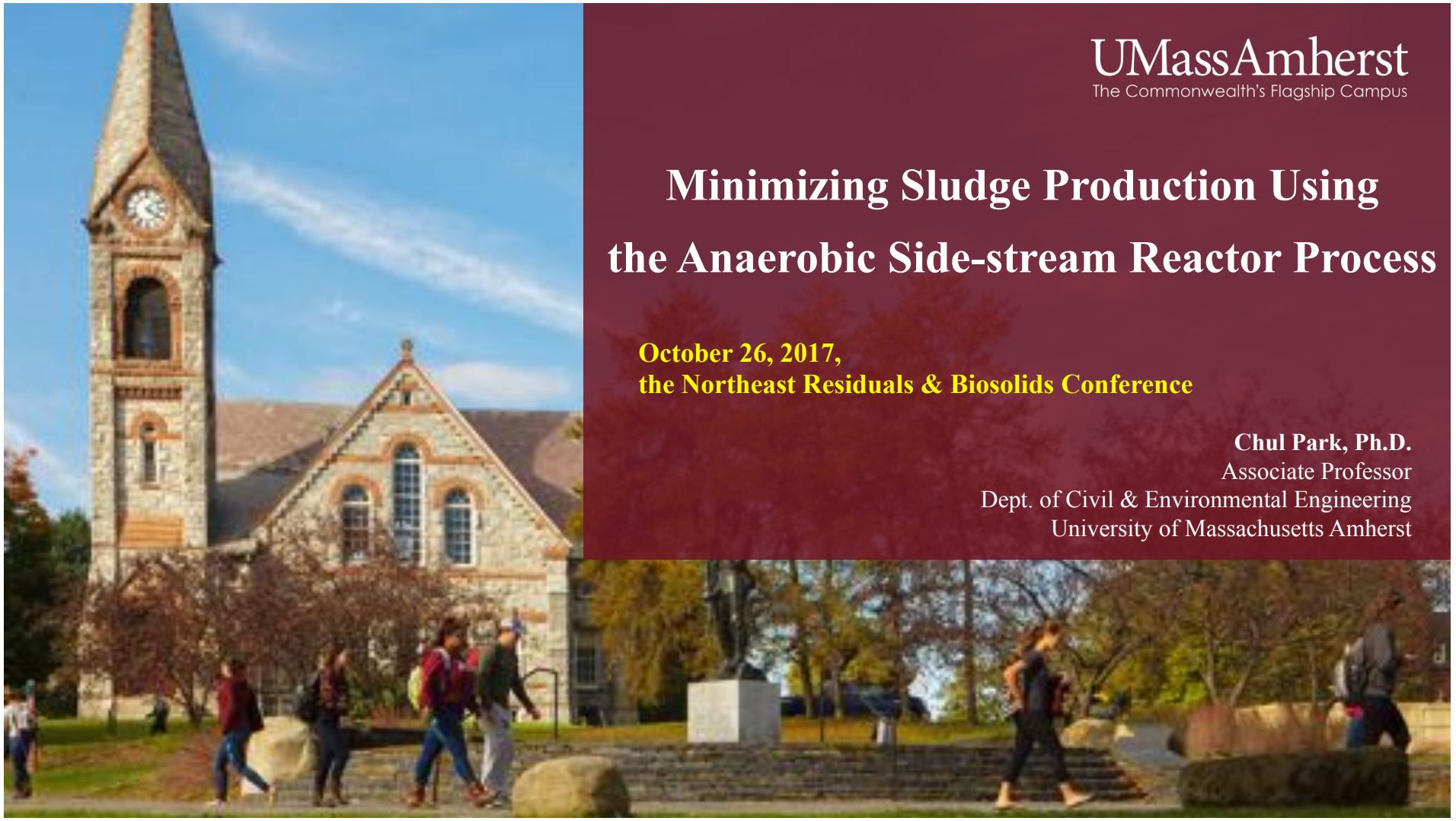

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Minimizing Sludge Production Using the Anaerobic Side-stream Reactor Process

