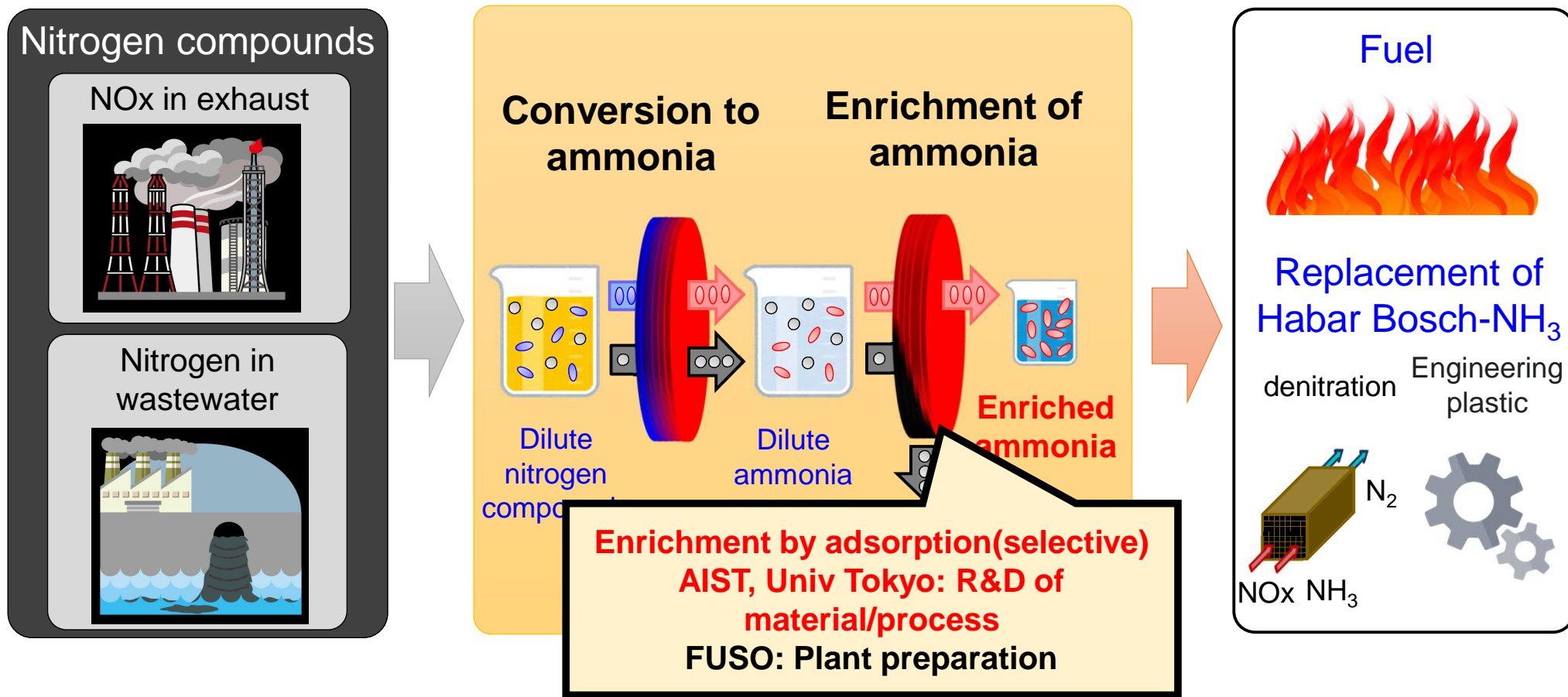


Innovative Circular Technologies for Harmful Nitrogen Compounds/ To Solve Planetary Boundary Issues

Theme 2. Recycling nitrogen compounds in wastewater to ammonia resource
Theme 2-2. R&D on ammonia recycling by separation and concentration
R&D of NH_4^+ adsorbent and recycling processes

Presenter : Tohru Kawamoto (National Institute of Advanced Industrial Science and Technology (AIST))
PM : Dr. 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,

