

PRODUCTION OF SLOW-RELEASED NITROGEN FERTILIZER FROM URINE

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Introduction

- Nitrogen resource in domestic wastewater
 - 3.9 N-kg / ca / year from urine as urine (85 %)
 - 0.14 and 0.45 N-kg /ca / year from gray water and feces
- Fate of nitrogen from domestic wastewater
 - Transformed into N₂ (Nitrification – denitrification process)
- Nitrogen in urine for agriculture
 - 486,000 N-tones of nitrogen fertilizer was consumed in Japan (2008)
 - 468,000 N-tones (3.9 kg x 120,000 k ca) of nitrogen is discharged as wastewater.

How to use nitrogen in urine as fertilizer?

○ Stored urine

- Long time for stabilization
- Volume for storage
- Nitrogen as ammonium form
- Contains much amount of salts

○ Compost

- Nutrients for microorganisms
- Escaping ammonia into the air and the ground water

○ Collection by acids

- Ammonium sulfate

Slow released fertilizer

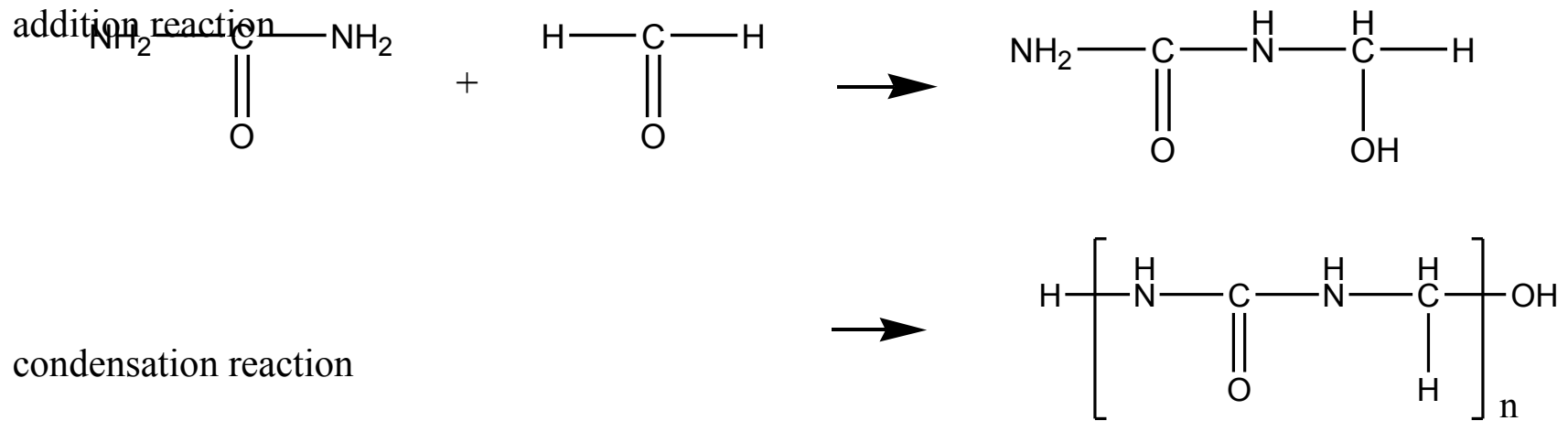
- Long effect owing to low degradation rate
- Lower-saving efforts for fertilization
- Low emission of nitrogen into surface and ground water

