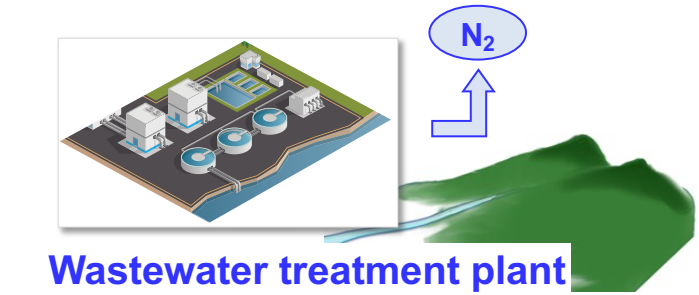
Innovative Circular Technologies for Harmful Nitrogen Compounds/ To Solve Planetary Boundary Issues

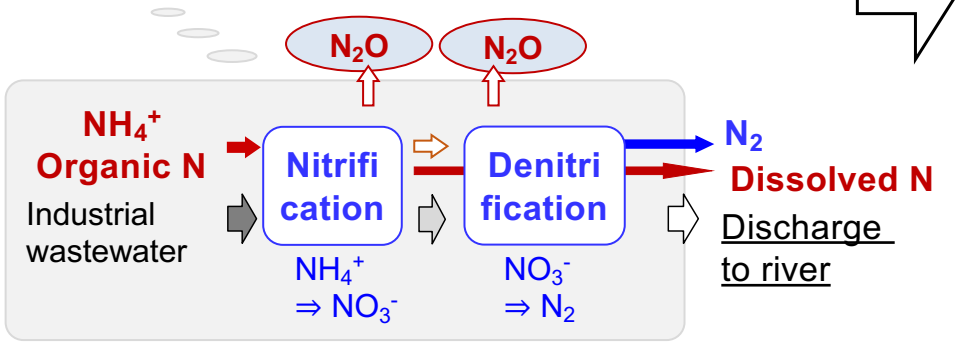
Theme 2. Recycling nitrogen compounds in wastewater to ammonia resource
Theme 2-1. R&D on microbial conversion of nitrogen compounds to ammonia

Presenter : Dr. Tomoyuki Hori (National Institute of Advanced Industrial Science and Technology [AIST])
PM：Dr. KAWAMOTO Tohru , National Institute of Advanced Industrial Science and Technology (AIST)
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,