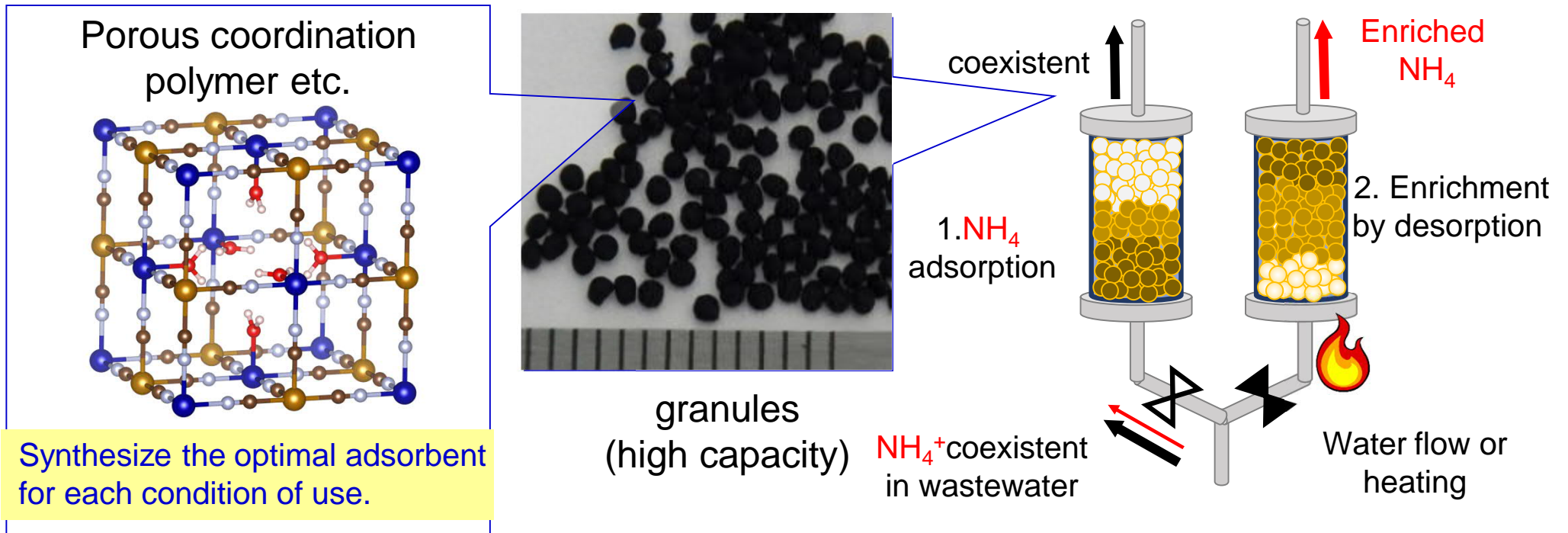


Target of Theme 2 for FY2029 : demonstration with a pilot plant with and enrichment on a scale of 5~15 m³/d.

Position of AIST:R&D of Adsorbents and Adsorption Technology for Selective NH₄⁺ Enrichment

Target of AIST for FY2029:Establishment of materials and basic processes for the pilot demonstration of NH₄⁺ adsorption and recovery.

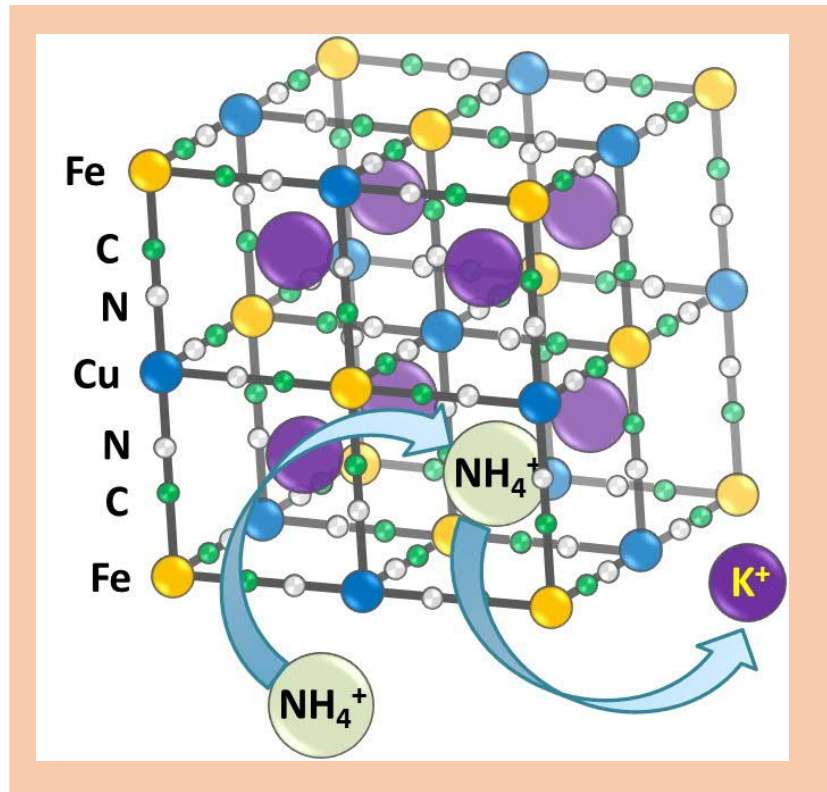
R&D of selective ammonium adsorbent its utilization processes for the enrichment of the ammonium for the recovery as a resource