- Present fertilizers
 - Coated fertilizer
 - Urea form, IBDU, Cyclo diurea

Urea form

- Polymerization of urea and formaldehyde under the acidic condition

- Reaction formula

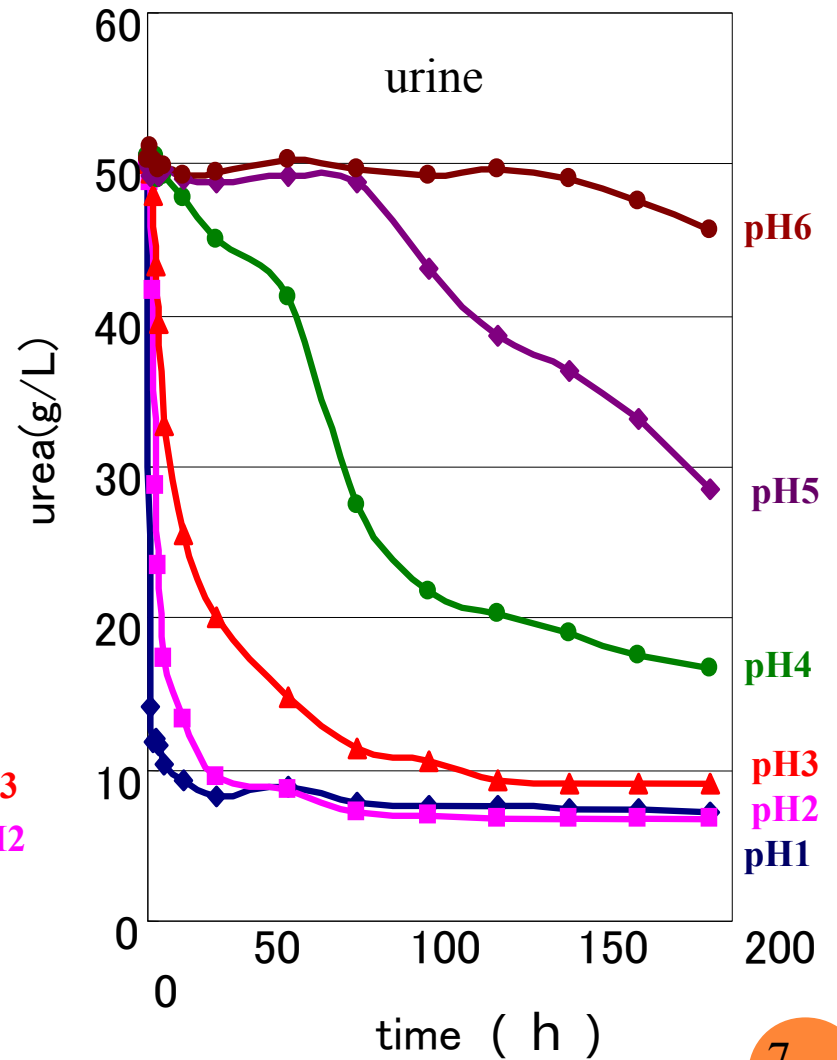
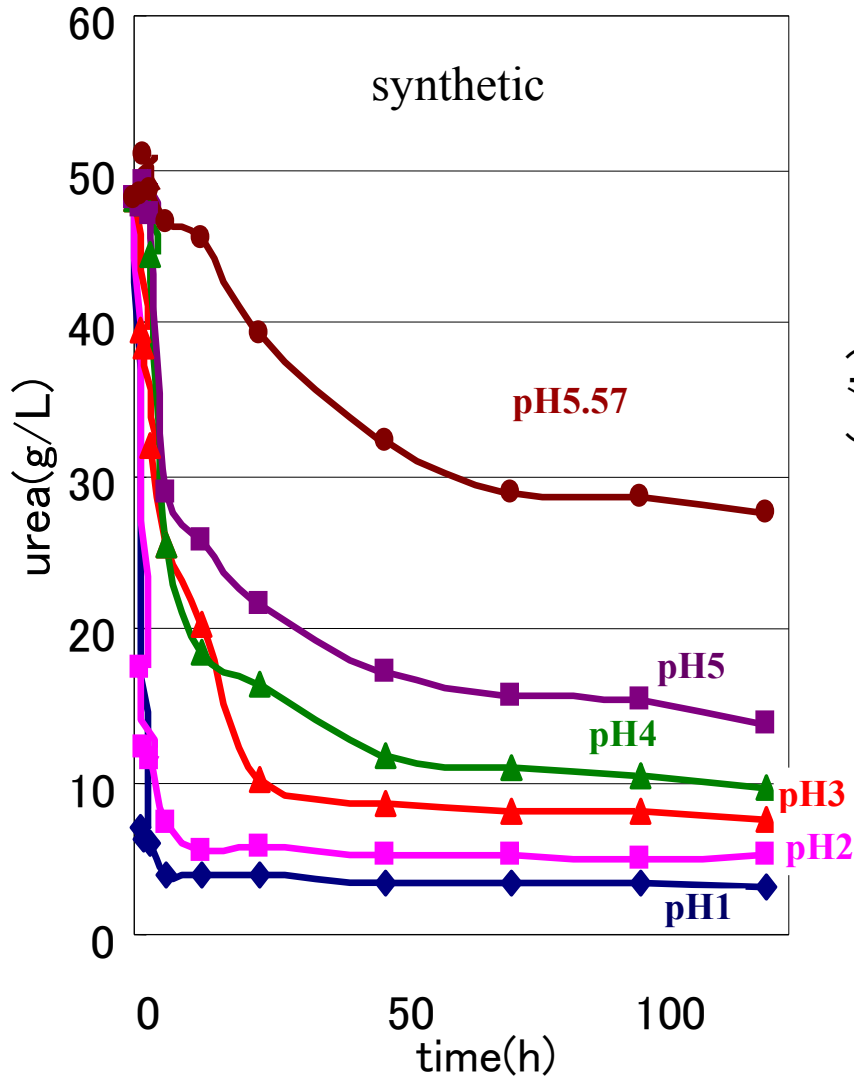


