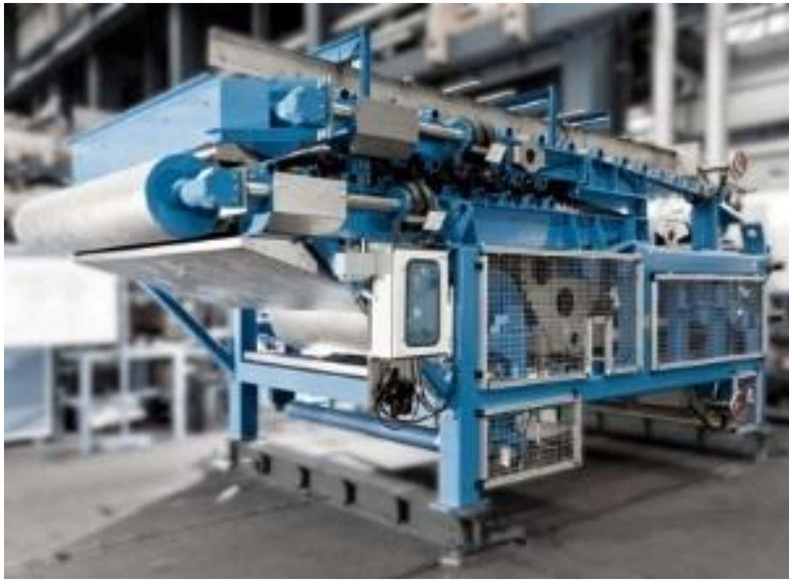
Hazen



Ohio Water Environment Association
Preserving & Enhancing Ohio's Water Environment

How to get the most out of your dewatering equipment

Dr. Mohammad Abu-Orf, Residuals Group Practice Leader

Presentation outline

- Introduction
- How to get drier cake from an existing dewatering device
  - Dewatering device
  - Sludge issues
  - Polymer issues
- Polymer QA/QC
- BioP and dewatering
- Innovative in dewatering devices: Bucher Press
- Innovative in conditioning: Orege, SLG Technology

Introduction

Dewatering is a central piece in sludge processing

Liquid Sludge Pathway
Processing/Disposition

Digestion

Dewatering

Landfill or
daily cover

Class A or B
cake biosolids
land application

Processing (*Class A)
alkaline stabilization (*)
enclosed composting (*)
drying/pelletization (*)
incineration

Residual Products (*EQ)
alkaline soil (*),
compost humus (*)
pellets/granules (*)
ash

Agricultural or
horticultural
soil amendment

Fertilizer or
filler supplement

Fuel for
energy production

Value added
application
(ash into bricks)

Solids dewatering

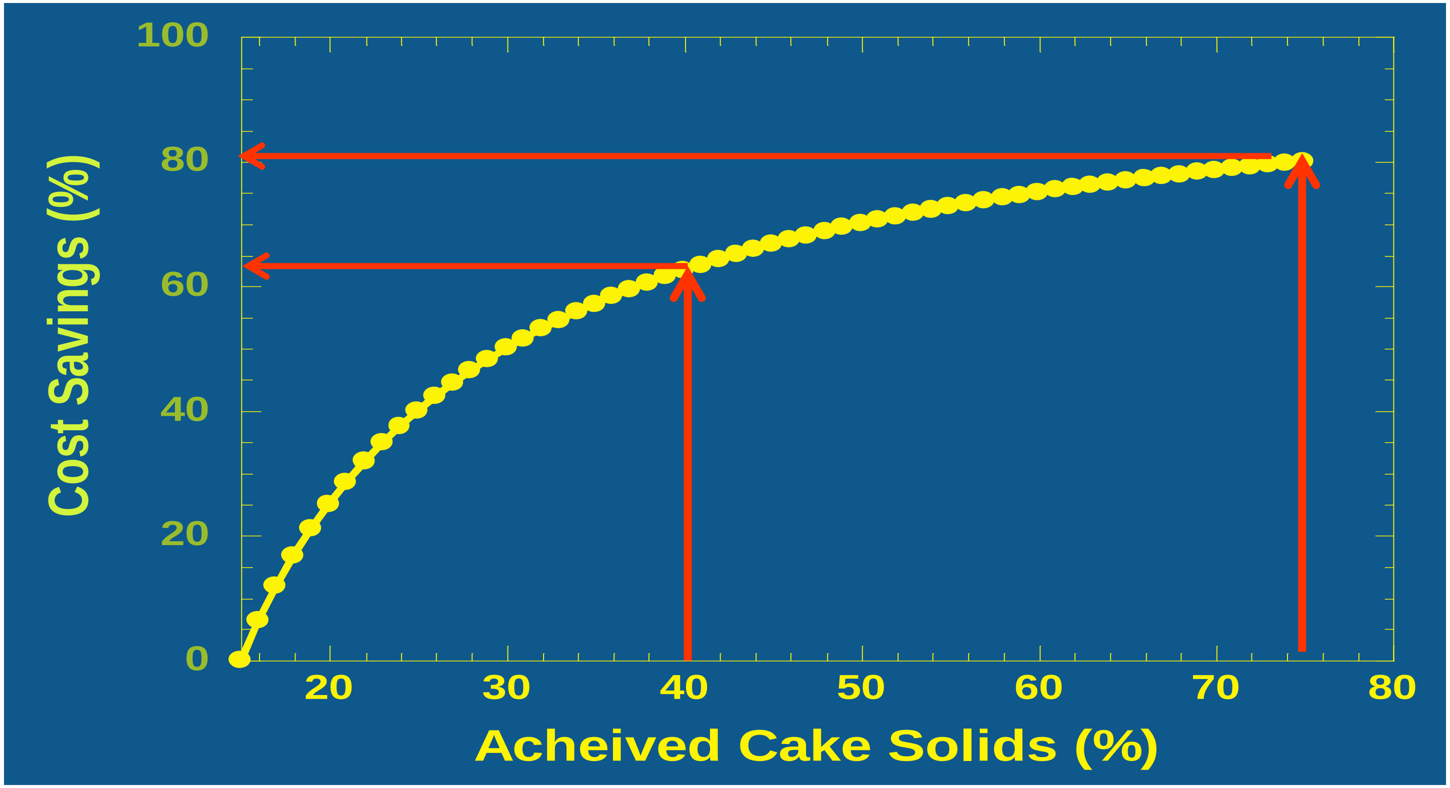
- Dewatering is a center piece in the biosolids processing
- Removal of water to reduce volume of sludge to be hauled away and reused
- Mechanical dewatering achieves 20-35% cake solids
- Requires chemical conditioning
- Mechanical dewatering devices

  Centrifuge, Belt Filter Press, Filter Press,

  Screw Press, Rotary Press, Bucher Press

  Electrodewatering

Cost savings from drier cake



Helps justify any investment in optimization or new machines

How to get a drier cake from my dewatering device?

How can I measure my device performance?

- **Cake dryness** – % solids in the cake
- **Polymer dose** – lbs of active polymer needed per dry tons processed
- **Capture rate or solids recovery** –

  Mass of solids in cake as compared to mass solids processed
- **Throughput**: lbs of solids processed per hr

Can sacrifice poly, capture and throughput for cake dryness, but at what cost?

Remember, these are the ones you were promised when you purchased your device!

Why am I not getting drier cake as before?