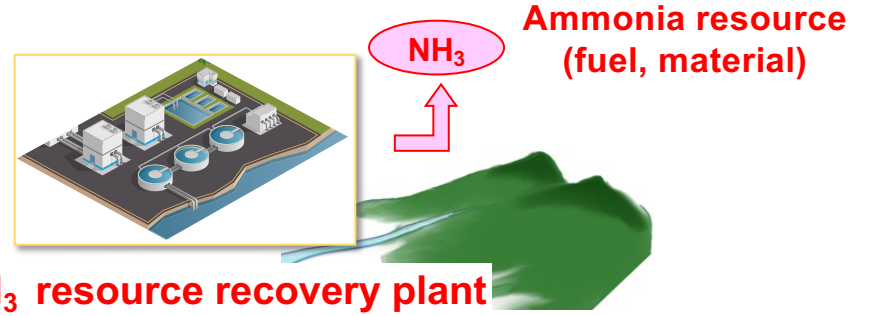
Overview of theme 2

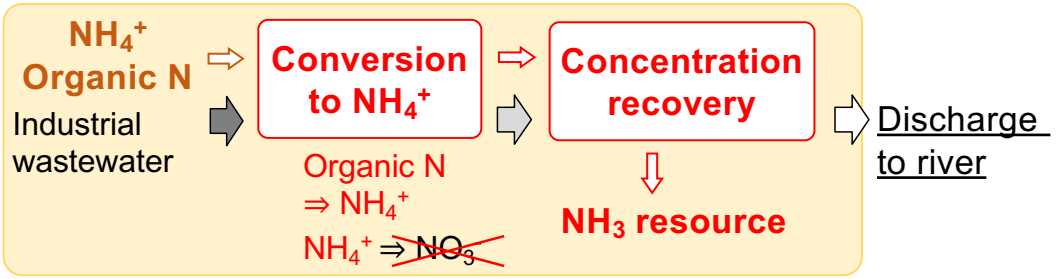
Current state





Future image in 2050





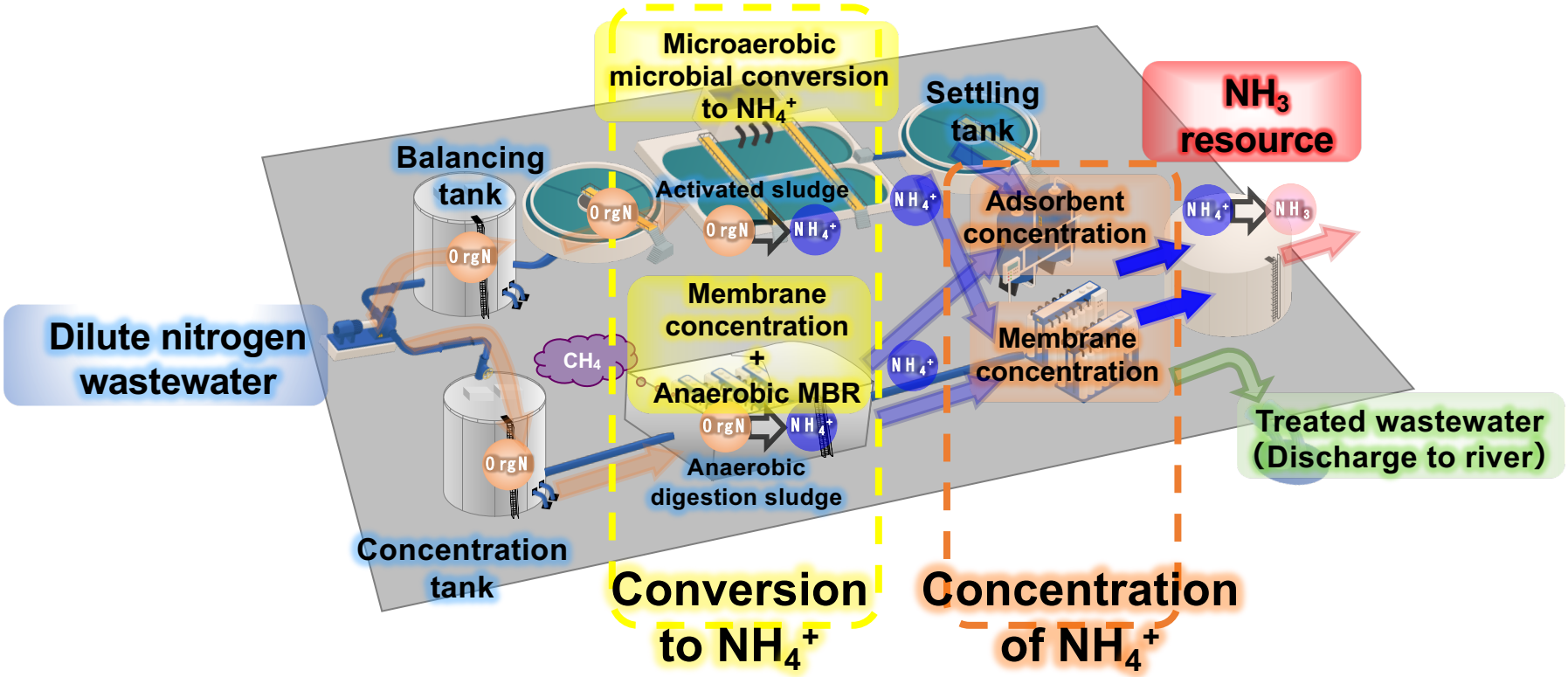
Industrial wastewater

→ **Theme 2 – 1**: Conversion of nitrogen compounds to NH_4^+

→ **Theme 2 – 2**: Separation and concentration of NH_4^+

→ Ammonia resource

Expected plant image



Theme 2 – 1 : Objective and content

We develop the microaerobic process and anaerobic MBR (AnMBR) to covert various nitrogen compounds in wastewater to NH_4^+