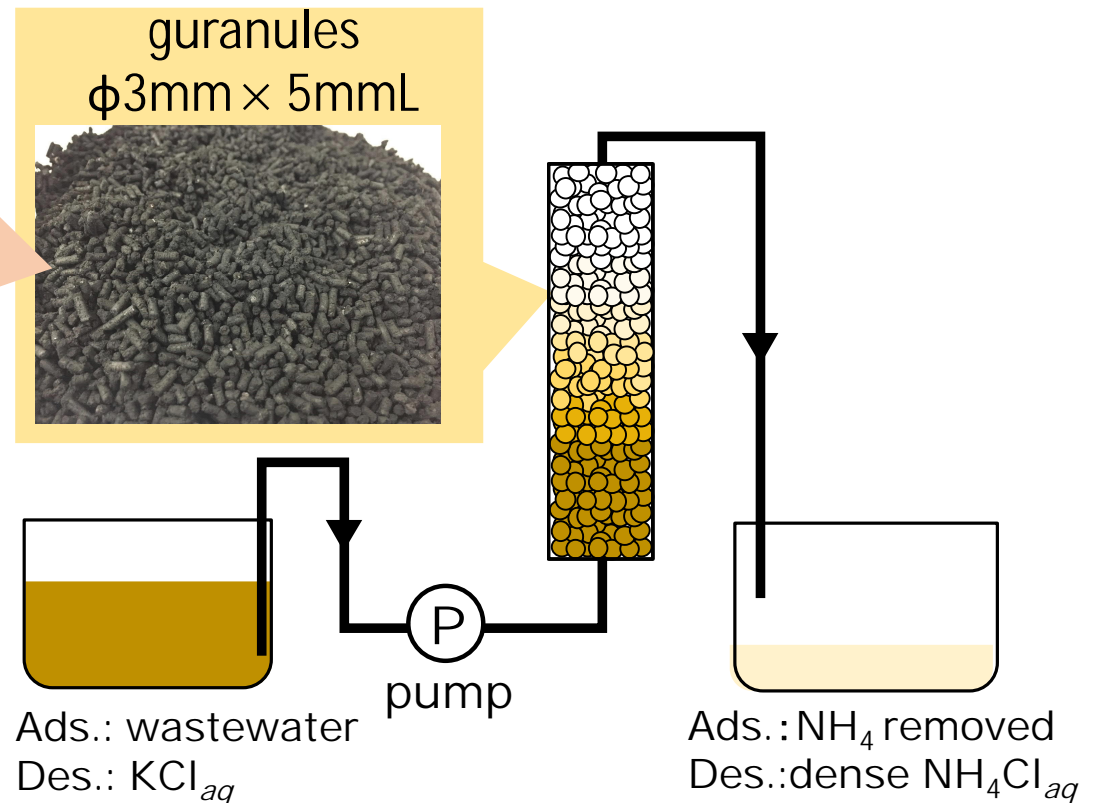
R&D Items

- Research and development of adsorbents that can selectively recover and concentrate NH_4^+ ions in water
- Basic design of a system to produce ammonia resources by using the adsorbents

- Adsorbent with selective adsorption NH_4^+ by exchange with K^+
- NH_4Cl solution is generated by passing KCl solution, enabling separation from coexisting substances.