- Dewatering Device
  - Is device well maintained?
  - Do I need to re-check device operating parameters?
- Sludge Characteristics
  - Did your sludge change?
- Conditioning
  - Do you have the right polymer for your solids and device?
  - Is it still the same polymer?
  - Did you introduce the polymer at the right location?

You think this is the most you can get out of your dewatering device, but not enough!

What to do?

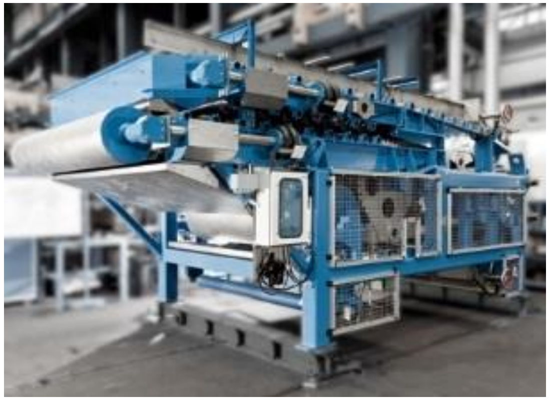
First – Dewatering device

- **Follow the maintenance schedule**
- **Re-adjust operational parameters: Run response tests at constant polymer and sludge feed**

Differential Speed

Torque

Pond Depth



Belt Tension

Belt Speed

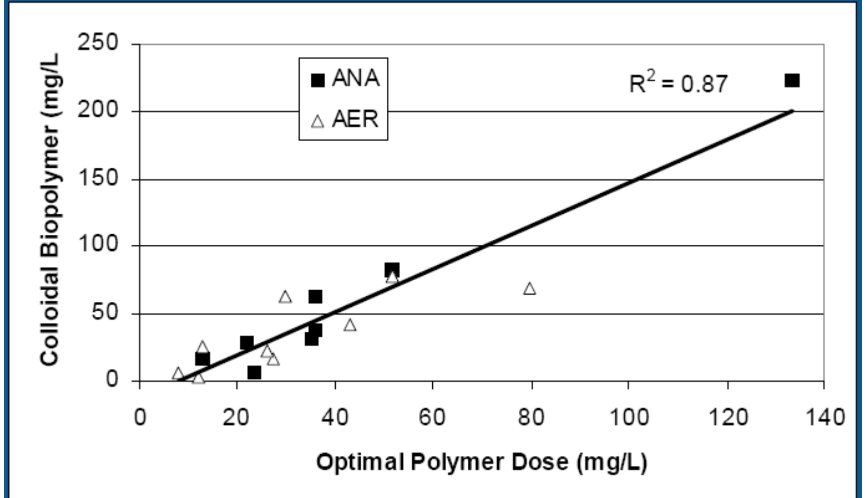
Belt Blinding

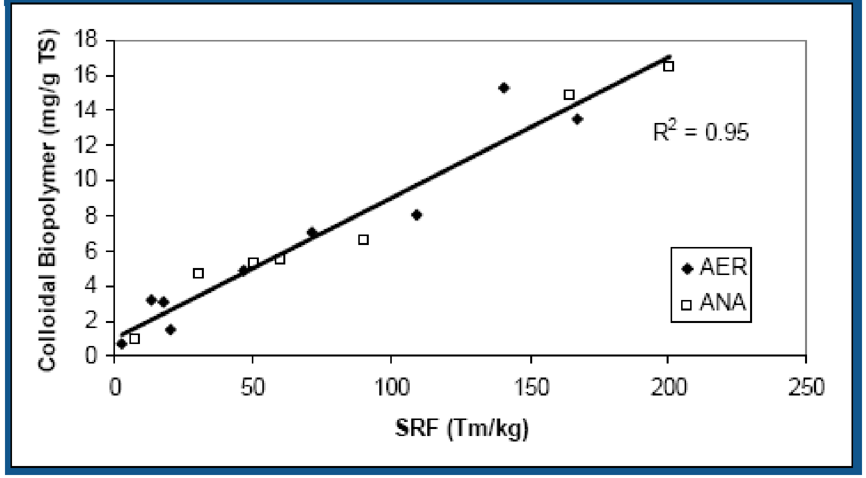
Belt replacement

Second – Did the sludge change on you?

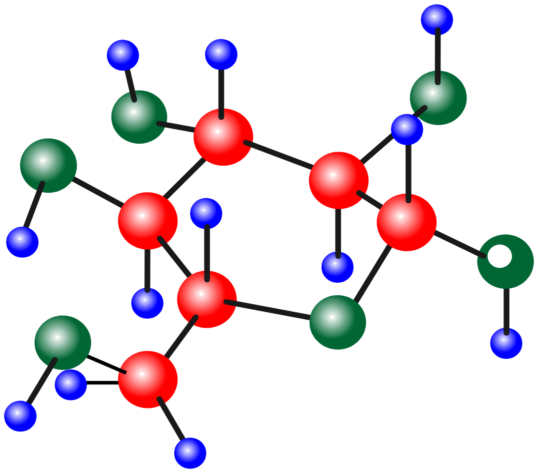
- Sludge floc structure and content is affected by upstream processes: primaries, WAS, digestion, thickening
- Main parameter affecting dewatering is colloidal biopolymer content
- Colloidal biopolymer correlates to soluble COD
- Routinely measure sCOD in sludge/biosolids

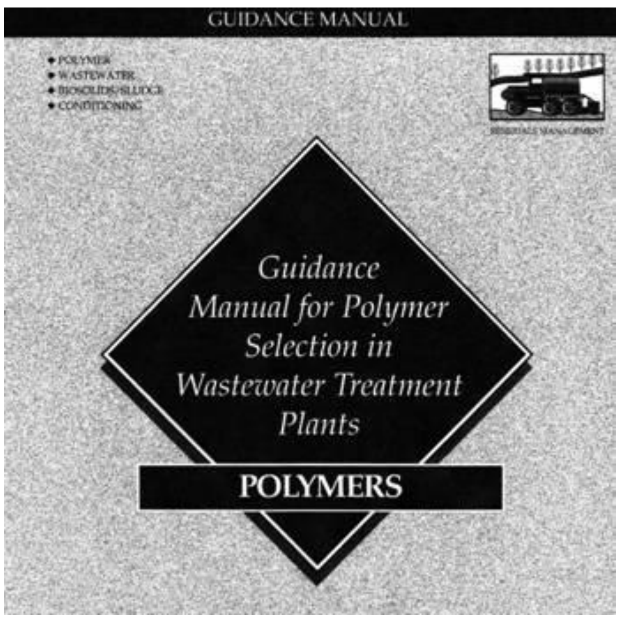
(Novak, Abu-Orf, Park, J RS&T, **Vol 1. 2004**)





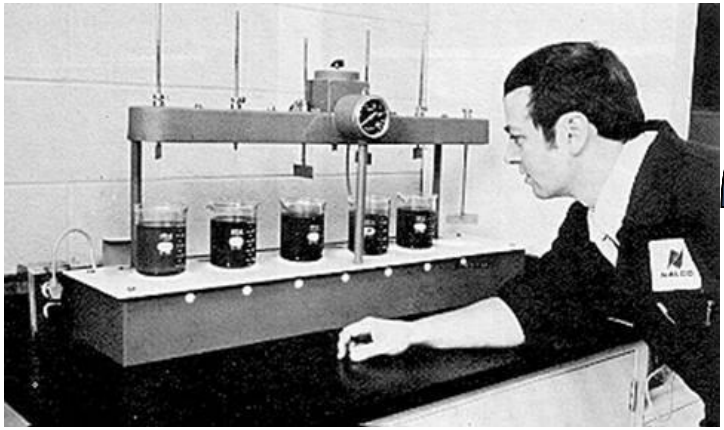
Third – Polymer conditioning





- If sludge changed for some reason: Do I have the right polymer?
- Polymer considerations:
  - Dry vs. liquid vs. emulsion
  - Charge meq/g
  - Linear vs. branched vs. structured
  - How strong is the floc when subjected to shear?
- If sludge didn't change and my device is well maintained, is my polymer vendor giving me the same polymer?