Theme 2 – 2 : Objective and content

We develop the concentration systems for the converted NH_4^+ in the theme 2-1 using various separation membranes and high-performance adsorbents

About theme 2-1

Industrial wastewater

Theme 2 – 1

Conversion of nitrogen compounds to NH_4^+

Theme 2 – 2

Separation and concentration of NH_4^+

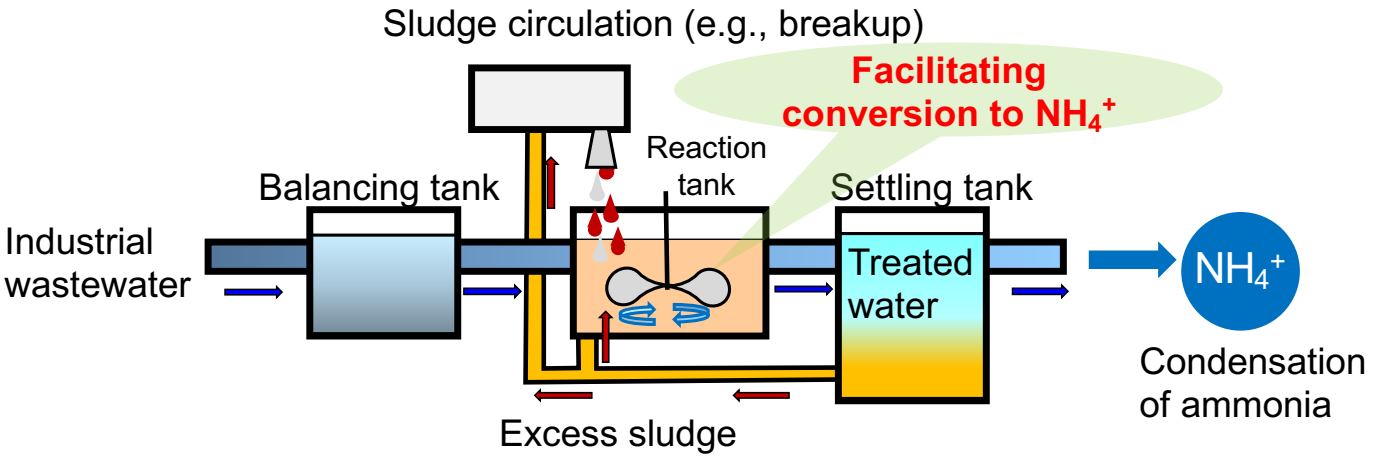
Ammonia resource

Comparison of microaerobic conversion process from nitrogen compounds to NH_4^+ and AnMBR capable of efficient treatment under high ammonium concentrations

	Microaerobic conversion process	AnMBR
Organic loading	○ Low concentration	○ High concentration
Organics decomposition ability	○ Most of organics-C is degraded	○ Residual organics-C is <10%
Nitrogen recovery	○ Recovery by nitrification inhibition	○ Complete recovery
Biogas recovery	-	◎ CH_4 recovery
Retrofit	◎ Current infrastructure can be used	△ Process renewal is needed
Target wastewater	○ Low-concentration industrial and municipal wastewater	○ High-concentration industrial and livestock wastewater

R&D contents and organizations（1）

- **Microaerobic conversion process from nitrogen compounds to NH_4^+**



- **Inhibition of NH_4^+ degradation**
- **Recycle of excess sludge as NH_4^+ source**

- Development of operation management based on microbial community control (AIST)
- Development of operation management based on nitrogen compound dynamics control (TUAT)

  ＜Recommitment＞ Energy and material balance evaluation and N_2O emission mitigation strategy development（Kyoto Univ.）

- Construction, operation and maintenance of a bench-scale microaerobic conversion process (KHB)


Dr. Hori (AIST)