Polymerization reaction in synthetic urine

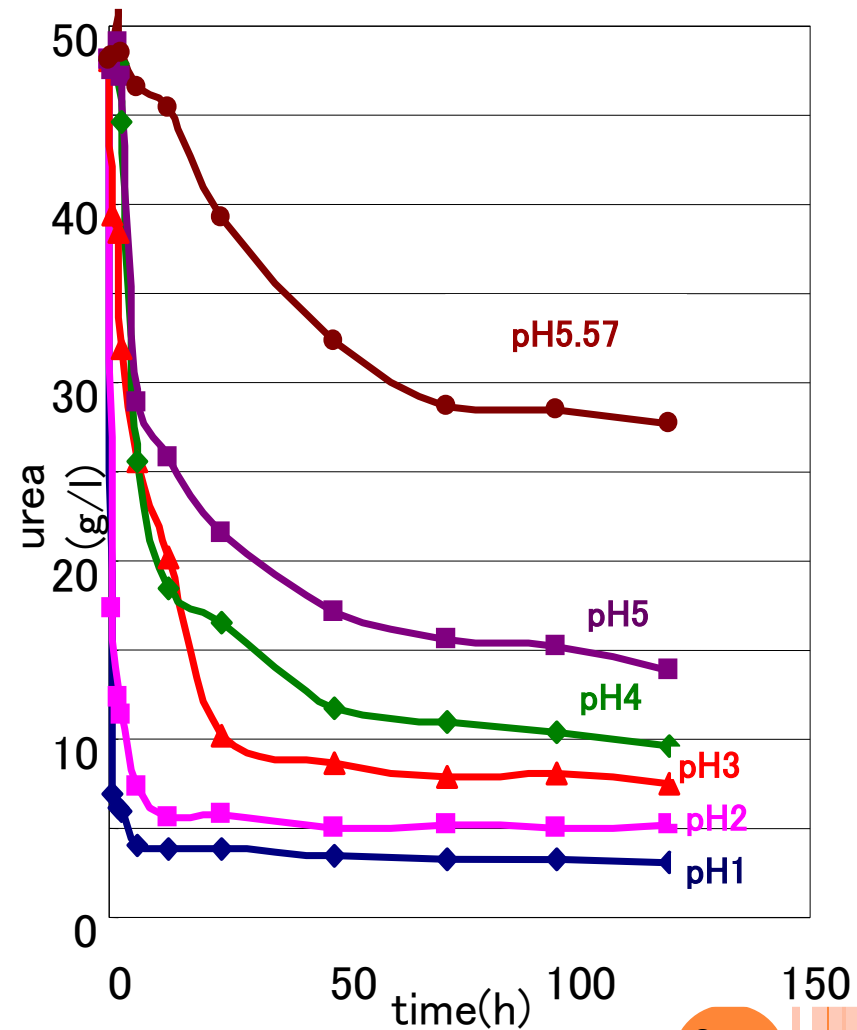
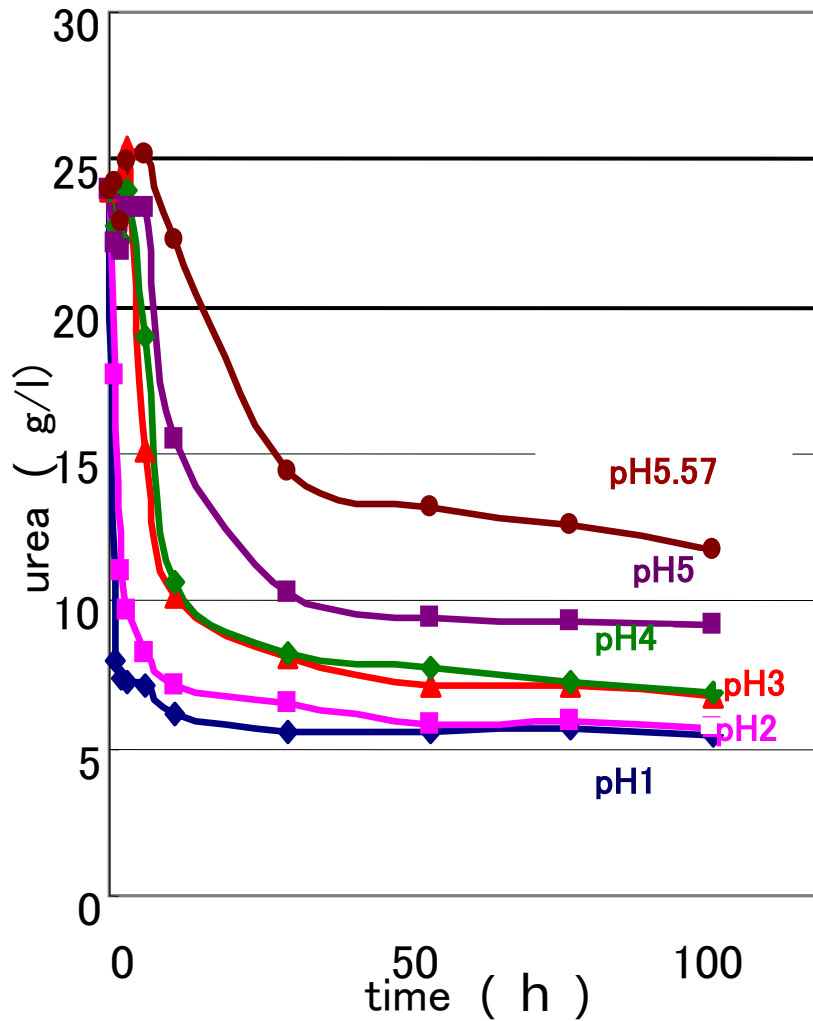
- Typical concentration
- Doubled concentration
- Urine sample: 200ml
 - pH 1 ~ 5 : adjusted by sulfuric acid
- Formaldehyde: 10ml
- Temp.: 20°C
- Process of polymerization

Composition		pH	5	5	7
regents	Concentration(mM)				
MgCl ₂ ·6H ₂ O	3.	2			
NaCl	78.	7			
Na ₂ SO ₄	16.	2			
Na ₃ (C ₆ H ₅ O ₇)·2H ₂ O	2.	6			
KCl	21.	5			
C ₄ H ₇ N ₃ O	9.	7			
CaCl ₂ ·2H ₂ O	4.	4			
KH ₂ PO ₄	30.	9			
NH ₄ Cl	18.	7			
(NH ₂) ₂ CO	41	7			
Na ₂ (COO) ₂	0.	15			
C ₆ H ₈ O ₆	0.	57			