October 26, 2017,
the Northeast Residuals & Biosolids Conference

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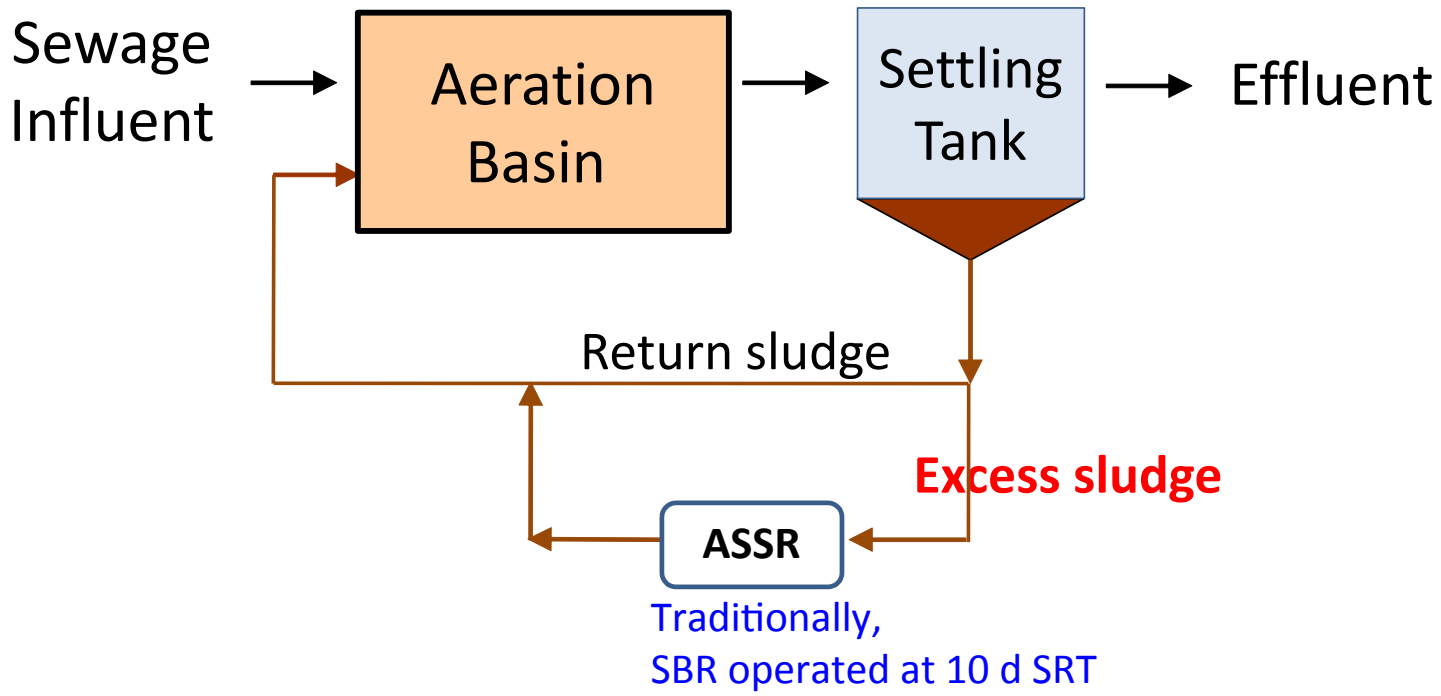
Motivation for the today's talk

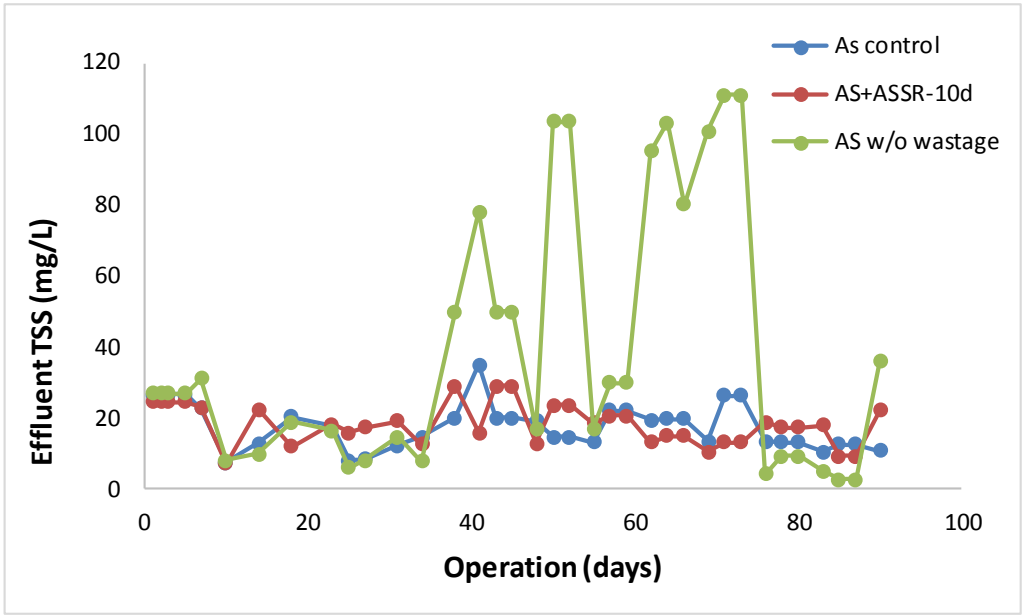
- In conventional wastewater treatment, regular sludge wasting is necessary
- Sludge: nutrients, organic matter, and energy
- However, sludge is traditionally considered nuisance materials
- Sludge management causes the highest operational cost for WWTPs
- What about decreasing sludge production? This may be potentially an important issue for:
  - WWTPs that do not have anaerobic digesters
  - Sludge disposal in remote places

