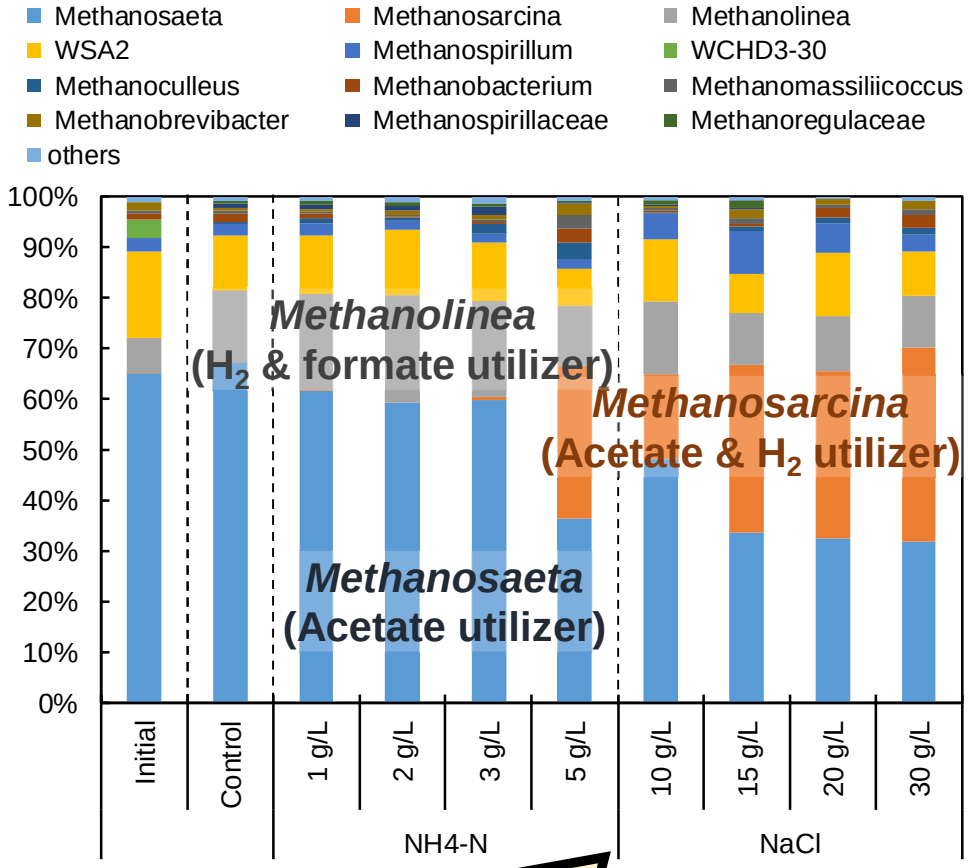


Confirmation of tolerable/inhibitory levels of NH_4^+ and NaCl

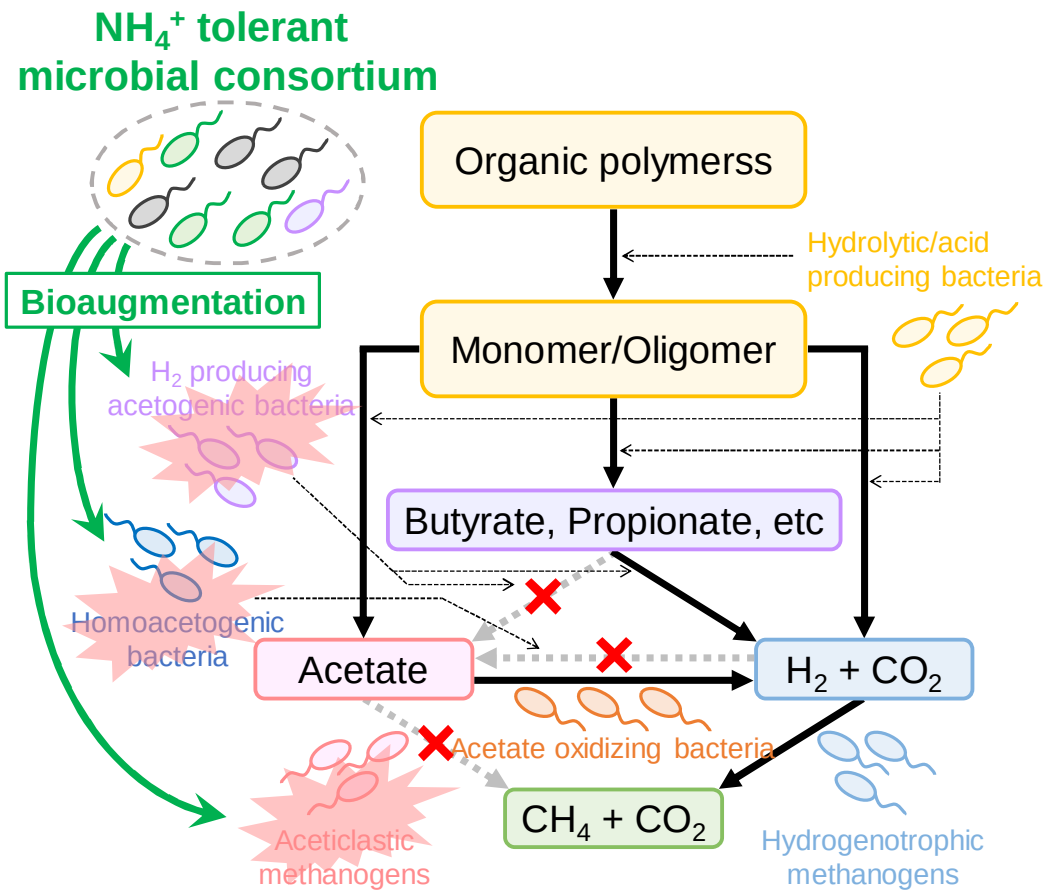
Achievement (2) Conception of bioaugmentation strategy (Osaka Univ.)