Jar test for polymer testing



- Used to measure water release rates from conditioned sludges
- Used to optimized polymer conditioning:

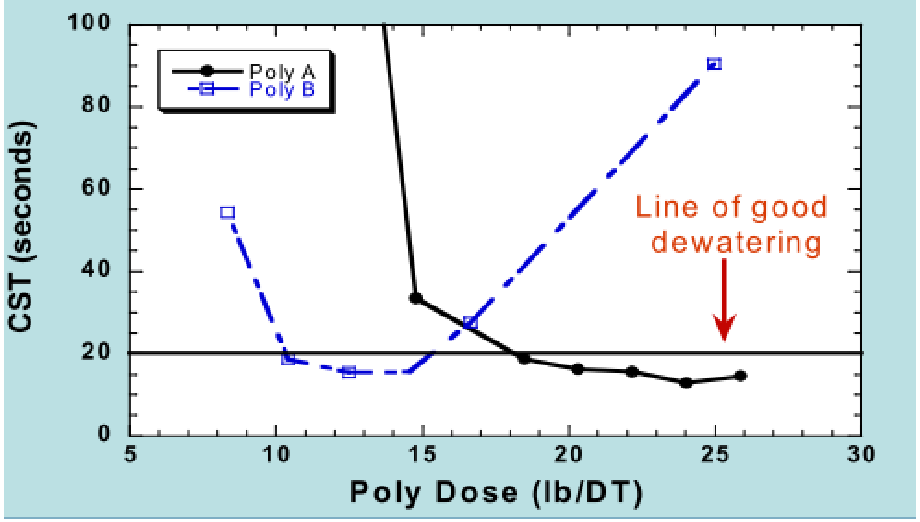
  Polymer type, dose

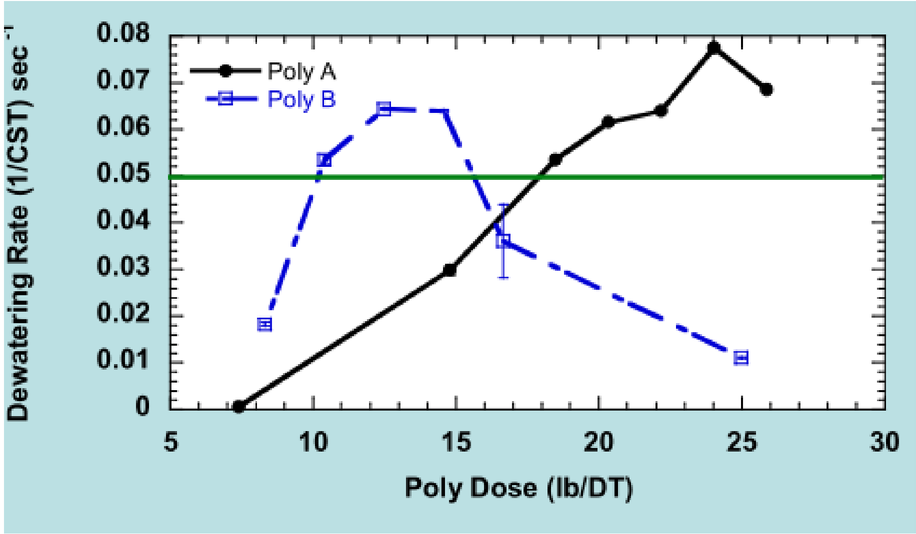
  Mixing time

  Mixing energy
- Recommend once a week

CST Apparatus

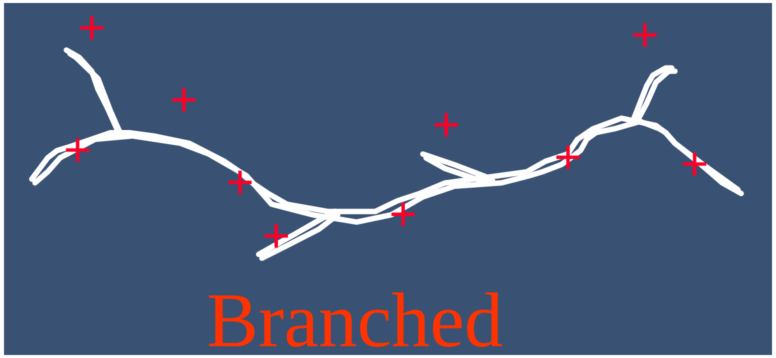
Example CST results

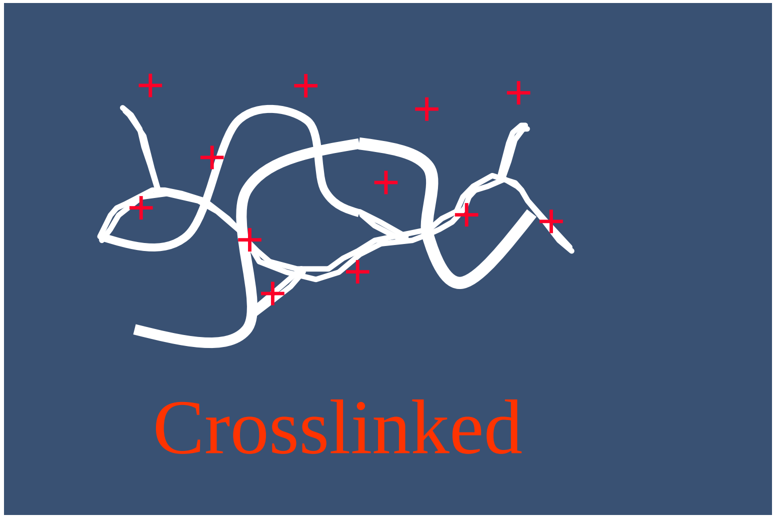


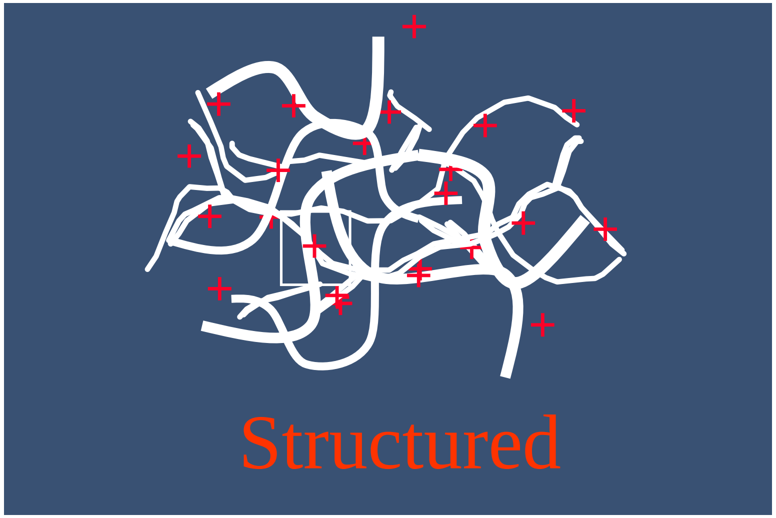


- Values below 20 seconds, indicate good conditioning and dewatering
- Minimum values correlates with optimum polymer dose
- 1/cst (sec^{-1}) defines dewatering rate