➢ *I have had meetings with several groups interested in this approach*

Schematic of the ASSR Process



Stable System Performance

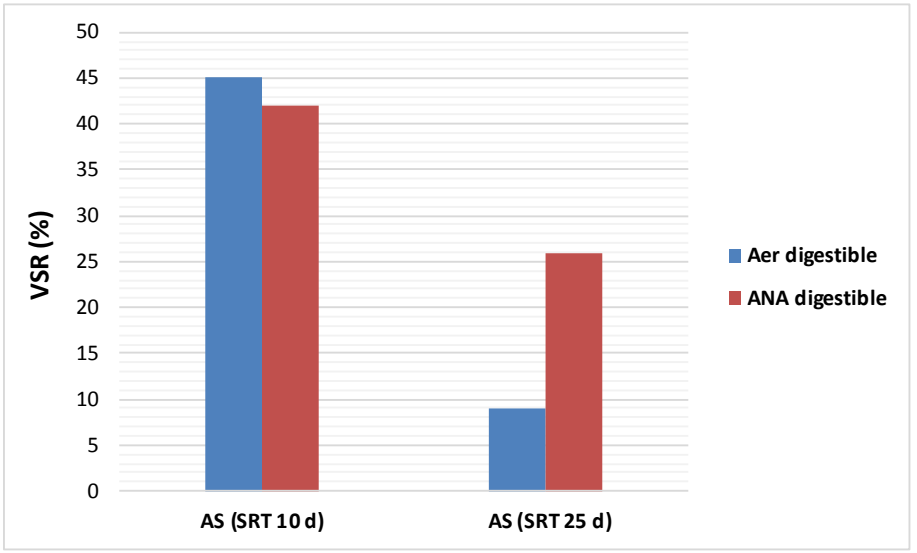


Chon et al. (2011) *Water Research*

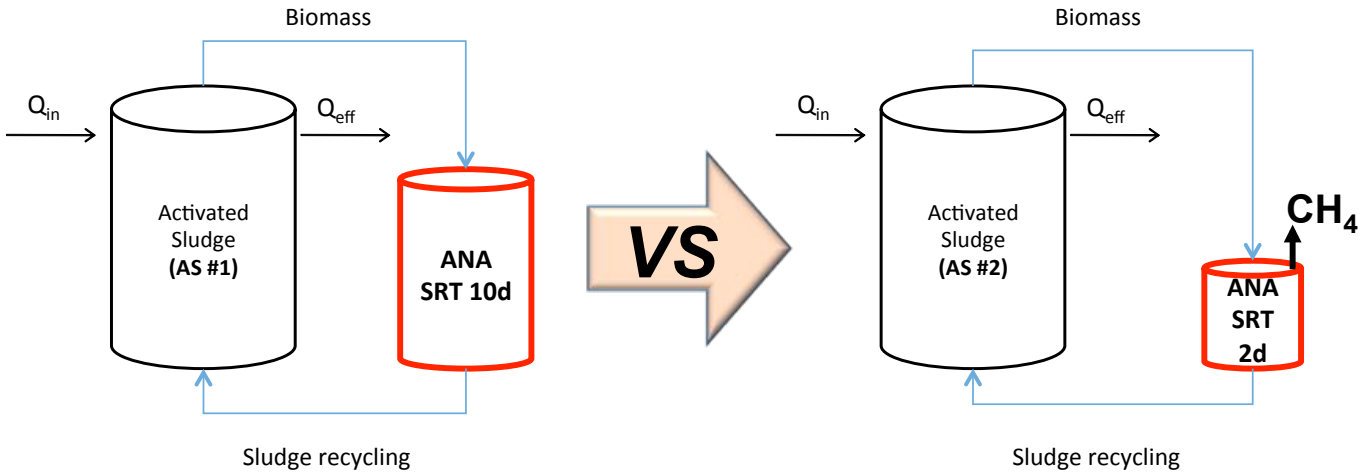
Digest Sludge Aerobically or Anaerobically?