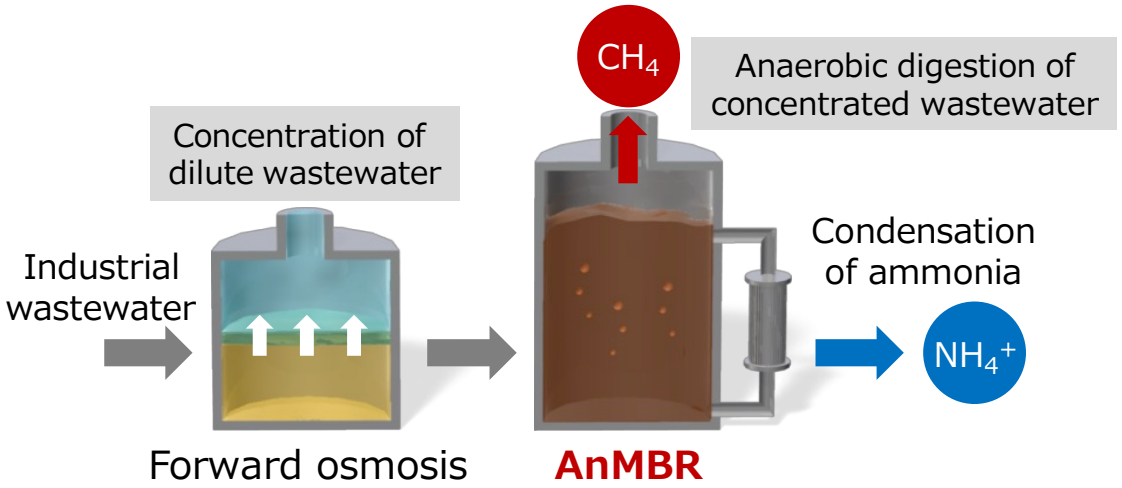

Prof. Terada (TUAT)


Prof. Fujiwara (Kyoto U)


Dr. Ohashi (KHB)

R&D contents and organizations (2)

- **AnMBR capable of efficient treatment under high ammonium concentrations**



- **Reinforced NH_4^+ tolerance**
- **Improvement of compactness and treatment efficiency**

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


Prof. Ike (Osaka U)


Prof. Tajima (Hiroshima U)


Prof. Ihara (Kobe U)

