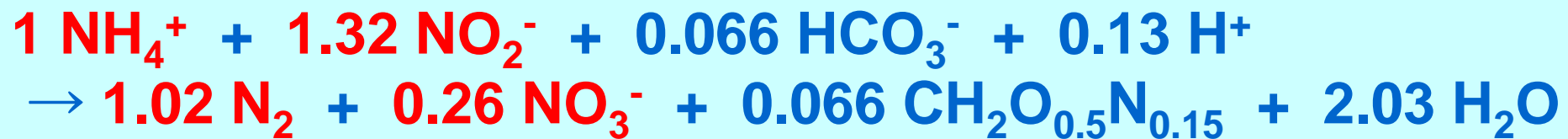




3. Anammox Process

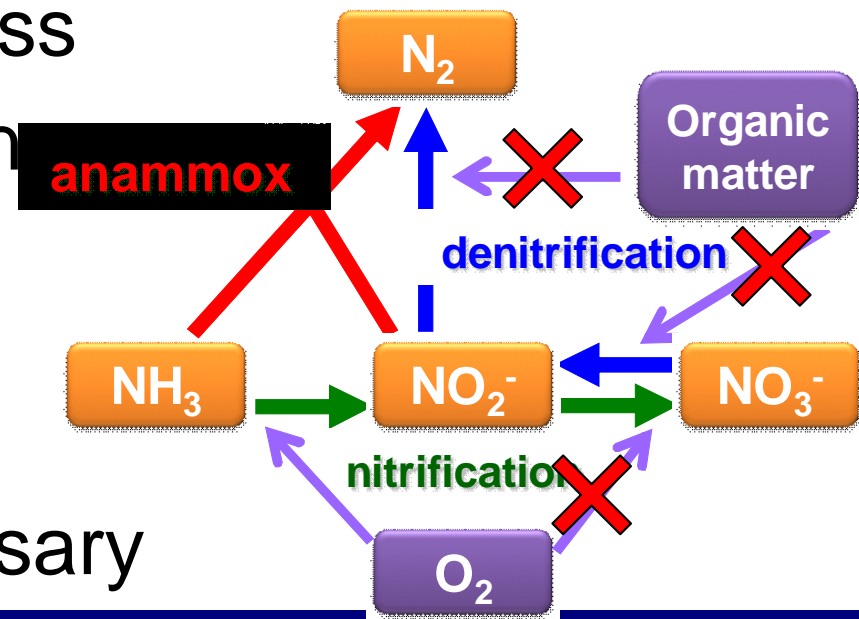
Outline of Anammox Process

- **Anammox** (**an**aerobic **amm**onium **ox**idation) is a novel anaerobically autotrophic nitrogen transformation pathway.



- The advantages of anammox process compared with conventional BNR process

- ✓ **Energy saving**: Reduction of O_2 requirement
- ✓ **Cost saving**: Organic matter (methanol) for denitrification is not necessary