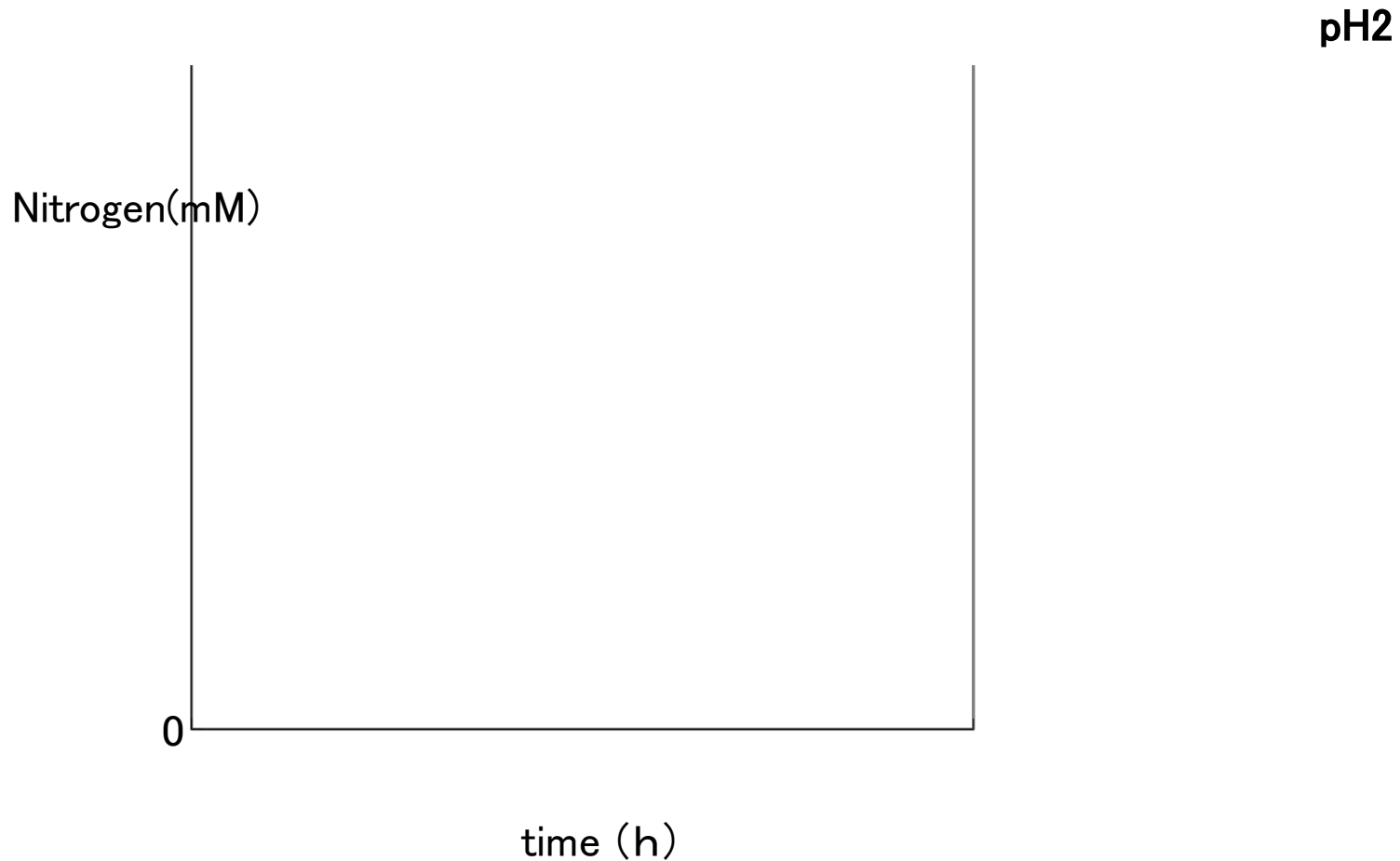
Decrease of urea concentration in urea solution and synthetic urine



