Making Dewatering Work

Selecting The Right Chemical For Your Sludge

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SNF (UK) LIMITED

Selecting The Right Chemical For Your Sludge

- Range of polymers available
- Coagulation – Flocculation
- Factors affecting polymer choice
- Test procedures

SNF (UK) Ltd – Key Facts

- Based in Normanton, Junction 31 of the M62
- £32M turnover
- Facilities include;
  - Offices
  - Applications laboratories
  - Engineering workshops
  - Blending plant
  - Warehousing
- 41 employees;
  - 4 Business Managers
  - 8 Technical Field Based staff
  - 10 Engineering staff
  - 4 Warehouse and Distribution staff

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Range of Polymers Available

(This is what we've got)

Commercial forms of flocculants

- **Several commercial forms exist and they come from different methods of polymerization:**
- **The main two forms being powders and emulsion**

- **Powders: the monomers are polymerized in a gel form. The gel obtained is then ground and dried.**
  - **The main advantage of powders is the 100% active matter.**
- **Emulsions: the monomers are emulsified in a solvent and then polymerized. At the end of polymerization, a surfactant is added. It will make the emulsion dilutable in water.**
  - **The main advantages of these products are their liquid form (easy to use) and an increased efficiency on certain applications.**

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Range of Polymers Available

- Organic flocculants are characterised by four main parameters:
  - Charge – anionic, non-ionic, cationic
  - Charge density - % of – or + charge
  - The molecular weight
  - The molecular structure

Range of Polymers Available

- Charge

- **Powders:**
  - Cationic
  - Non-ionic/Anionic
  - Amphoteric
- **Emulsions:**
  - Cationic
  - Non-Ionic/Anionic

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Range of Polymers Available

- **Cationic Powders and Emulsions**
  - Low cationic – 0.75-5%
  - Medium cationic – 10-25%
  - High cationic – 30-45%
  - Very high cationic – 50-100%

- **Amphoteric Powders**

Range of Polymers Available

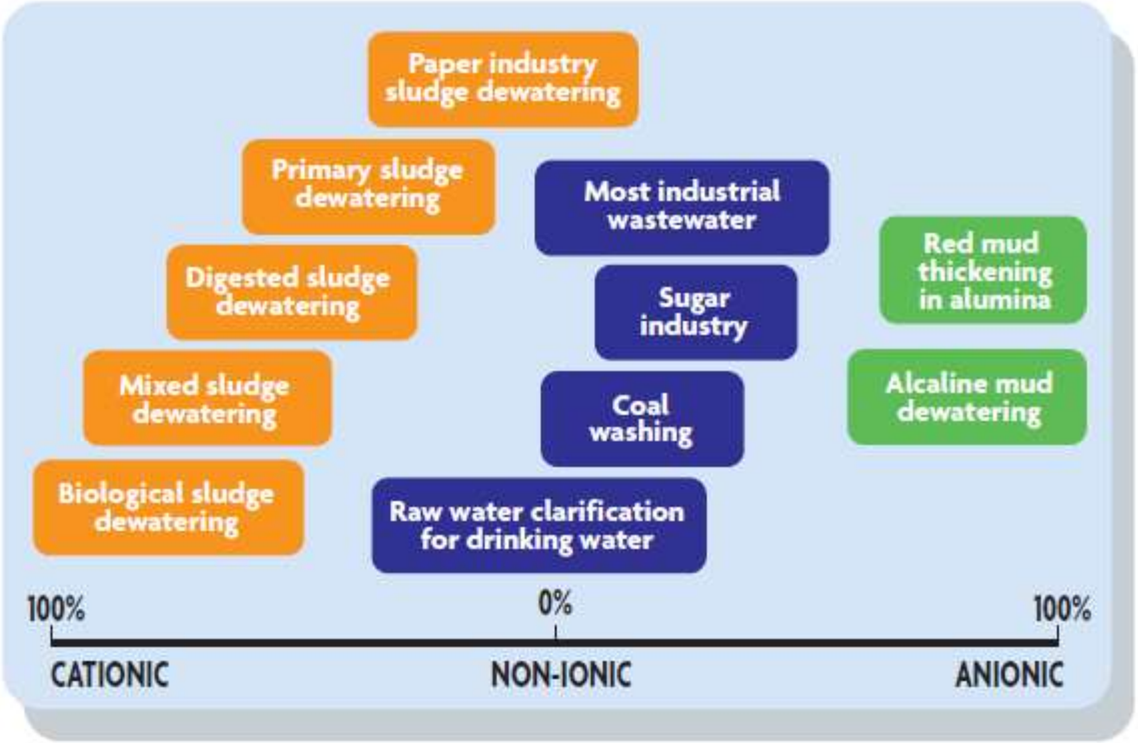
- Non-ionic/Anionic Powders and Emulsions
  - Non-ionic – 0%
  - Low anionic – 5-10%
  - Medium anionic – 13-40%
  - High anionic – 50-80%
  - Very high anionic – 90-100%