Polymer structure IS important

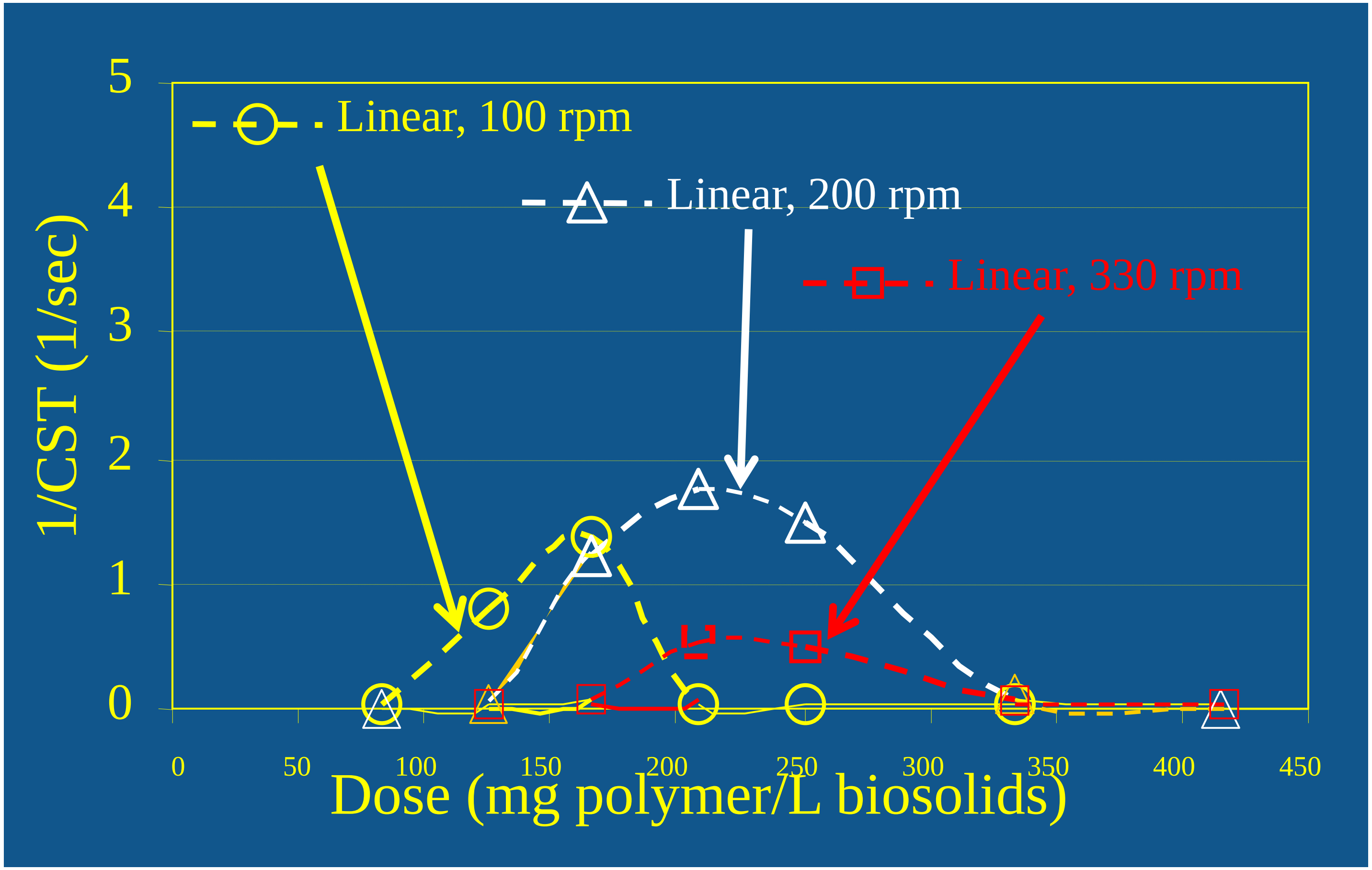






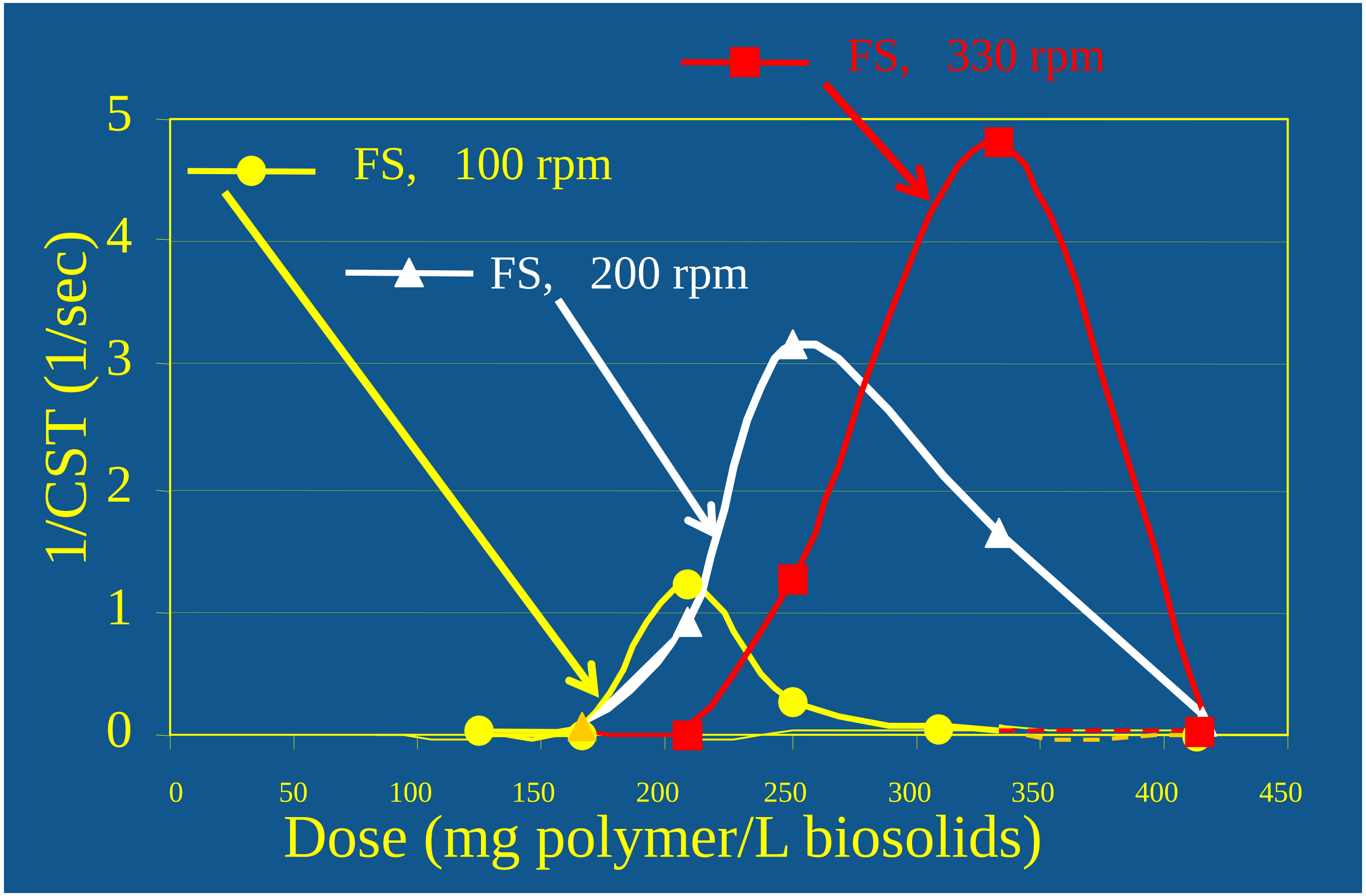
A structured polymer can improve sludge dewatering properties if sludge is easily deformable