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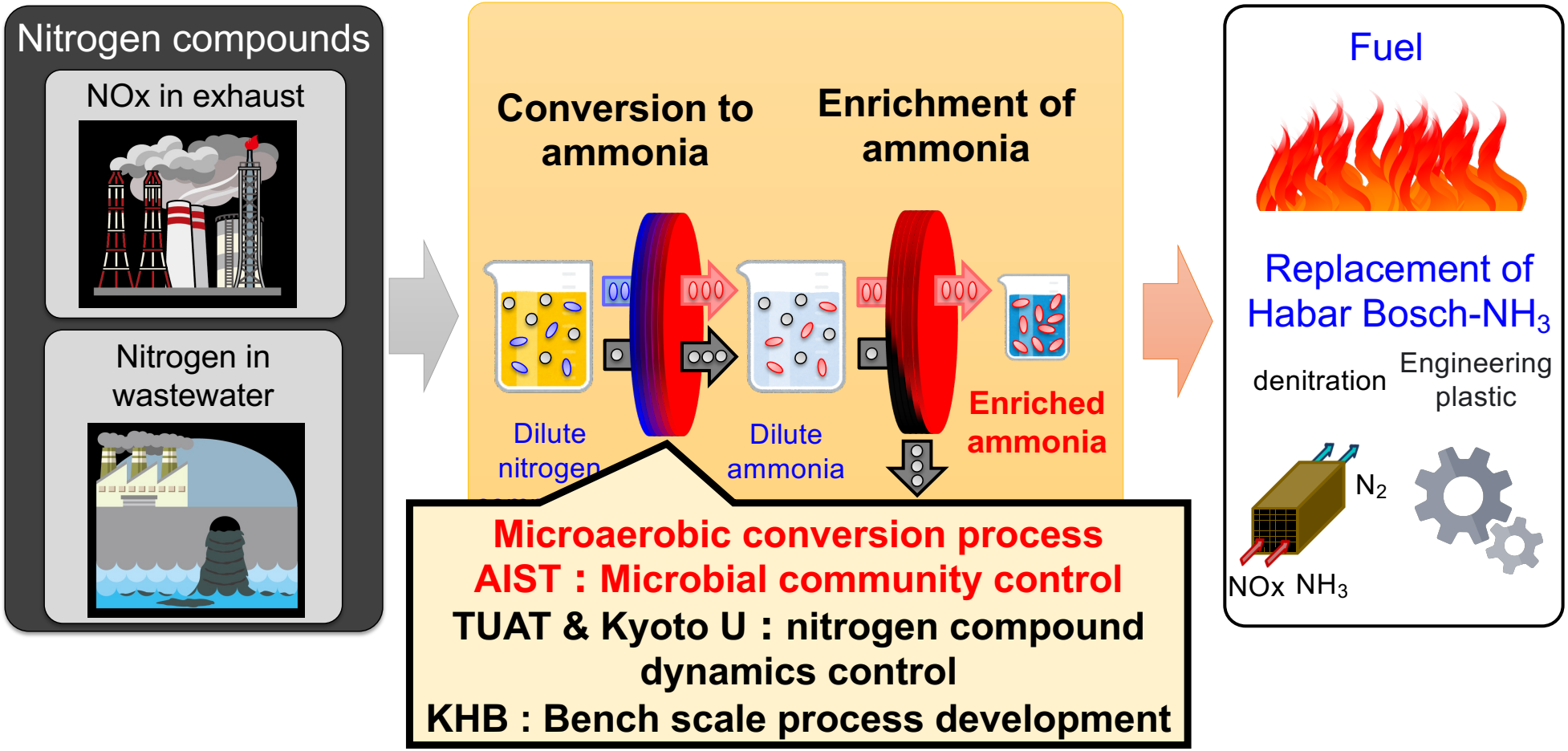
Position in the Project



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

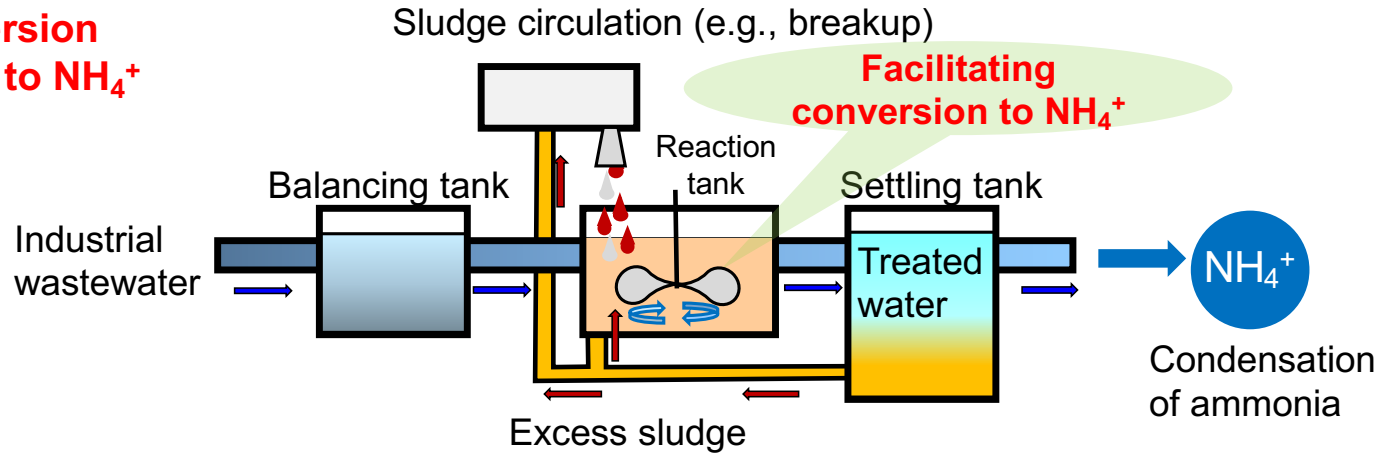
Position of AIST: Development of operation management based on microbial community control