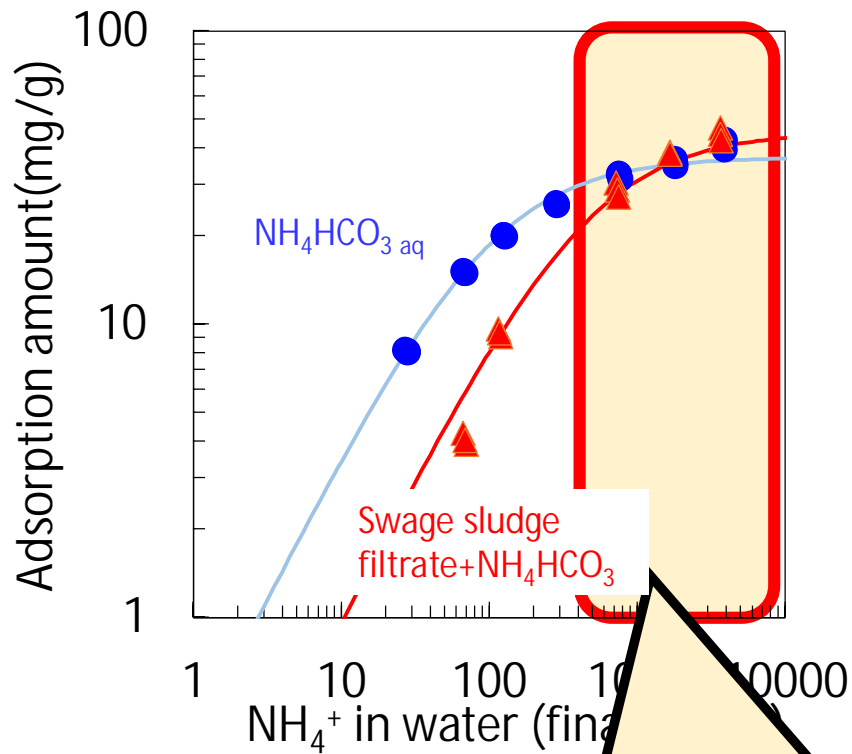


Copper-substituted Prussian blue-type complexes with Optimized composition



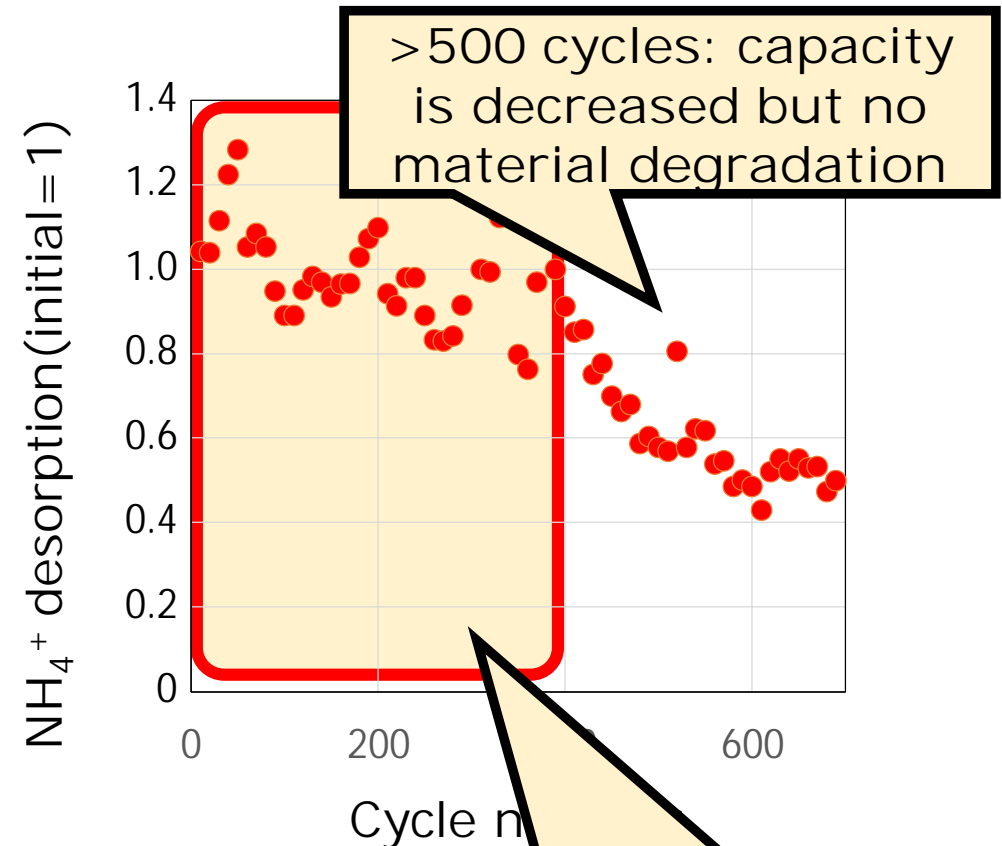
- Adsorbent that can selectively adsorb NH_4^+ even from wastewater
- 400 times recyclability, washing is considered for more improvement