Composition of flocs

- Cells
- Extracellular polymeric substances (EPS)
- Cations
- Other inorganics



High-rate ASSR process



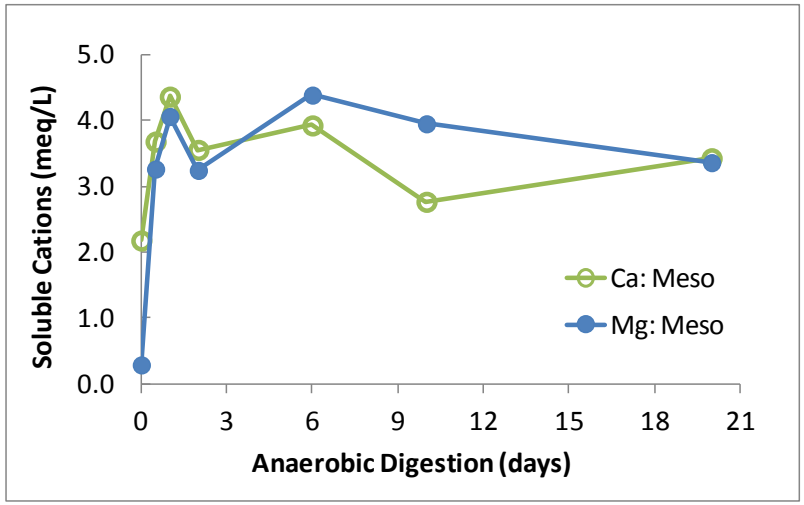
Previous ASSR System

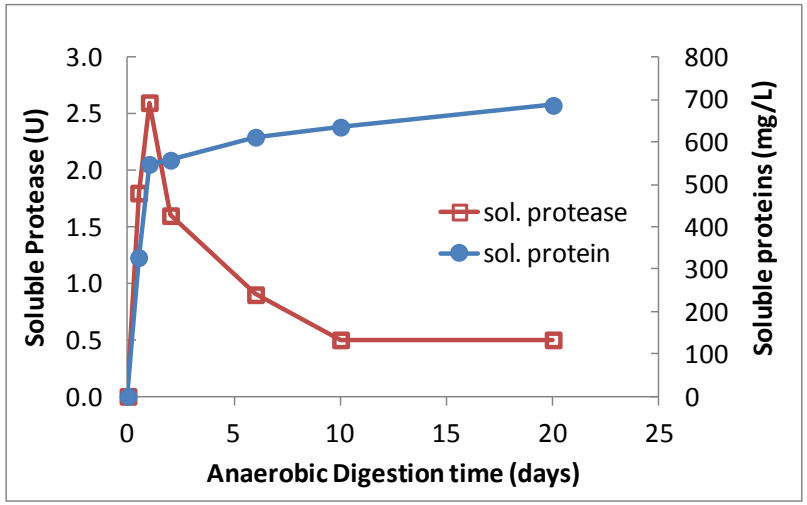
High-Rate ASSR

Motivation for Developing a High-rate ASSR

- Unique sludge (WAS) hydrolysis occurs during short-term anaerobic digestion
  - ➢ Behavior of floc cations
  - ➢ Release of protein-degrading enzymes
- You can have more compact ASSR system
  - ✓ 10 d vs. 2 d