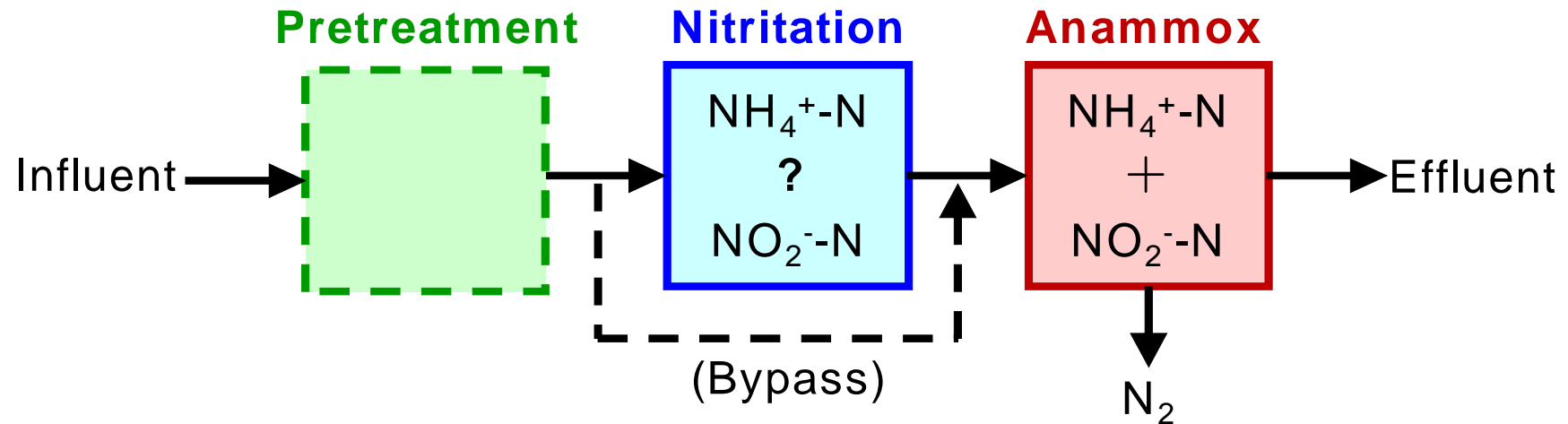


Application of Anammox Process to Municipal Wastewater

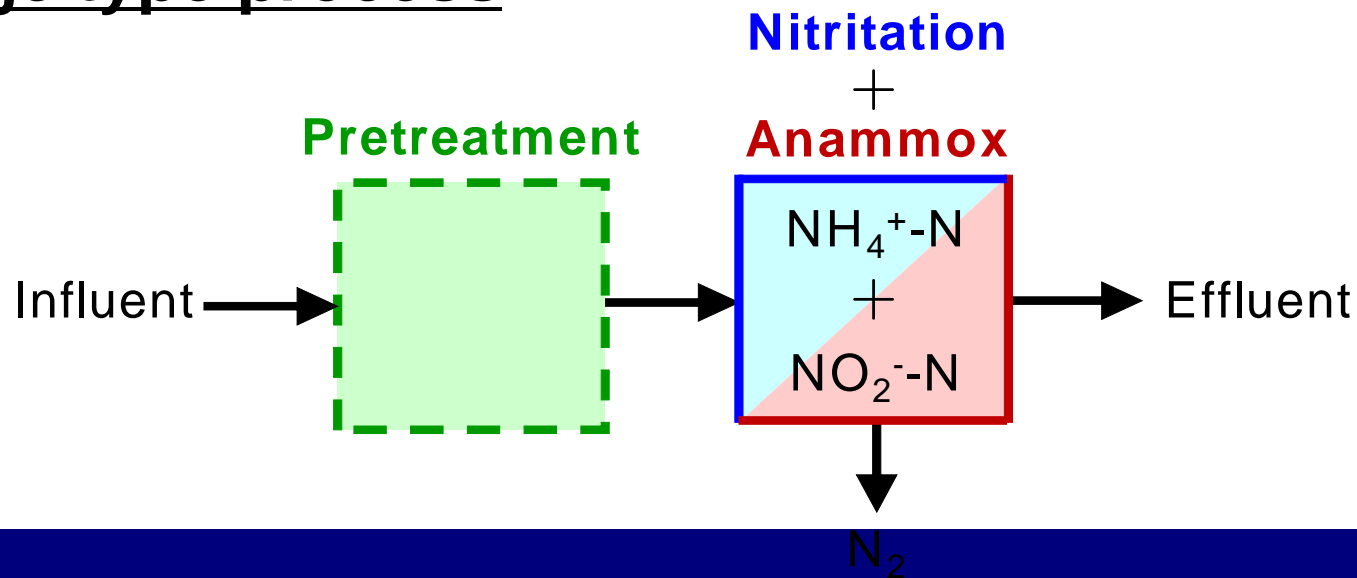
- **Target of application to municipal wastewater**
 - Treatment of **filtrate from a dewatering process of anaerobically digested sludge**
 - ✓ Characteristically **high levels ammonia**, relatively little organic matter
 - ✓ **High water temperature** (optimum growth temperature of anammox bacteria: 30-40C°)
- **Two different processes are required;**
 - Converting ammonia to nitrite (**nitritation**)
 - Converting ammonia and nitrite into nitrogen gas (**anammox**)