Conditioning with linear polymer under shear, Dentel et al. (2000)



Linear polymer worsens dewatering with high shear

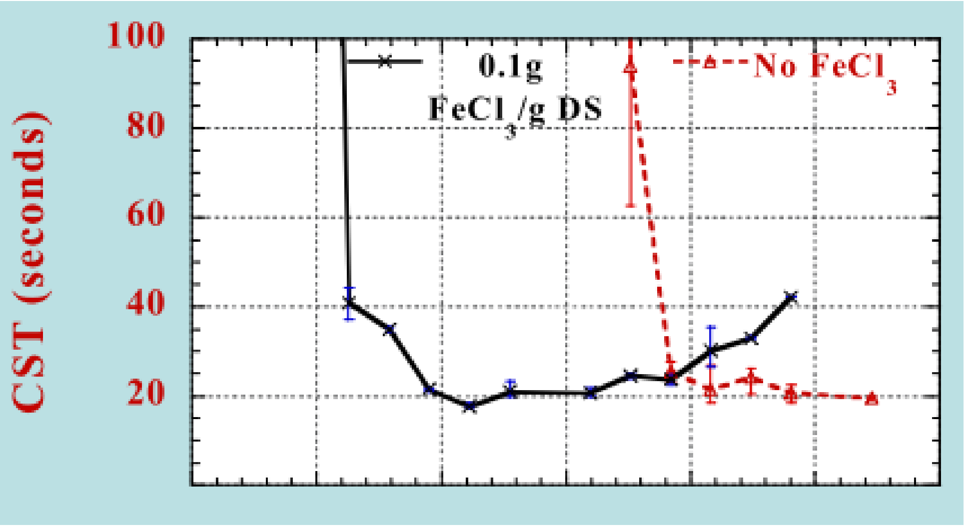
Conditioning with cross linked polymer under shear, Dentel et al. (2000)



Cross-linking improved dewatering, especially for high shear

BUT, MORE POLYMER IS NEEDED

Combine ferric and polymeric conditioners



- Not new, but now makes better sense
- Cuts poly costs
- Can be more effective than either product alone
- However, increased mass to be disposed
- Ferric chloride handling issues

Full-scale dose response testing

1. Stabilize the device at higher polymer dose
2. Collect the following samples
   * centrate and cake TS,
   * conditioned sludge for CST,
   * raw sludge and polymer for TS
3. Reduce polymer feed rate and allow to stabilize
4. Repeat from (2) until done
5. Obtain optimum operating conditions:
   * Is my polymer still good?
   * Polymer dose
   * Percent recovery and cake solids

May want to test different locations of polymer addition!

Recommend run test at least once a month

Polymer QA/QC

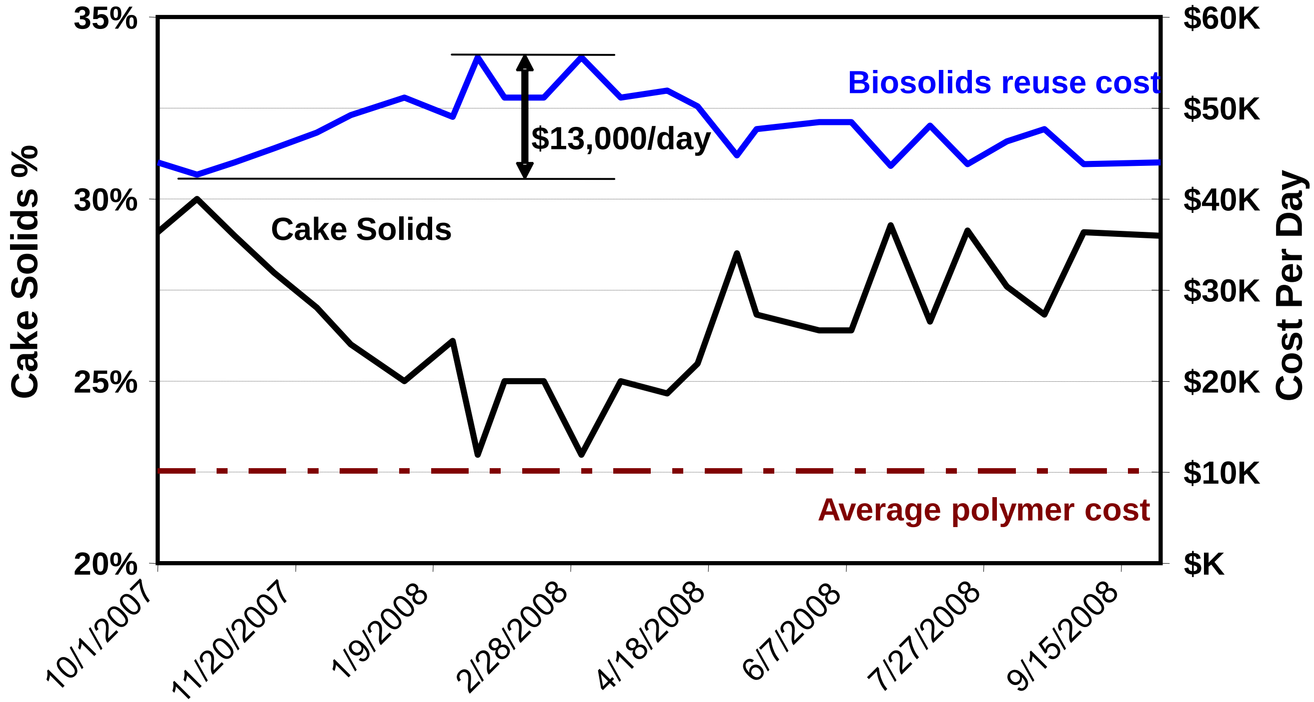
**IS YOUR PLANT RECEIVING THE SAME PRODUCT
IN DIFFERENT POLYMER BATCHES?**

Abu-Orf, Mohammad[1]; Tepe-Sencayir, Nalan[1]; Dentel, Steven K.[2]; Mahmudov, Rovshan[2];
Tesfaye, Aklile[3]; Smith, Wendell[3]
[1] AECOM, 1700 Market Street, Suite 1700, Philadelphia, PA 19103
[2] University of Delaware
[3] District of Columbia Water and Sewer Authority

ABSTRACT

The overall cost of wastewater solids management is highly dependent on the use of an effective conditioning polymer. However, it can be difficult to quantify or monitor the quality of these complex chemical products. This paper describes methods for polymer characterization and identification that are suitable for use in analytical laboratories at relatively large treatment facilities. Physical-chemical tests include active polymer content, charge density, ionic regain, viscosity, and polymer "fingerprinting" by Fourier Transform Infrared (FTIR) spectrometry. These procedures were developed for the District of Columbia Water and Sewer Authority in order to quantify the characteristics of different polymer batches and assure that the polymer being delivered has the same characteristics as the product originally proffered. A procedures manual was developed to be generally usable in any treatment facility with a well equipped lab. Equipment costs, presented in the paper, should be compensated by process savings at moderately large treatment plants.