Target of AIST for FY2029: Support for the pilot-scale demonstration by controlling microbial communities

Details and Items of R&D

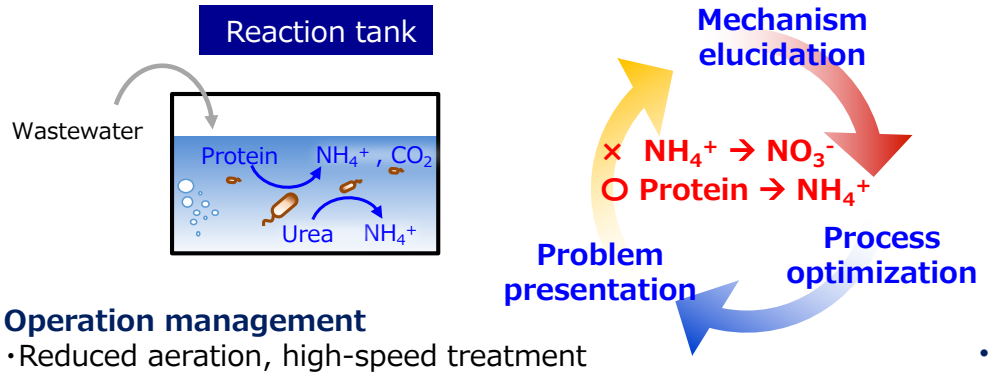
Contribution to ammonia resource recovery by facilitating conversion of organic N compounds to NH_4^+, preventing nitrification and recycling excess sludge as NH_4^+ source in industrial wastewater

- **Microaerobic conversion from N compounds to NH_4^+**



R&E items

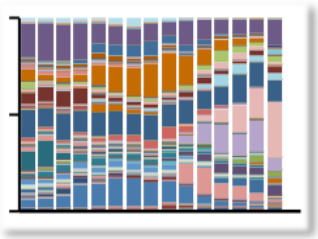
- Development of operation management based on microbial community control



Operation management

・Reduced aeration, high-speed treatment
→ Energy saving, nitrification inhibition
→ Identification and activation of key microbes

High-throughput sequencing
High sensitivity stable isotope probing

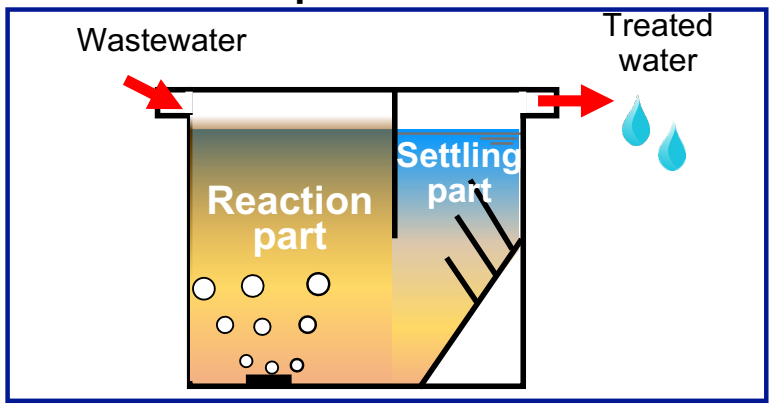


- **Identifying a million species of microbes**
- **High-sensitive functional assay of uncultured microbes**

Achievement

- Drastic decrease in nitrifying bacteria and high efficiencies (about 80%) of conversion to NH_4^+ using a simplified laboratory-scale reactor fed with synthetic wastewater
  (extended by the results attained under the NEDO New Energy and Environment Program)