Basic Flow of Anammox Process







Two-stage type process



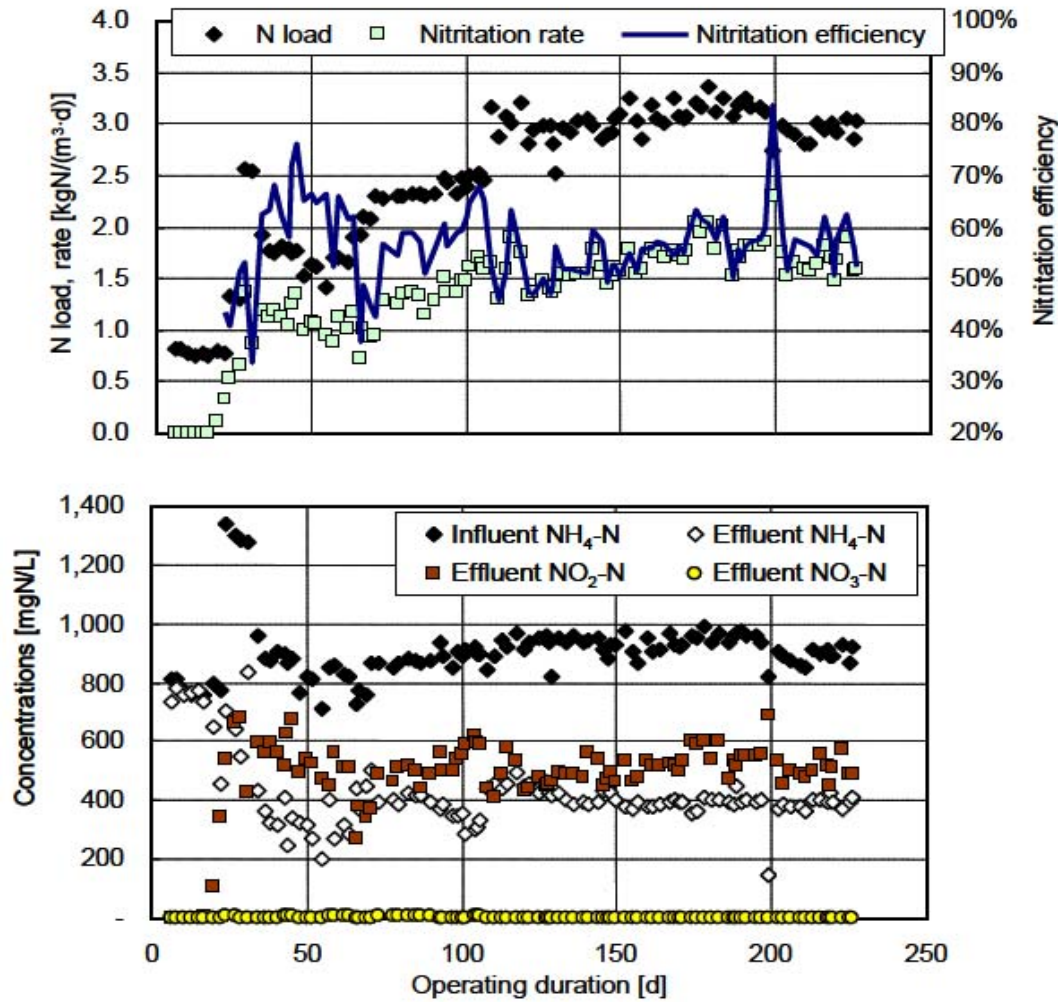
Single-stage type process



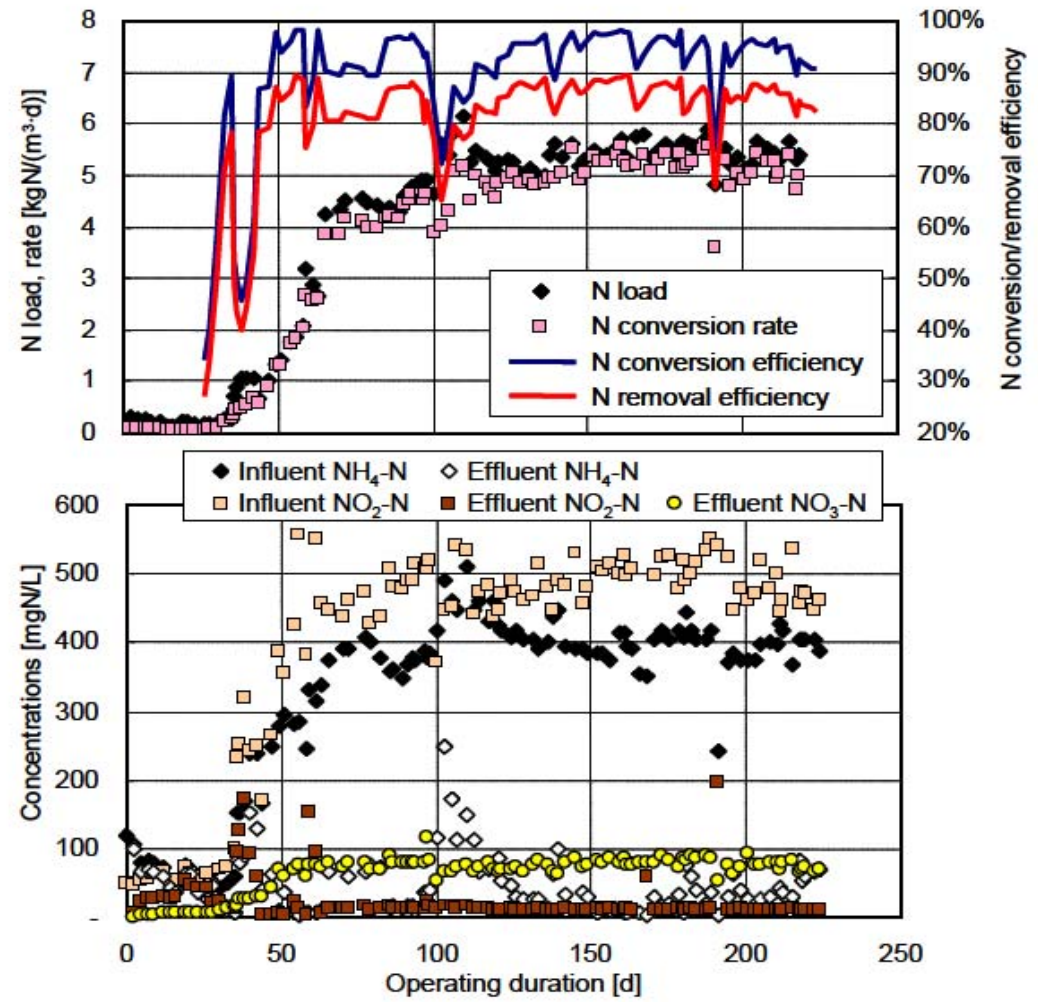
Outline of Anammox Processes Evaluated in JS Technology Evaluation

	Process A	Process B	Process C
Pretreatment	Flow equalization (BOD removal) Screen	Flow equalization (BOD removal) (Coagulation)	Flow equalization (Coagulation) (Pre-aeration)
Nitritation reactor	Immobilization in PEG gel 	Fixed bed 	Sponge carrier 
Partial nitritation	One-pass	Bypass	One-pass
Nitritation control	Heating of PEG gel	Water temperature and pH control	Water temperature and pH control
NO ₂ /NH ₄ ratio control	Aeration flow rate	Bypass flow rate	Aeration flow rate
Anammox reactor	Immobilization in PEG gel 	Fixed bed 	Granule 
Anammox control	Water temperature and pH control	Water temperature and pH control	Water temperature and pH control

Example of Pilot-scale Plant Experiment Results (Process A)



Performance of nitrification reactor



Performance of anammox reactor

Evaluation Results of Characteristics of Anammox Process

- **N removal rate of 70-80%** can be expected by combining partial nitrification and anammox. Applicable $\text{NH}_4\text{-N}$ concentration is 700-1000mg/L and N volume load is 0.7-2.0kgN/m³/d.