Release of Key Floc Components



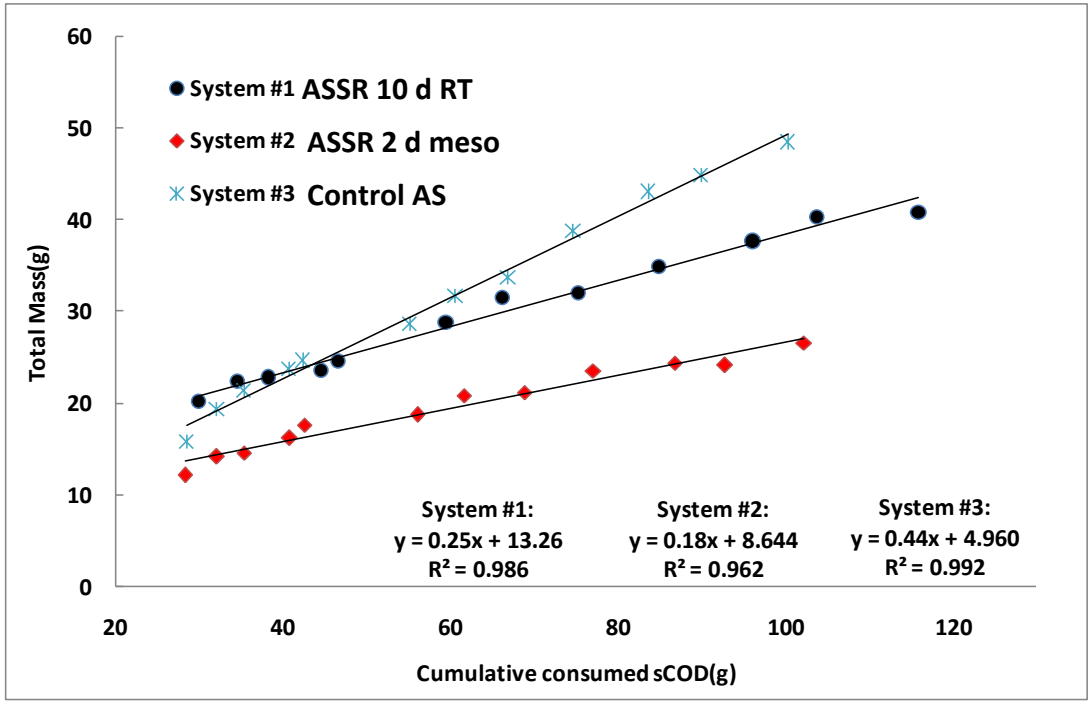


Park and Chon (2015) *Water Environment Research*

Controlled Reactor Study

- Operation of bench-scale reactor systems
  - 10 d ASSR (RT)
  - 2 d ASSR (RT, 37 C, 55 C)
  - Control activated sludge
- Used primary effluent