Adsorption isotherms for NH_4^+ ions from pure water NH_4HCO_3 solution and from sewage sludge digestate



Almost no difference in wastewater and in pure water → sufficient selectivity

Dependence of the amount of NH_4^+ on number of cycles (column test)



Adsorption capacity is kept after the 400 cycles

- >60 MOFs synthesized and screened for NH₄⁺ adsorption out of Reviewed 240 MOFs reviewed
- Several MOF candidates discovered (First time for MOFs)

Screening for resistant MOFs

Water-resistance examined



...ca. 240

Water-resistant MOFs



...ca. 120

Affordable MOFs

...47

+

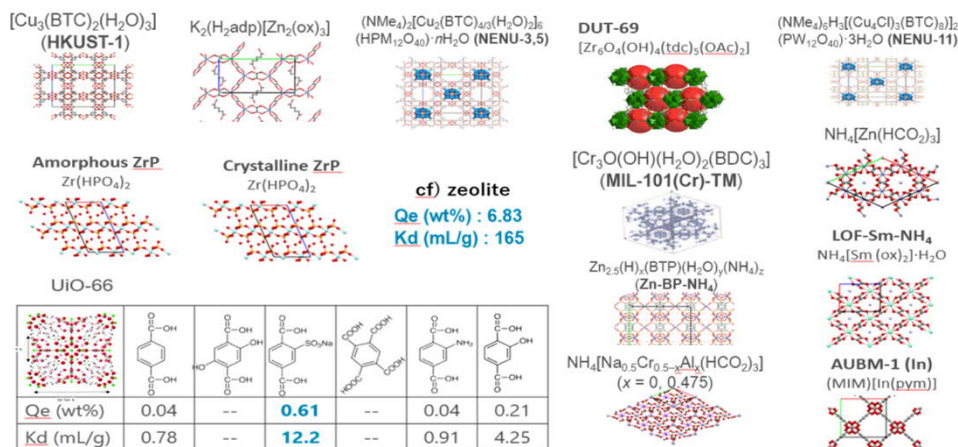
Other candidates

...15

} 64

Screened MOFs (partially)

MIL-53(Cr)	AITCS-2	PCN-333(Al)	UiO-67-BIPY	MFM-303(Al)
MIL-101(Cr)	DUT-5(Al)	PCN-333(Fe)	HKUST-1	Ni ₃ (BTP) ₂
MIL-53(Al)	HP-DUT-5(Al)	PCN-777(Zr)	H ₂ Q-HK	NENU-3
MIL-53-NH ₂ (Al)	DUT-67(Zr)	SUMOF-7	Zn ₃ IPA ₃	NENU-5
HP-MIL-53(Al)	DUT-68(Zr)	LnBTN	kag-MOF-1	NENU-11
HP-MIL-53-NH ₂ (Al)	DUT-69(Zr)	Eu ₆ (OH) ₈ (NDC) ₆	Cu ₆ (Trz) ₁₀	AmNaCr
MIL-68(In)	MOF-467	UiO-66	MOS-1	NH ₄ [Zn(HCO ₂) ₃]
MIL-68-NH ₂ (In)	MOF-808-Formate	UiO-66-NH ₂	MOS-2	LOF
MIL-125-NH ₂ (Ti)	MOF-808-OAc	UiO-67	MOS-3	K-adp-Zn(ox)
CAU-1	PCN-222	HP-UiO-66	IISERP-MOF2	ZnBP-NH ₄
AUBM-1	PCN-223	HP-UiO-66-NH ₂	Mn-MOF-74	ZrP
AITCS-1	PCN-225	HP-UiO-67	Mg-MOF-74	ZrPOF-EA



Position in the project

R&D of Adsorbents and Adsorption Technology for Selective NH_4^+ Enrichment

Target for FY2029

Establishment of materials and basic processes for the pilot demonstration of NH_4^+ adsorption and recovery.

R&D items

- Research and development of adsorbents that can selectively recover and concentrate NH_4^+ ions in water
- Basic design of a system to produce ammonia resources by using the adsorbents

Achievement 1(AIST)

- Adsorbent that can selectively adsorb NH_4^+ even from wastewater
- 400 times recyclability, washing is considered for more improvement

Achievement 2(Univ. Tokyo)

- Several MOF candidates discovered from 60 samples(First time for MOFs)