- **Stable nitrification** can be maintained and **NO_2/NH_4 ratio is kept appropriate.**
- In the **anammox** reactor, **N conversion rate of 80% or more** (rate of decrease of total $\text{NH}_4\text{-N}$ and $\text{NO}_2\text{-N}$) can be expected. However, **N removal rate falls by up to 10%** compared to N conversion rate.
- **Required start-up period:** 0.5-1.0 months (partial nitrification) , 2.0-3.0 months(anammox)

Results of Case-study Compared Anammox and Conventional BNR

- Anammox process can be expected to realize more effective and less expensive sidestreen treatment
- We expect that the application of anammox will promote the introduction of anaerobic digestion in Japan

	Anammox process	Conventional BNR process*
Reactor volume	475-981 m ³ (Reduction rate:35-69%)	1,515 m ³
Construction costs	1.2-2.7 million JPY/kgN (Reduction rate:22-58%)	3.4 million JPY/kgN
Utility costs	240-370 JPY/kgN (Reduction rate:24-57%)	600 JPY/kgN
GHGs emission**	5.7-8.6 kgCO ₂ /kgN (Reduction rate:24-50%)	11.3 kgCO ₂ /kgN

*:Carrier-added step-feed biological nitrogen removal process

** :Volume of greenhouse gas emission from utility consumption