Decrease of urea concentration in synthetic urine

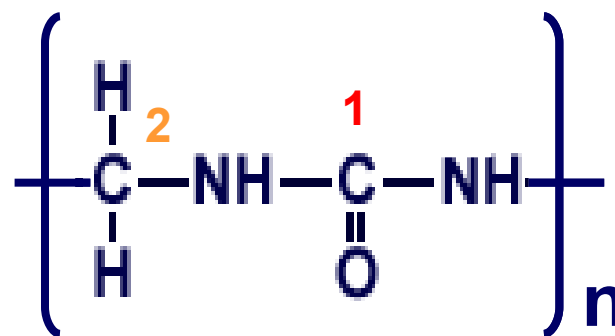
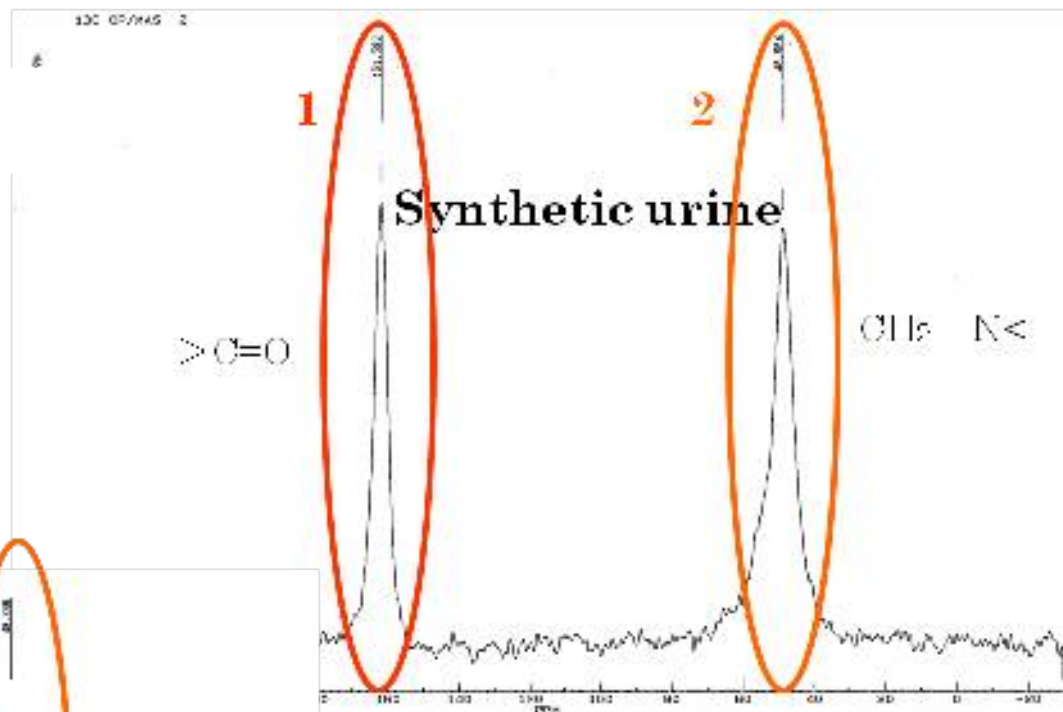
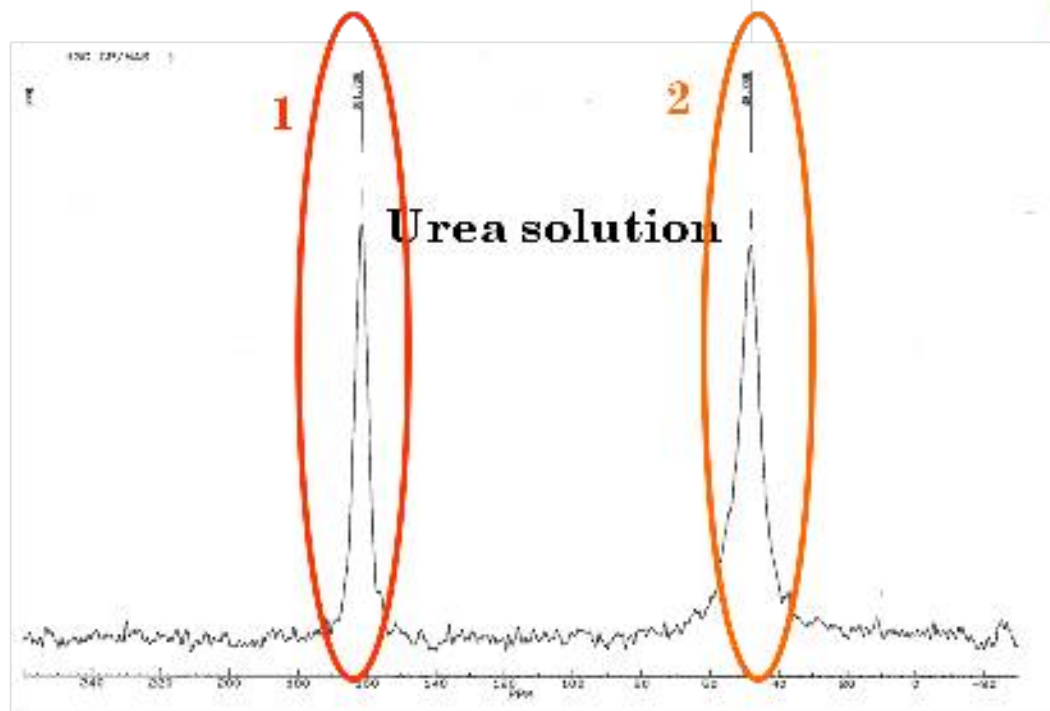