Range of Polymers Available

- **The charge density (%)**
  - The charge density represents the quantity of + or – charge necessary to obtain the best flocculation at the lowest dosage

But only a laboratory test can really determine which charge is best adapted

The Charge Density



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Range of Polymers Available

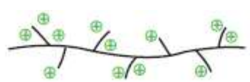
- **The molecular weight (MW)**
  - **The length of the polymer chain**
  - **2,000,000 to 20,000,000 dalton**

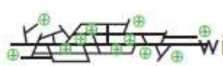
- **Range of molecular weights**
  - **Low – 2,000,000 dalton**
  - **Standard – 4,000,000 dalton**
  - **Medium/high – 6,000,000 dalton**
  - **Very high – 8,000,000 dalton**
  - **Ultra high – 12,000,000 dalton**

Range of Polymers Available

- **The molecular structure of the flocculent depends on the dewatering performance required. For cationic flocculants there are:**

● Linear structures:  with low dosage and good performance when the correct molecular weight is chosen.

● Branched structures:  with medium dosage and excellent drainage performance.

● Cross-linked structures:  with high dosage and exceptional drainage performance and shear resistance.

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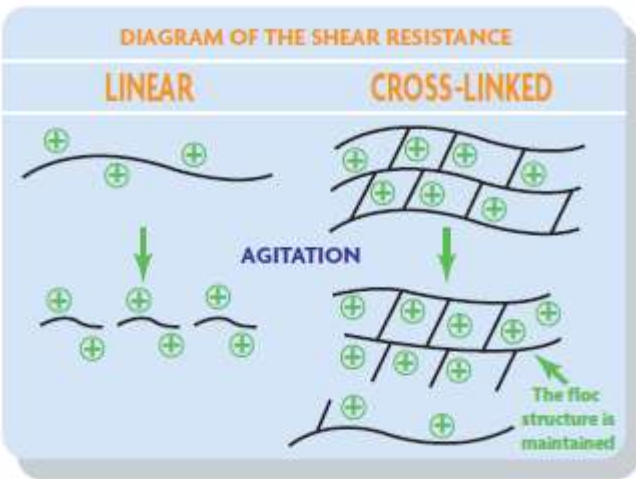
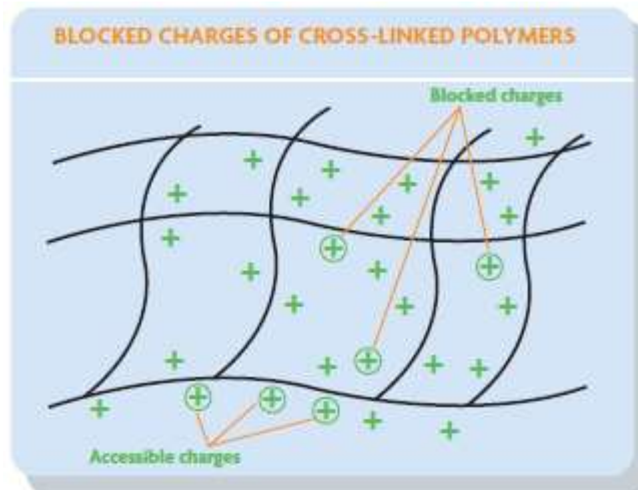
Range of Polymers Available





LINEAR OR CROSS-LINKED STRUCTURE ?