Cake solids affect costs for treatment plants



Can this variation be attributed to changes in polymer?

Blue Plains spends ~ $3.65 M on polymer annually

Good conditioning is crucial

- Chemical conditioning is critical to effective dewatering
- Decreased cake solids has a big cost impact
- Polymer quality makes a big difference
- *BUT polymer bid documents generally do not include quality control specifications!!*

Variations can exist in different polymer batches

CHARACTERISTIC/ METHOD USED	RESULT Batch A	RESULT Batch B	RESULT Batch C
Total Solids Content: **Solution Dry Weight**	100 %	93.4 %	93.2 %
Inorganic Content: **Ash in 700°C furnace**	11.6%	4.0%	9.0%
Charge: **Colloid Titration**	4.65 meq/g	3.24 meq/g	4.41 meq/g
Molecular Weight: **Single Point Intrinsic Viscosity**	10.4 dl/g	12.0 dl/g	8.0 dl/g

Cannot even compare these to the polymer characteristics in your bid documents or MSDS!

Logical steps

Develop and implement analytical methods for testing

Build these specifications into polymer bid documents

Requirements for the analytical methods …

Should be relatively easy to perform because they should be done regularly

Must be reliable because the results may be contentious

Should quantify the polymer properties that lead to good conditioning

What are the properties of a good polymer that will make the conditioning process work effectively and reliably?

Product purity

Chemical (monomer) structure

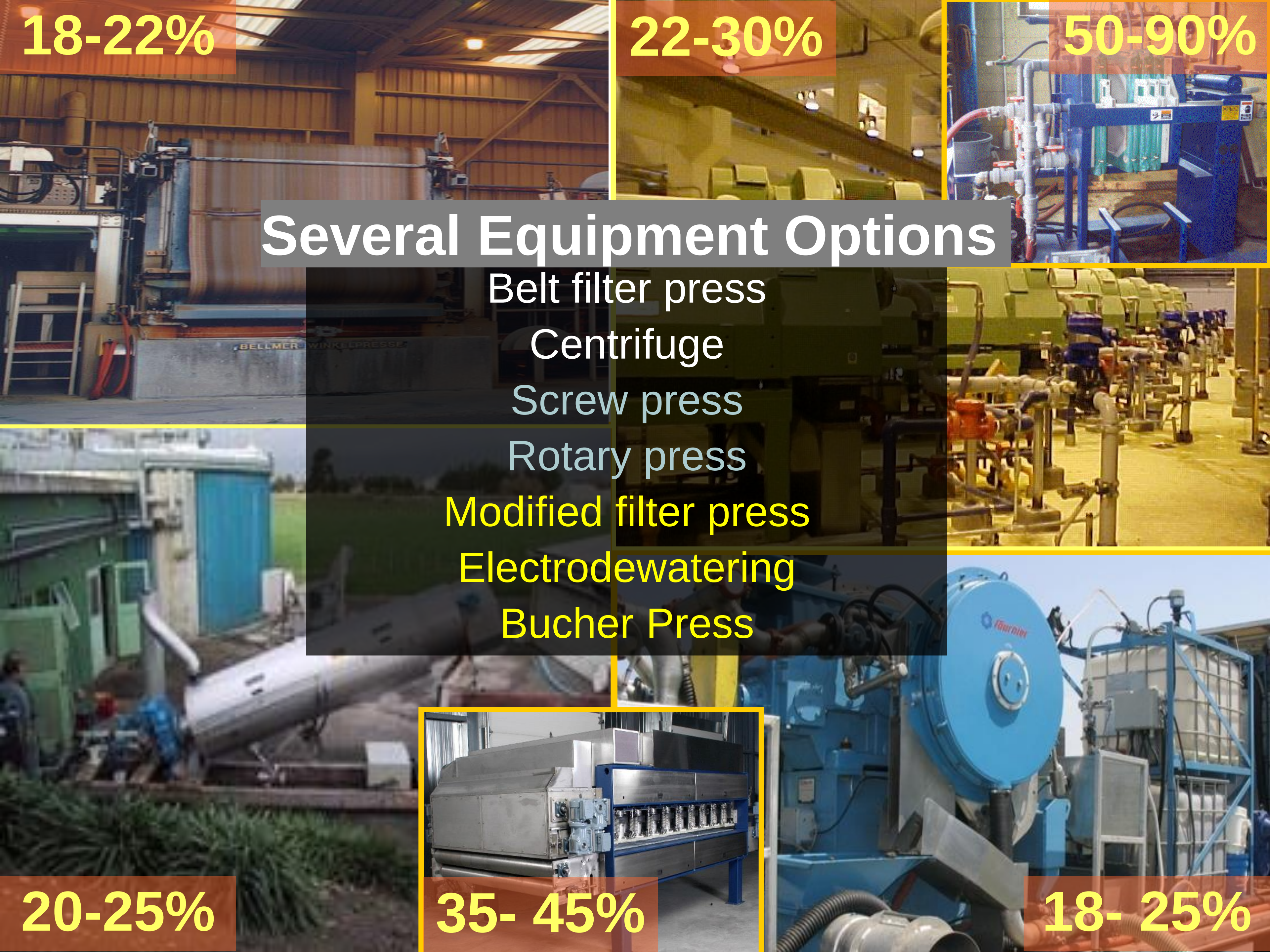
Positive charge (charge density)

Molecular weight

Chain structure

You think this is the most you can get out of your dewatering device, but not enough!

WHAT TO DO?