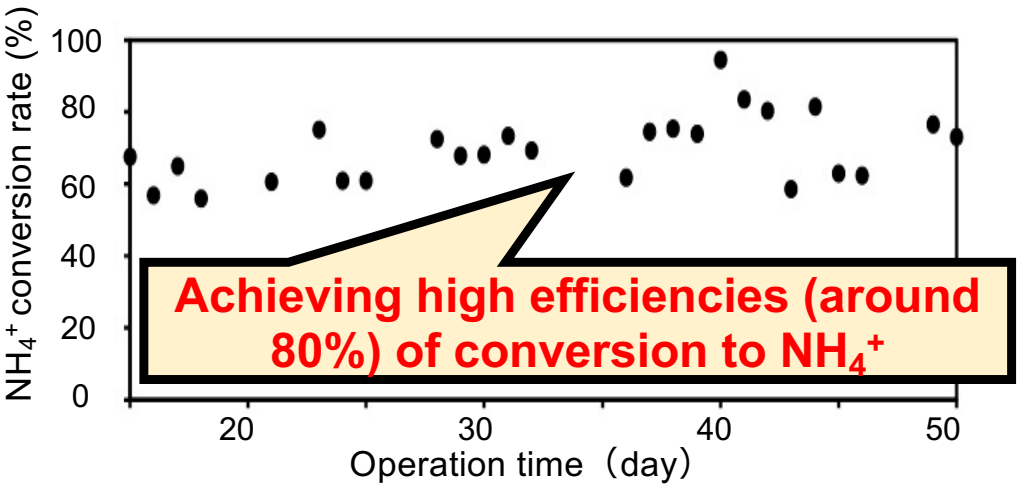
Operation of a simplified lab-scale bioreactor



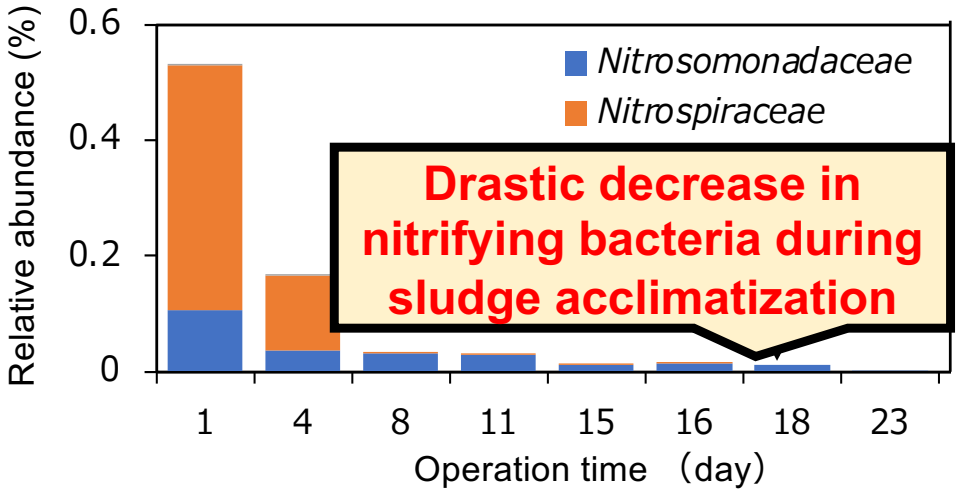
Synthetic wastewater as influent
(simulated wastewater from fermentation industry)

- NH_4-N approx. 600 mg-N/L
- Total nitrogen (TN) approx. 800 mg-N/L
- Total organic carbon (TOC) approx. 300 mg-C/L
- pH approx. 7.5

Operating parameter



Monitoring nitrifying bacteria



Toward the effective treatment of actual industrial wastewater

Summary

Position in the project

R&D of microaerobic conversion process from nitrogen compounds to NH_4^+

Target for FY2029

Construction and demonstration of a pilot-scale microaerobic conversion process for ammonium recovery using actual wastewater

R&D items

Development of operation management based on microbial community control

Achievement

・Drastic decrease in nitrifying bacteria and high efficiencies (about 80%) conversion to NH_4^+ using a simplified laboratory-scale reactor fed with synthetic wastewater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