LINEAR	CROSS-LINKED
ADVANTAGES	
• Low dosage • Large range of MW	• Very strong flocs • Excellent drainage • Higher cake dryness
DRAWBACKS	
• Low strenght of the flocs • Possibility of overdosing	• High dosage

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Coagulation and Flocculation

(This is what we want it to do)

Coagulation and Flocculation

Settling times for various particles (according to Stokes' law).

Particle diameter		Type of particle	Settling time through 1 m of water
mm	µm		
10	10^4	Gravel	1 second
1	10^3	Sand	10 seconds
10^{-1}	10^2	Fine sand	2 minutes
10^{-2}	10	Clay	2 hours
10^{-3}	1	Bacteria	8 hours
10^{-4}	10^{-1}	Colloid	2 years
10^{-5}	10^{-2}	Colloid	20 years
10^{-6}	10^{-3}	Colloid	200 years

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Coagulation and Flocculation

- Colloids are insoluble particles suspended in water. Their small size (less than 1 micron) makes the particles extremely stable. They can have different origins:
- Mineral: silt, clay, silica, hydroxides and metallic salts
- Organic: humic and fulvic acids, color, surfactants
- Micro-organisms such as bacteria, plankton, algae, viruses are also considered as colloids.

Coagulation and Flocculation

COAGULATION

Inorganic and / or organic coagulant →

Contaminated water
↓
Chemical precipitation
↓
Destabilisation
↓
Flocs formation

FLOCCULATION

Flocculant →
↓
Agglomeration
↓
Solids / Water separation → Cleaned water

Flocculant →
↓
→ Cake

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Coagulation and Flocculation

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Factors Affecting Polymer Choice

(These are the things that can ‘stop it from working’)

Factors Affecting Polymer Choice

- Sludge
- Dewatering equipment
- Polymer/Sludge mixing
- Polymer preparation and dosing equipment
- Customer

Factors Affecting Polymer Choice

- **Parameters that influence the dewatering abilities of sludge**
  - The concentration (thickness) of the sludge
  - The organic matter content
  - The colloidal nature of the sludge

Factors Affecting Polymer Choice

- **The concentration (thickness) of the sludge will influence:**

  - the incorporation of the flocculent. The higher the concentration of the sludge, the harder it is to mix in a viscous solution of flocculent. Solutions to this problem are: post dilution of the flocculent, injecting the flocculent upstream, multiple injection points of the flocculent, use of an in-line mixer.

Factors Affecting Polymer Choice

- **The organic matter content (%):**

  - the organic matter content is comparable to the Volatile Solids content (VS).

  The higher the VS, the more difficult the dewatering. The dryness achieved will be lower, and the flocculent consumption (dosage) will be high

Factors Affecting Polymer Choice

- **The colloidal nature of the sludge:**

  - this characteristic has a very important effect on dewatering performance.

  The higher the colloidal nature, the more difficult it is to dewater.

  Four factors will affect the colloidal nature of the sludge:

Factors Affecting Polymer Choice

- **The colloidal nature of the sludge:**

  1. The origin of the sludge:

  2. The freshness of the sludge: the colloidal nature of the sludge will increase with its level of fermentation (septic sludge).

  3. The origin of the wastewater: a dairy or brewery origin will increase the colloidal nature of the sludge.

  4. The sludge return: a badly controlled return of sludge will increase its colloidal nature.

Factors Affecting Polymer Choice

Primary sludge:

Has a low level of Volatile Solids content (VS around 55% to 60%) and its dewatering ability is excellent.
A drawback is that this sludge ferments very easily.