18-22%
22-30%
50-90%
Several Equipment Options
Belt filter press
Centrifuge
Screw press
Rotary press
Modified filter press
Electrodewatering
Bucher Press
20-25%
35- 45%
18- 25%

If you need to chose a new device

Recommend conducting side-by-side pilot testing

	SWPCF		CWPCF		NWPCF	
Parameter	BFP	Centrifuge	BFP	Centrifuge	BFP	Centrifuge
% Cake TS	23.8	26.1	22.1	22.4	25.3	25.9
Poly Dose (lb active/DS)	15.8	26.7	30.9	33.7	30.4	34.3
% Solids Recovery	97.7	98.2	97.4	98.8	98.2	98.7
Amp Draw	15.4	31.6	13.4	31.9	16.8	30.2
Throughput (lb/hr)*	574.7	323.8	672.1	360.1	776.0	455.1

SWPCF, when use 25 lb/DT poly dose, achieved about 25% (closer to centrifuge results)

Poly dose and cake are site specific

BioP Practice and Dewatering Impacts

BioP and dewatering impacts

~ 4pts decrease of cake solids

Mainly due to PO4-P

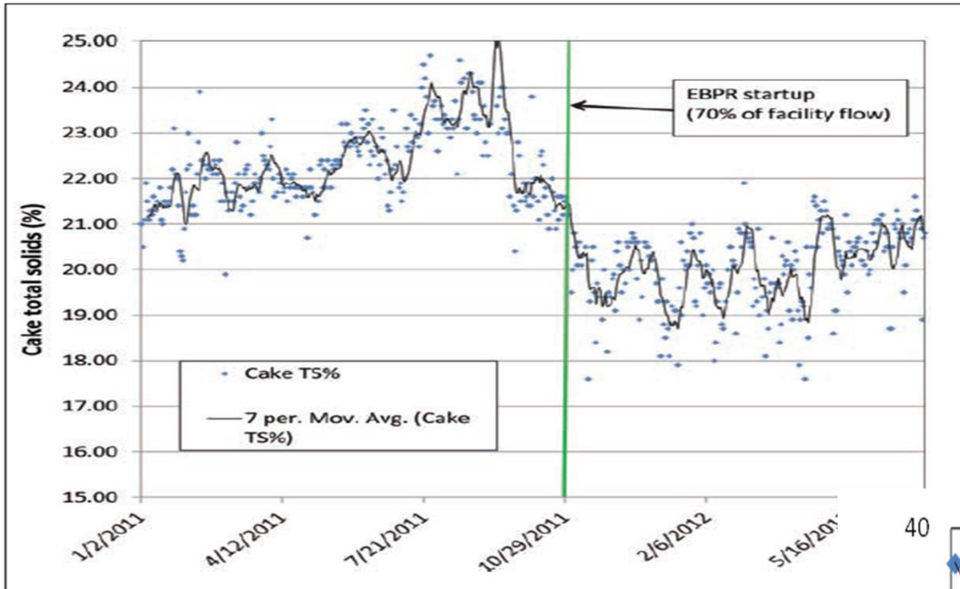
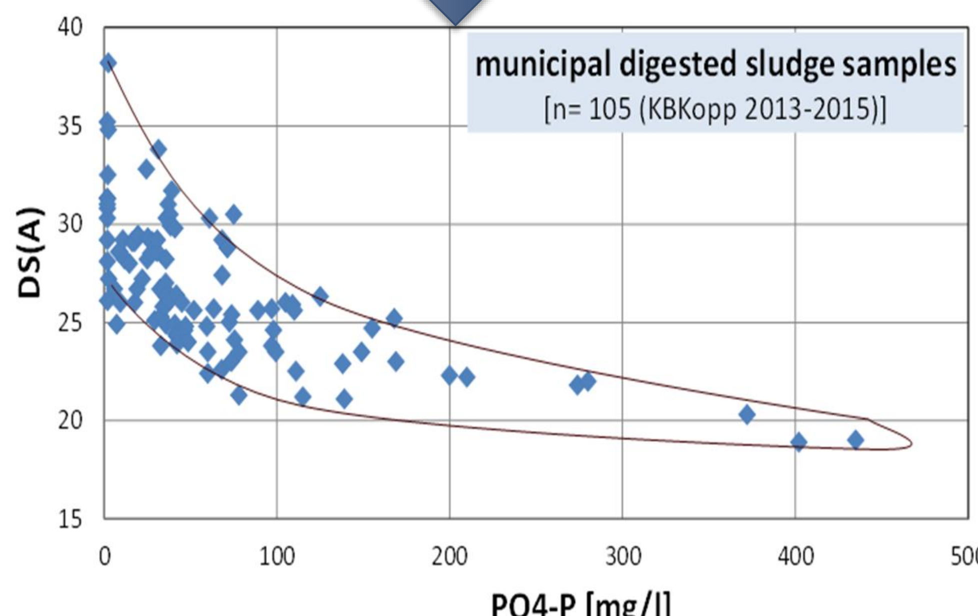


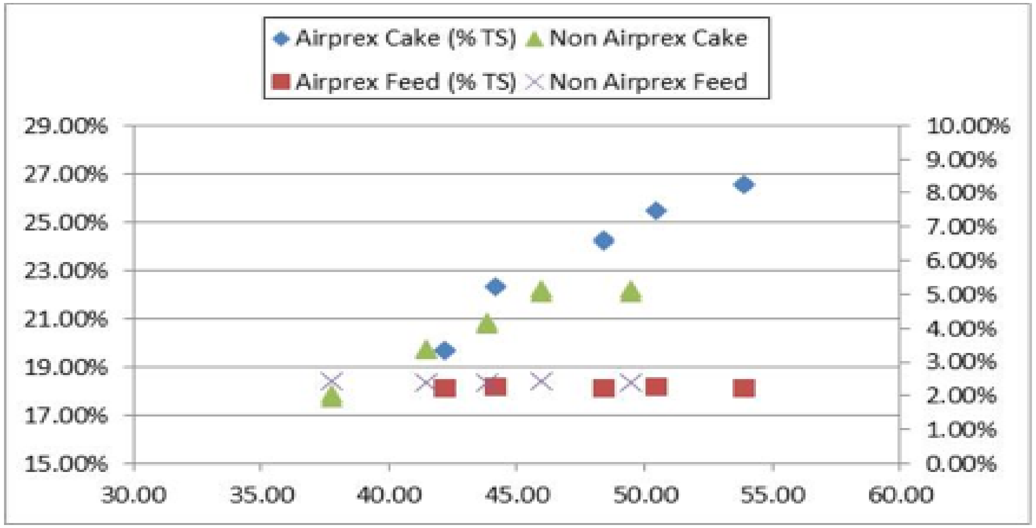
Figure from Cavanaugh, L., K. Carson, C. Lynch, H. Phillips, J. Barnard, and J. McQu
(2012). "A Small Footprint Approach for Enhanced Biological Phosphorus: Remov
Results from a 95 MGD Full-Scale Demonstration," WEFTEC 2012 Proceedings (O



(Kopp, 2016)