Comparison of Sludge Yields

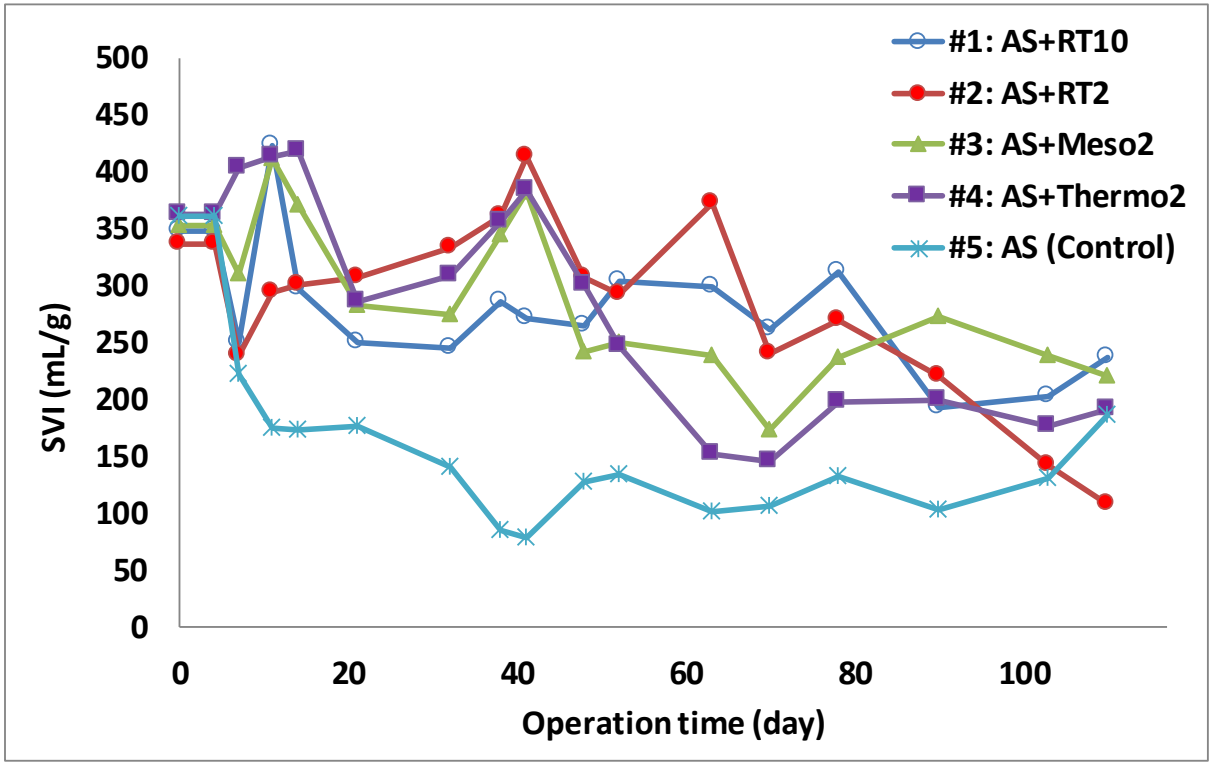


$$Y_{obs} = \frac{\Delta X / \Delta t}{\Delta S / \Delta t} = \frac{\text{the amount of biomass produced}}{\text{the amount of substrate removed}}$$

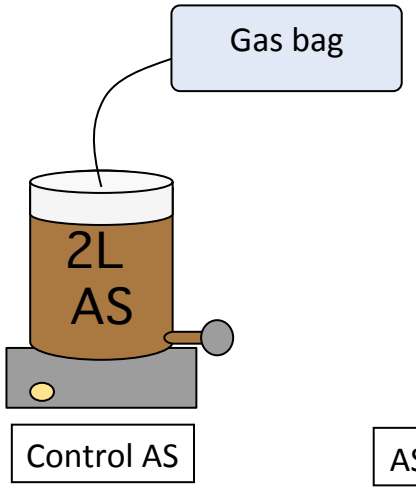
Observed sludge yield (lb VSS/lb COD)

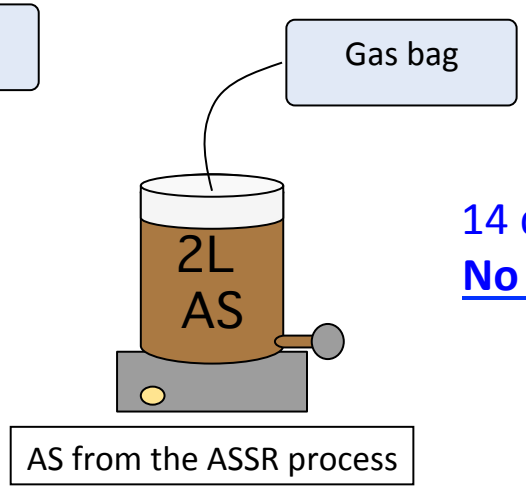
- **ASSR 10 d RT: 0.25**
- **ASSR 2 d Meso: 0.18**
- **Control AS: 0.44**

SVI


#1: AS+RT10
#2: AS+RT2
#3: AS+Meso2
#4: AS+Thermo2
#5: AS (Control)
SVI (mL/g)
500
450
400
350
300
250
200
150
100
50
0
0
20
40
60
80
100
Operation time (day)

Batch Anaerobic Digestion of Activated Sludge





14 days of digestion

No anaerobic seed biomass

Activated sludge	% VS reduction	Biogas (mL)	% CH_4	$m^3CH_4/kg\ VS_{red}$
Control	24	255	4	5
From ASSR	24	**1180**	**47**	**226**