- Identification of vulnerable microbial populations and metabolic pathways
- Conception of bioaugmentation strategy to reinforce the NH_4^+ tolerance

Relationship between NH_4^+ / NaCl conc. and archaeal composition



Bioaugmentation strategy to reinforce the NH_4^+ and NaCl tolerance



Identification of vulnerable microbial populations
→ Clarification of pathways to be reinforced

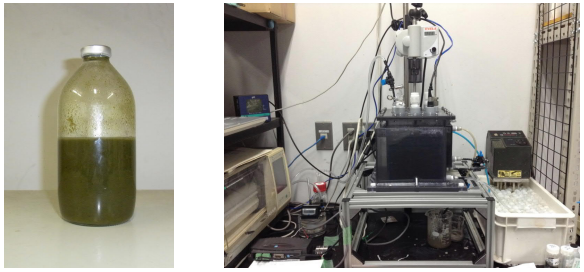
Achievement (3) Construction of highly NH_4^+ tolerant microbial consortia (Hiroshima Univ.)

- Enrichment of highly NH_4^+- and NaCl-tolerant microbes from marine sediments and anaerobic sludge as the potential microbial sources

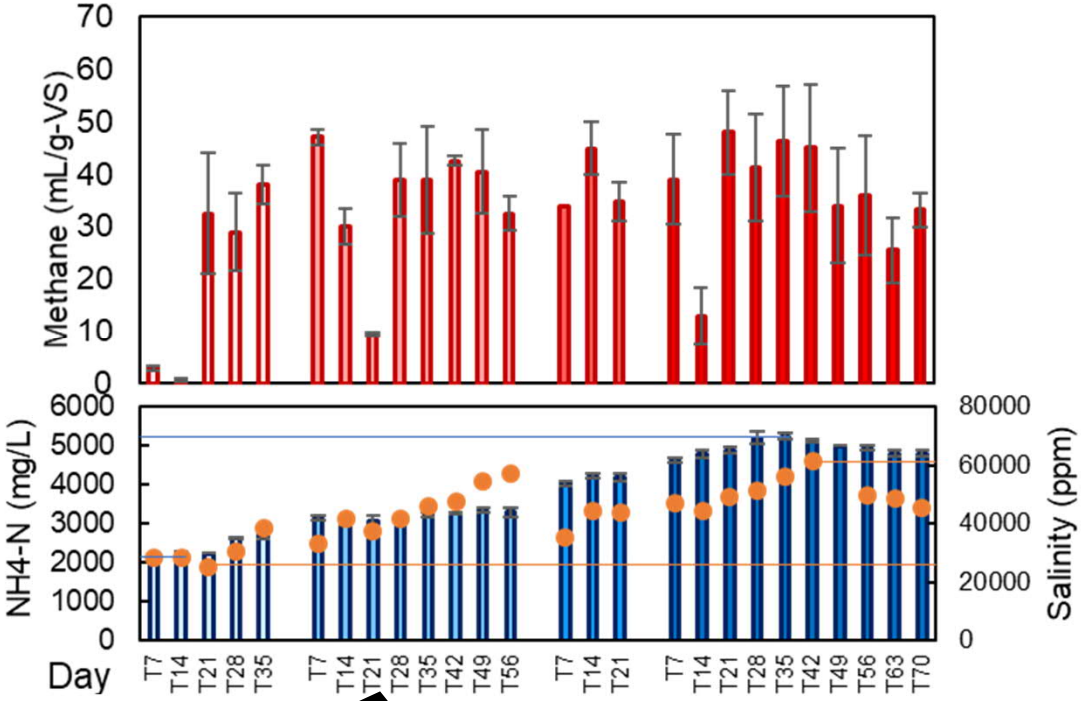
Construction of highly NH_4^+- and NaCl-tolerant microbial consortia