Molecular weight distribution of nitrogen substances



Structure analysis

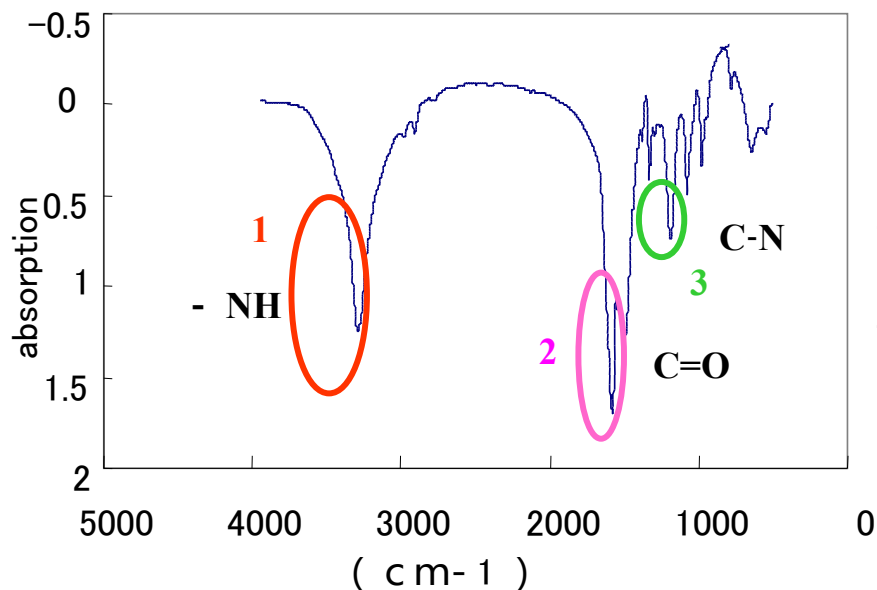
C^{13} NMR



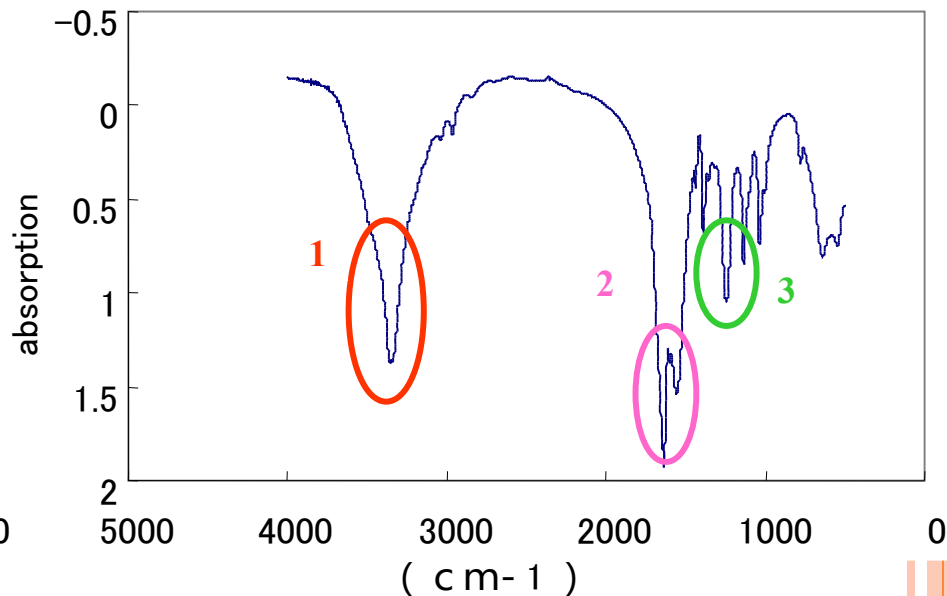
Structure analysis

IR

Urea solution



Synthetic urine

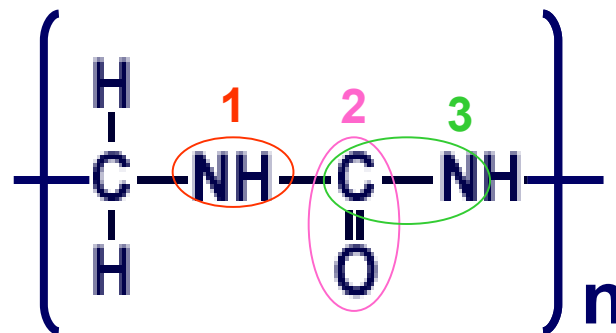


CHN elements analysis

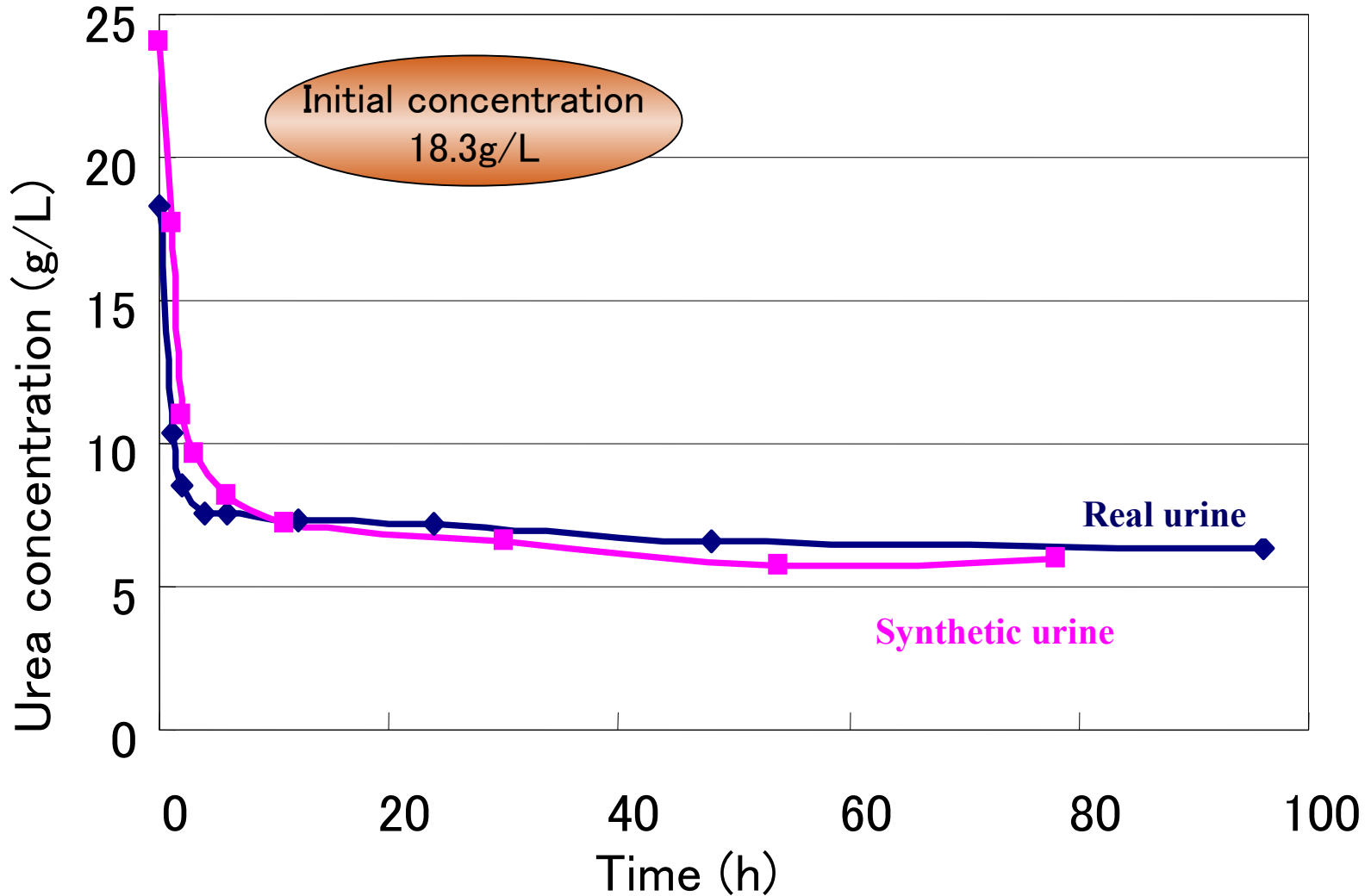
Urea solution C29.78 H5.59 N36.82

Synth C28.52 H5.57 N35.33

◁ Mol ratio C:H:N
1:2:1



Time course of urea concentration during the re action