Biological sludge:

Has a high VS content: VS around 70% to 80%.
The dewatering ability is medium. It depends partially on the VS. The higher the VS the harder it is to extract the water from the sludge.

Digested sludge:

A lower VS content: VS around 50% - but a higher colloidal nature than primary sludge.
A good dewatering ability.

Post-THP sludge:

A very low VS content: VS around 40% to 50%.
Potential for excellent dewatering ability – cake solids of 30 – 40% - ***BUT*** **mixing is critical!!!**

Approximate Polymer Dosages by Sludge Type by Equipment Type

	Dose	GBT	Drum	Press	Centrifuge
Sludge Type					
SAS	kg/tds ppm	3 - 6 20 - 50	5 – 7 35 - 55	n/a	n/a
Primary	kg/tds ppm	2 – 5 20 - 100	3 – 7 150 - 200	2 – 7 150 - 250	6 – 12 180 – 400
Digested	kg/tds ppm	n/a	n/a	4 – 8 140 - 250	7 – 15 200 - 500

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Polymer recommendations by Sludge Type by Equipment Type

	GBT	Drum	Press	Centrifuge
SAS	High charge, structured, high MW	High charged and structured.	n/a	n/a
Primary Sludge	Medium charged, std to high MW	Medium charged and std MW	Medium charged, low – std MW.	Medium charged and high to very high MW.
Digested	n/a	n/a	Medium – high charged, low to std MW	Medium to high charged, high to very high MW, sometimes structured
CAMBI	n/a	n/a	Typically medium charge, Low MW (Mixing is critical!)	Can vary in terms of charge requirement and MW

Factors Affecting Polymer Choice

Polymer preparation and dosing

- **Powder/Emulsion**

  - cost vs. performance

- **Polymer concentration**

  - size of make-up/dosing equipment

- **Customer preference**

  - asset standard

Test Procedures

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Test Procedures

Selection

It is extremely difficult to reproduce in the laboratory actual plant conditions

- Charge
- Molecular weight

Objective

- To select at least two polymers to trial on machine

Test Procedures

Lab Centrifuge

High Speed
Shearer

Jar Tester

Selecting Right Chemical For Your Sludge

- What does ‘selecting the right chemical for your sludge’ mean?

- What happens when we have the right polymer but still not the desired performance on site?

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The use of an in-line mixer when dewatering a post-THP (CAMBI) sludge – case study

– Background

- Configuration
  - Cardiff STW has an advanced digestion plant, commissioned in 2011
  - Post-THP sludge (high solids >5%) is processed via 4x STI belt presses
  - Cake exported from site to land

- Polymer treatment
  - Initially polymer was injected into the sludge line 3-4m before the belt press flocculator tank (fitted with a fixed speed stirrer).
  - The flocculator tank provided 3-4 minutes residence time.

Issues

- Following commissioning it became apparent that there was insufficient energy to provide adequate sludge/polymer mixing via the original polymer injection/mixing arrangement.
- Improvements -

- Upgrade to multipoint injection ring and shear arm

- But the polymer dose remained high 16kg/tds with a limited throughput 12-13m^3/h vs expectations 10kg/tds & 18m3/h

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Initiatives

1. FloMix (prototype) with a single polymer addition point was installed after the static mixer. Trials determined that a 50/50 polymer dose split between the static and the mechanical mixer provide optimum result.
   - Throughtput increased by 30%
   - Polymer dosage reduced by 30%
   - Long term – reduced run times and press wear

2. After full commissionning on the 4 presses, polymer addition was upgraded using rotameters and 2 types of mixing
   - A single point in to the body of the mixer
   - A multipoint injection ring

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Benefits

Prototype on 1 press

Permanent installation on 4 presses

Conclusions

- **Throughputs in excess of 18m3/h (+28%)**
- **Polymer dose rate 9-10 kg/tds (-25-30%)**
- **Cake solids constantly above 26%**
- **ROI < 18 months**