Recover dewaterability by removal of PO_4

AirPrex Piloting at SDWWTP, Miami Dade, March 2016



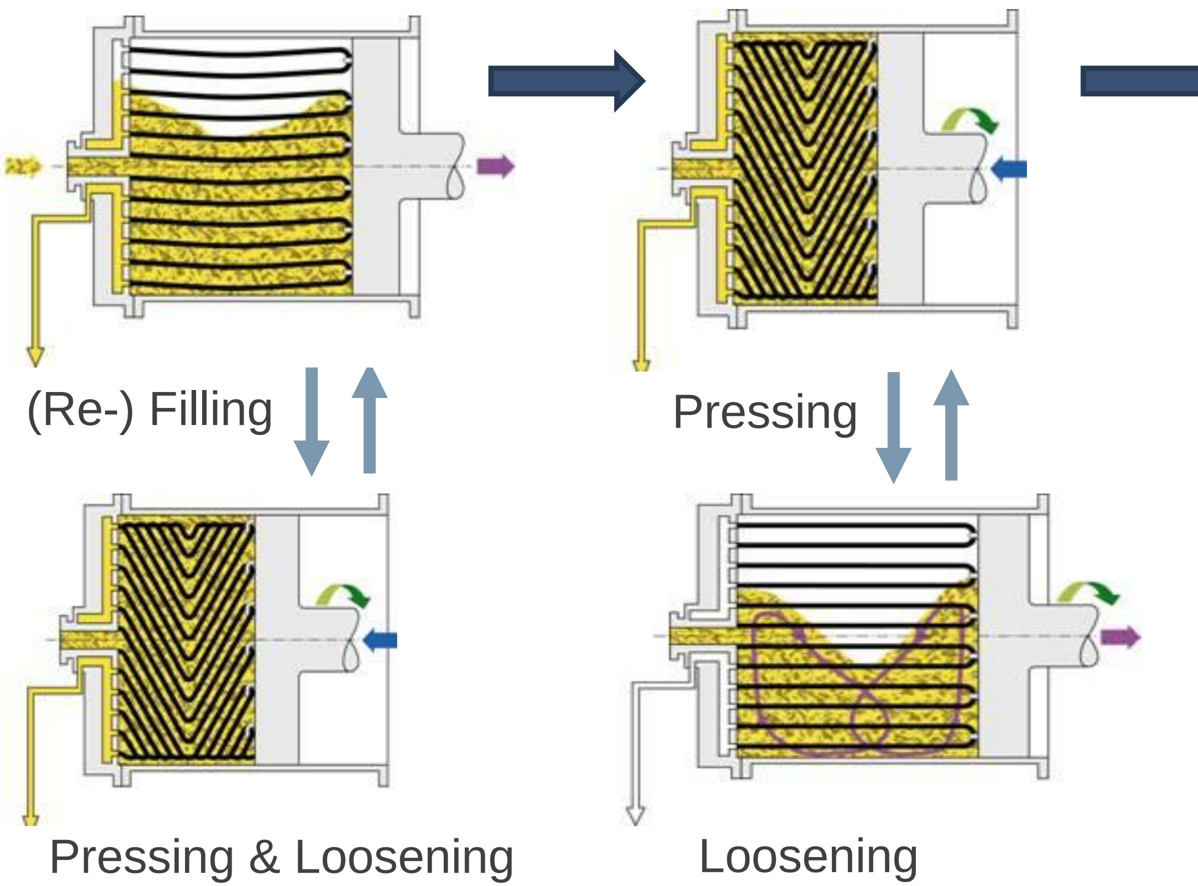
- Precipitation and/or recovery of struvite from biosolids enhanced dewatering performance
- Working with Metro Water Reclamation District to further understand and pilot
- WE&RF research project (Matt Higgins, Bucknell) is looking to shed more light

Innovations in Dewatering and Conditioning

Dehydris™ Twist / Bucher Press, SLG®, Orege

The Bucher Press working principle

Increase in cake dryness as compared to conventional mechanical dewatering devices

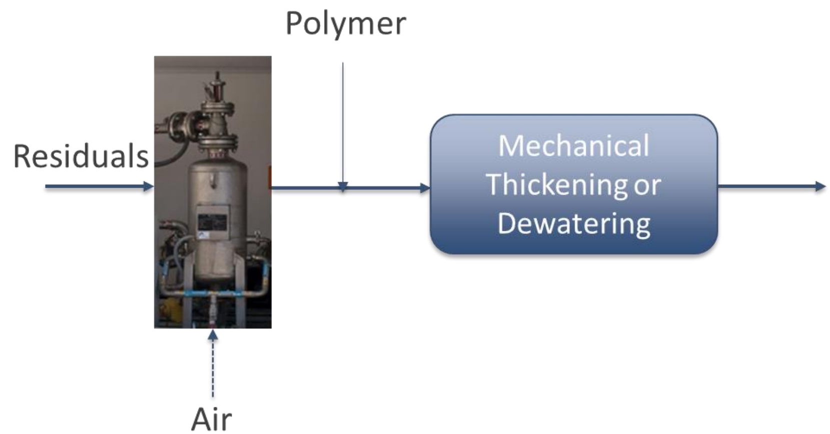


Bucher Press, Suez

- Technology from fruit pressing industry
- High capital
- ~ cake solids by up to 5 pts
- In UK recently practiced on THP, ~ 40% DS
- 15 to 18 kg/TDS polymer
- Serious consideration when hauling and use tipping fees are high

SLG Process, Orege France

- Adds pressurized air to the sludge line in vessel prior to polymer addition
- Proposed theory on conditioning mechanism:
  - Air bubbles get enmeshed in the sludge floc
  - Less dense flocs
  - Under compression, air bubbles collapse leaving behind passages/cracks that allow water to be easily squeezed out
  - Technology is expected to work better for BFP type technologies as compared to centrifuges

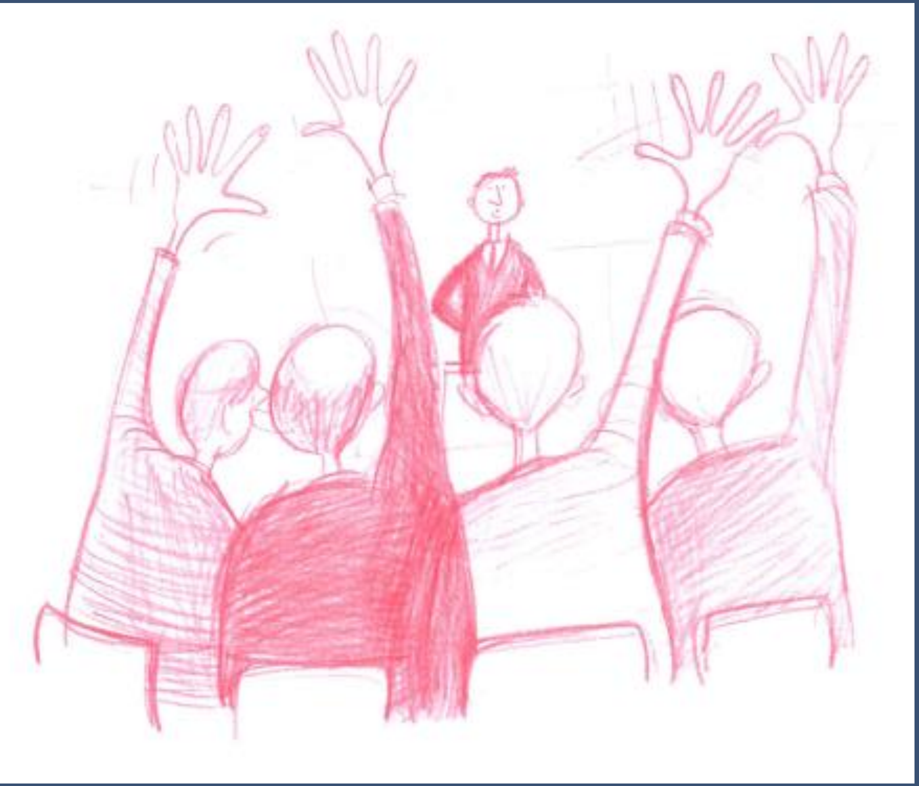


First USA installation: Lehigh County WWTP, PA

- 7 MGD, Anaerobic digestion
- 3 BFP
- Demonstrate to purchase agreement
- Side by side
- ~2 yrs payback
- Demonstration at Welsh Water and University of South Wales

	Control BFP	SLG/BFP	Improvement
Cake Dryness	15%	18-18.5%	20-30%
Polymer Usage (lb/dt)	60	45	25%
% solids recovery	98%	≥ 98%	Same or better

Thank You!



Q&A