Microbial source

Acclimatization to high NH_4^+ concentrations



Enrichment of tolerant microbes

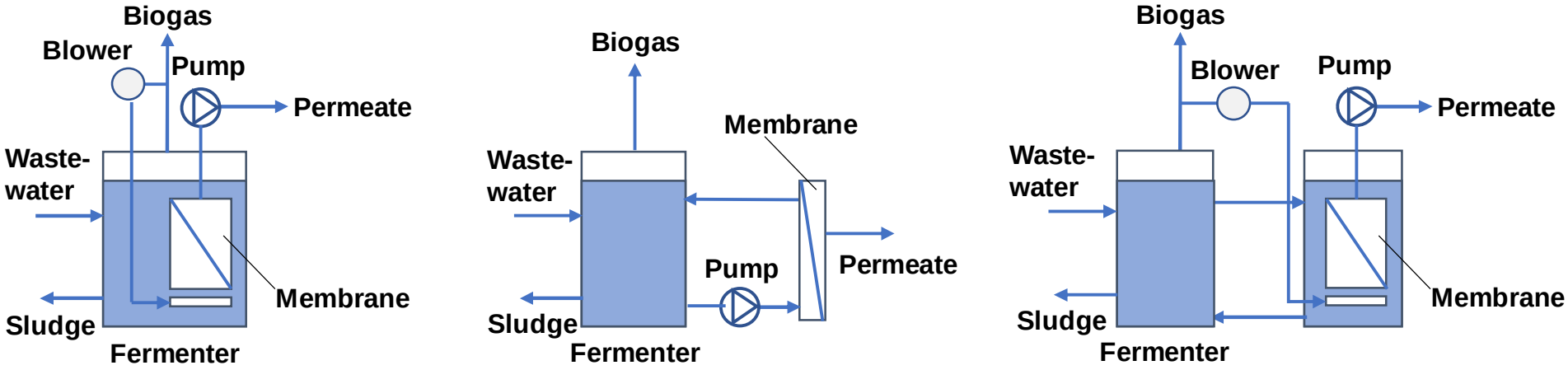


Construction of microbial consortia capable of stable CH_4 production under high NH_4^+ and NaCl concentrations → Bioaugmentation

Achievement (4) Development of efficient AnMBR (Kobe Univ.)

- Designing three different types of AnMBR
- Efficient treatment at 3 d of hydraulic retention time (HRT)

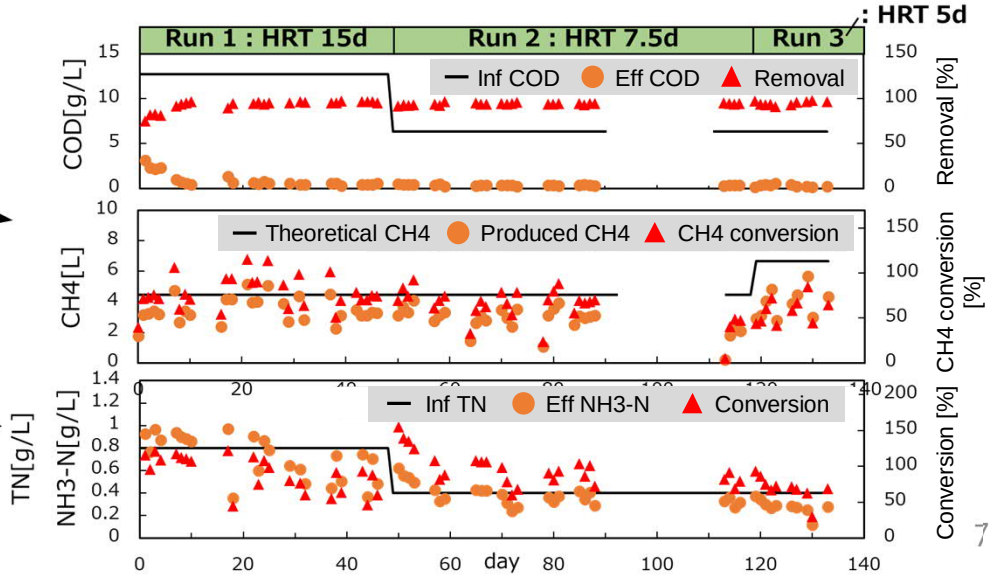
Three AnMBR design (Left: inner-submerged type, center: Cross-flow type, right: outer-submerged type)



Lab-scale AnMBR operation (inner-submerged type)

High COD removal and CH_4 production at ≥3 d of HRT

Recovery of nitrogen compounds in wastewater as NH_4^+ solution



Summary

Position in the project

R&D of AnMBR capable of efficient treatment under high NH_4^+ concentrations.

Target for FY2029

Construction and demonstration of a pilot-scale AnMBR for NH_4^+ recovery using actual wastewater.

R&D items

- Development of bioaugmentation technology using highly NH_4^+-tolerant microbial consortia (Osaka Univ.)
- Construction of highly NH_4^+-tolerant microbial consortia (Hiroshima Univ.)
- Establishment of efficient AnMBR operating methods (Kobe Univ.)

Achievement 1 & 2 (Osaka Univ.)

- Confirmation of inhibitory NH_4^+ and NaCl levels to CH_4 production
- Identification of vulnerable microbial populations and metabolic pathways
- Conception of bioaugmentation strategy to reinforce the NH_4^+ tolerance

Achievement 3 (Hiroshima Univ.)

- Enrichment of highly NH_4^+- and NaCl-tolerant microbes

Achievement 4 (Kobe Univ.)

- Designing three different types of AnMBR
- Efficient treatment at 3 d of HRT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