Production from urine sample

○ **Real urine**

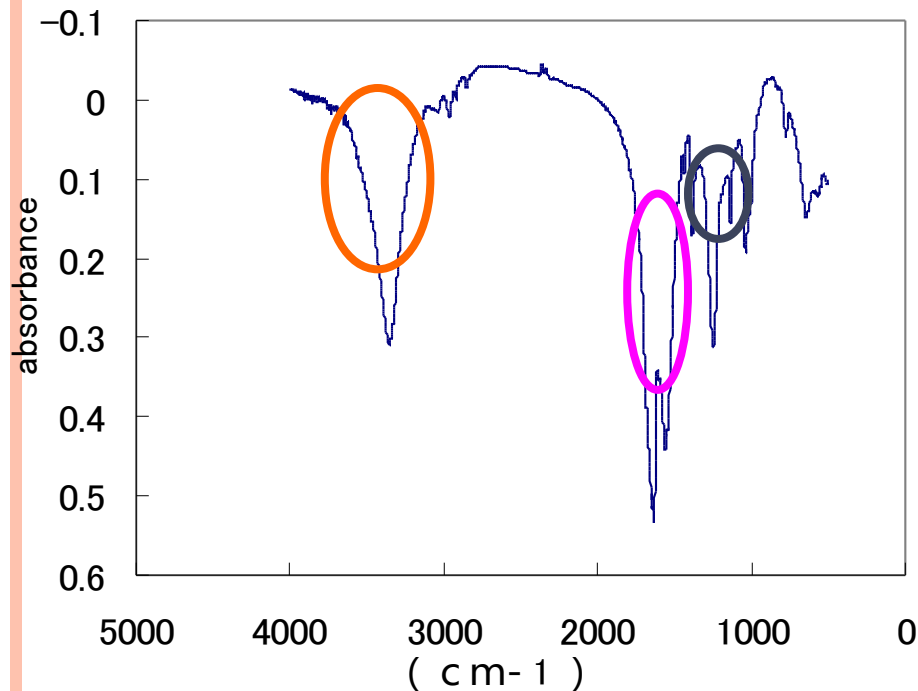


○ **Synthetic urine**

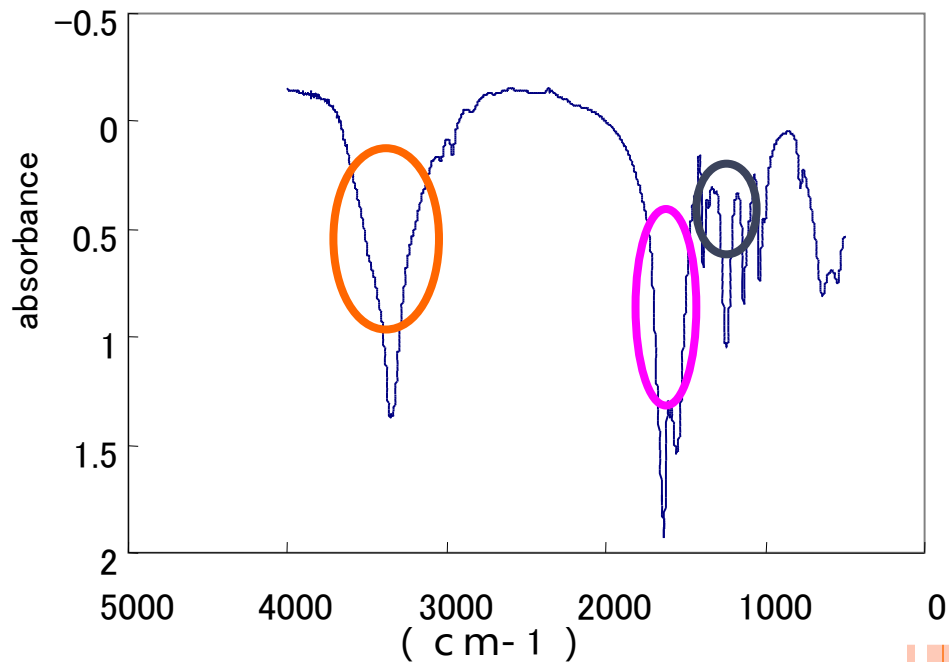


Structure analysis

Real urine



Synthetic urine

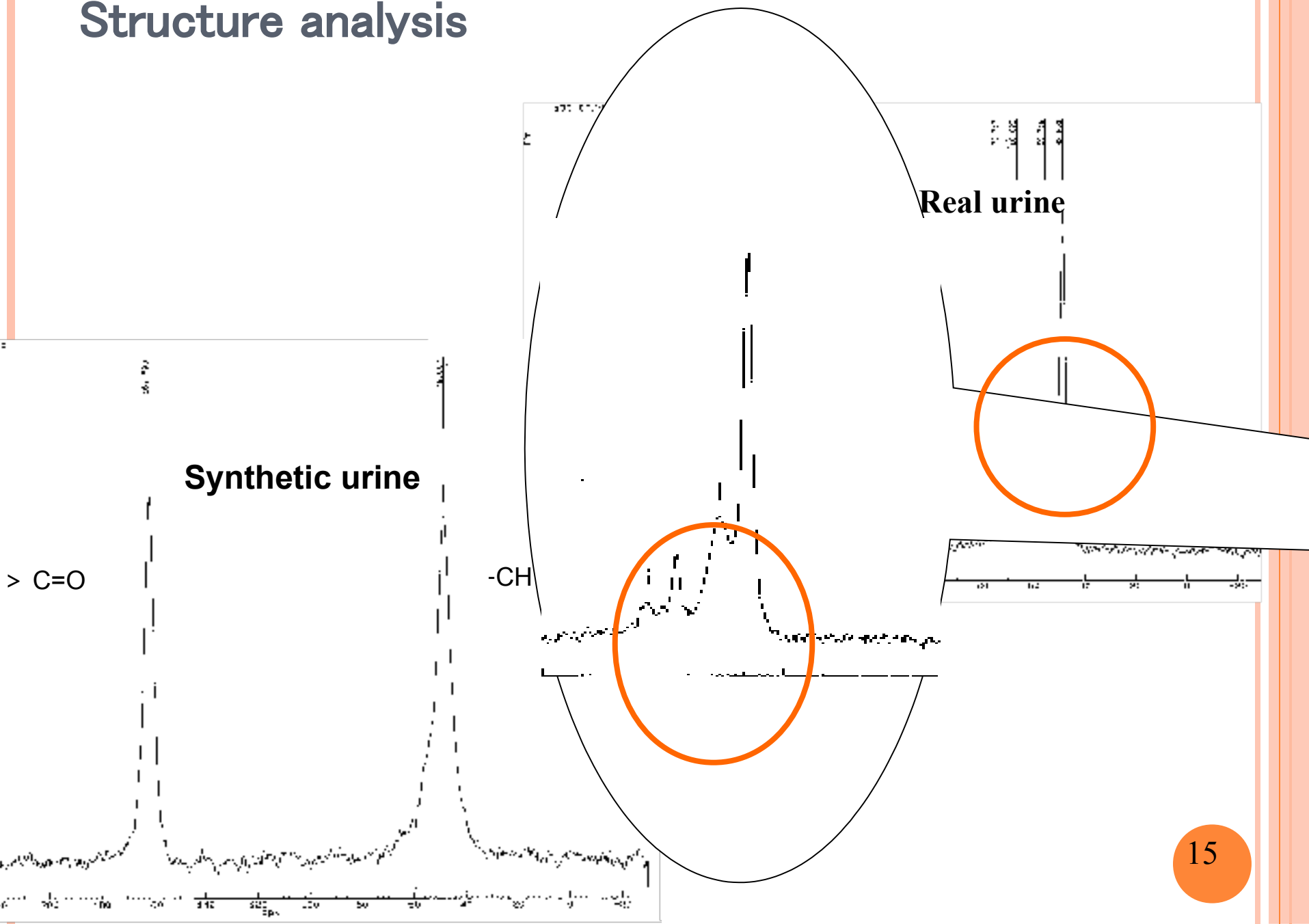


CHN element analysis

Real urine C 29.61 H 5.85 **N 30.35**

Synthetic urine C 28.52 H 5.57 N 35.33

Structure analysis



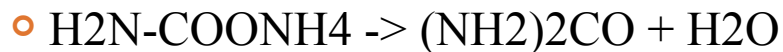
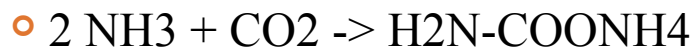
conclusion

- Possibility of precipitation of ureaform from urea solution and synthetic urine
 - Acidic condition
 - Most part was over $0.45\ \mu\text{m}$
- Structure of the precipitation
 - Co-polymer of urea and formaldehyde
 - 33 wt-% nitrogen
- Possibility of precipitation from real urine
 - Same polymer is obtained in acidic condition.

Value of nitrogen in urine

○ Energy consumption for production of urea fertilizer

- ammonium carbamate method



- Standard enthalpy for formation