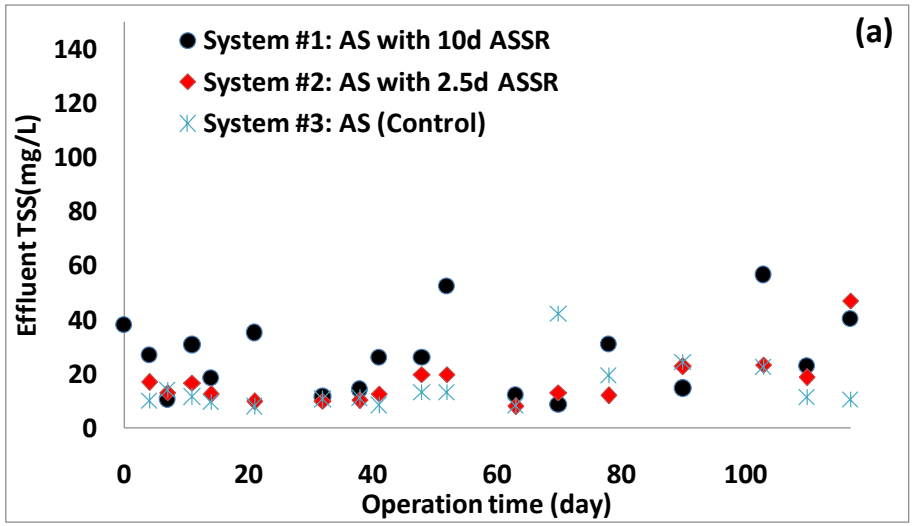
Conclusions

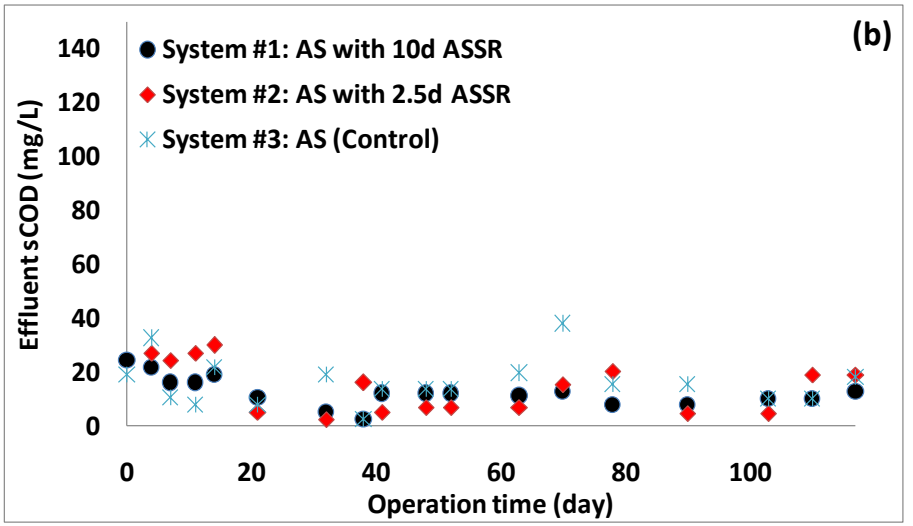
- A High-rate ASSR (2 d) is feasible
  - ✓ Significantly decreased sludge production
  - ✓ Effective sludge settling and good effluent quality
  - ➢ Unique biochemical reactions occur for activated sludge during the short period of anaerobic digestion (~ 2 d)
- 2 d ASSRs (mesophilic) generates a meaningful amount of CH_4
- Activated sludge biomass in the ASSR process contains significant anaerobic microbial community → Potential seed for conventional ADs

Generation of CH_4 from a Small ASSR

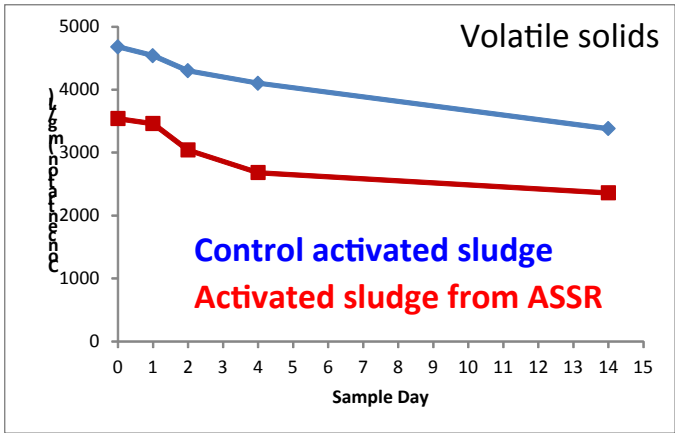
- 2 d mesophilic ASSR started producing biogas from day 40
  - Biogas yield: 0.33 m^3/kg VSS_{red} (~0.41 m^3/kg VS_{red})
  - 25-32% VSSR in 2d mesophilic ASSR
  - Cf (M&E): 0.75-1.12 m3/kg VS red
- How is this possible?
  - Both aerobic and anaerobic community are enriched in single sludge consortia and get activated immediately in designated environments