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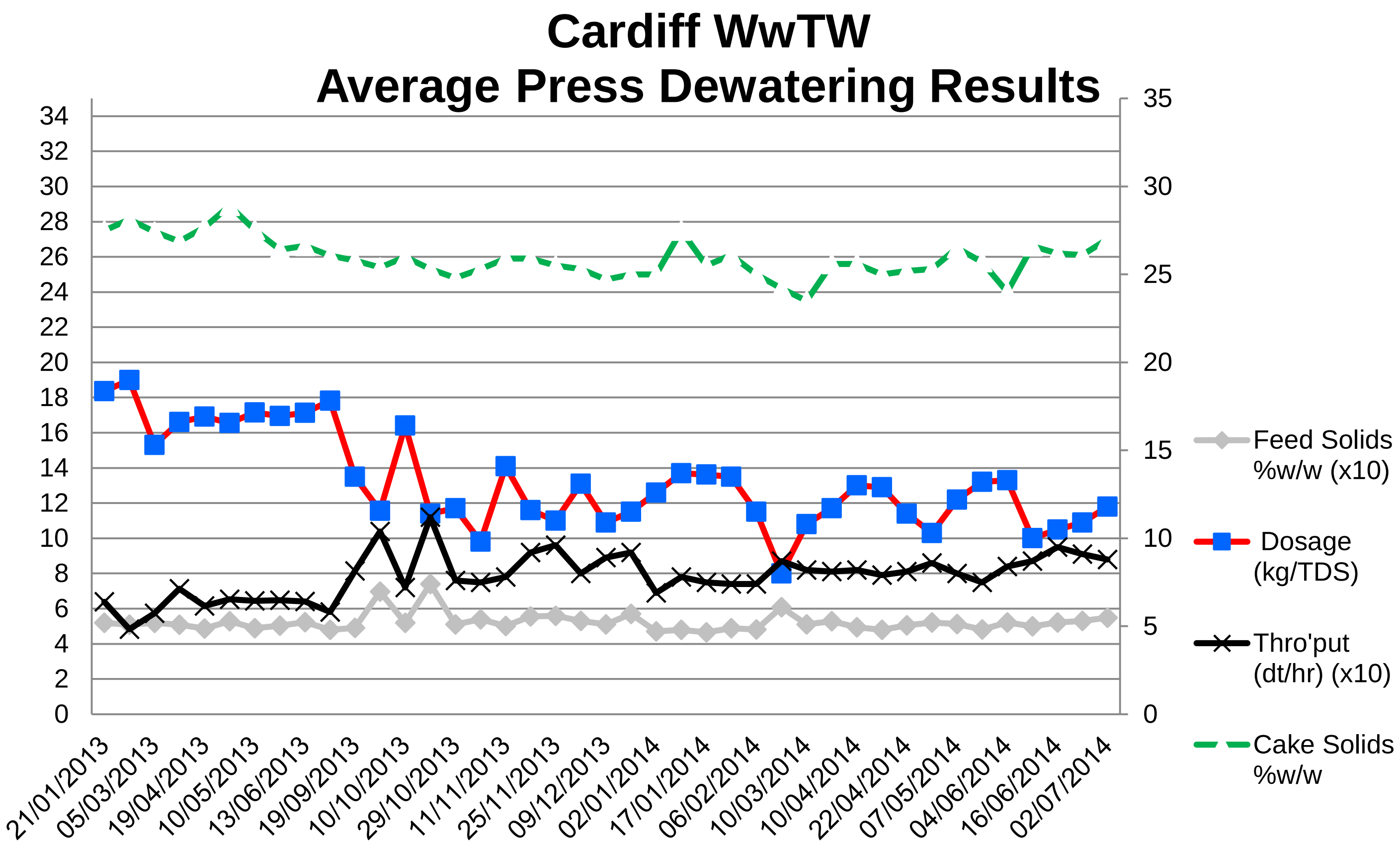

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Questions?