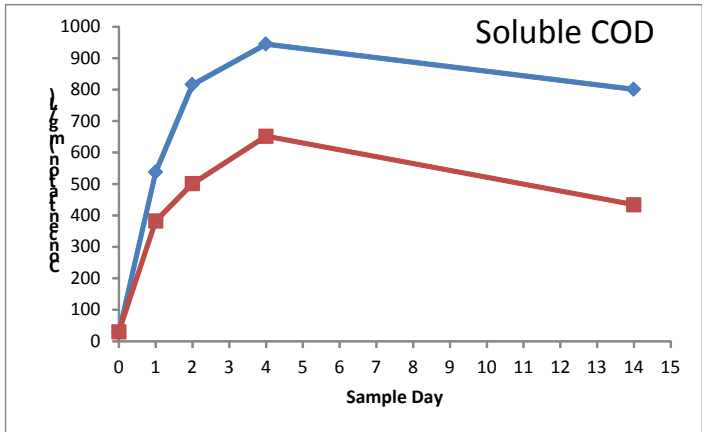
System Performance





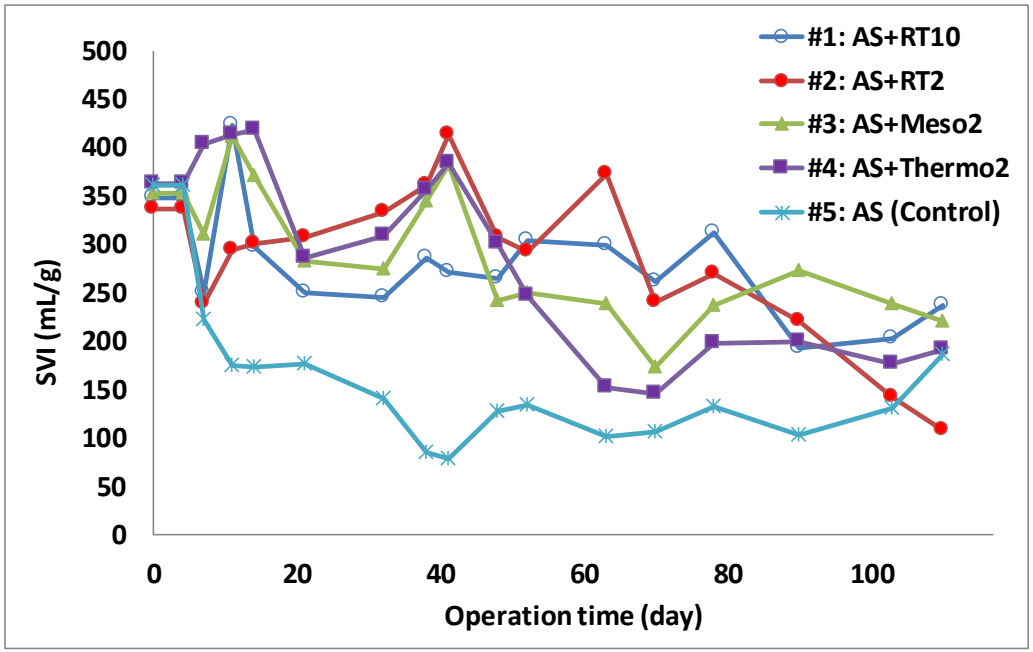
Aerobic-Anaerobic Sludge





Activated sludge	% solids reduction	Gas volume generated (mL)	% CH_4	$m^3CH_4/kg\ VS_{red}$
Control	24	255	4	5
From ASSR	24	**1180**	**47**	**226**

SVI


#1: AS+RT10
#2: AS+RT2
#3: AS+Meso2
#4: AS+Thermo2
#5: AS (Control)
SVI (mL/g)
500
450
400
350
300
250
200
150
100
50
0
0
20
40
60
80
100
Operation time (day)