Removal of Heavy Metals from Sewage Sludge

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Why Sewage Sludge?

Global average consumption of:
- ~2750 kcal/person/day in 2005/2007
- >3000 kcal/person/day in 2050
- ~50% increase in consumption!

- Mostly phosphate rock
- Finite mineral
- Predicted reserves max 130 years

- ~80% NH₃, Haber-Bosch
- 1.1592 x 10¹³ MJ in 2013!

- 28% of the N
- 44% of the P
Heavy Metals

[1] Westerhoff et al. 2015
[2] Vriens et al., 2017
[4] Liu et al., 2010
Hydrometallurgy

- Weak acid leaching
- Stabilise metals at higher pH
- Cheap, waste materials

- No filtration
- Ion exchange is unknown in weak acid media
Ion Exchange

• Small, functionalised polymer beads

• Ion exchange kinetics are fast

• The effect of complexing materials (such as the weak acids) is not well understood with respect to IX material

• Working backwards approach
Resin Screening

Acetate

Lactate

Citrate

Cu

Fe

Pb

Zn

J. P. Bezzina, et al., Water Research, 2019
• High affinity for all metals, increasing with pH
• High affinity for Pb and Zn, increasing with pH

J. P. Bezzina, et al., Water Research, 2019
Leach the Metals from Sludge

- Lower acidity required to stabilise metals due to complexation
- Environmentally safe acids
- Less cost in the neutralisation of the effluent
- Leaching kinetics are slow
Acetic Acid Leaches

• Simulant sludge used for experiments
• Extremely fast leaching of zinc
• Slow leaching of lead and copper
• Oxidants or reductants can be added depending on speciation
Mineral Refinery Overview

**Leaching Process**
- Lixiviant
- Mineral
- Oxidant/Reductant

**Filtration**
- Subject to blinding with organic matter
- Leaves a dewatered sludge

**Ion Exchange**
- Metals stabilised on resin surface
- Generates the “clean” liquid

**Elution and Precipitation**
- For metal recovery
Resin-In-Pulp

- pH 1.0; 24 hours
- Ambient temperature
- 0.5 M acetic acid

- pH 4.5; 24 hours
- Ambient temperature
- 2:100 resin:slurry

![Diagram of resin-in-pulp process](image-url)
Thank you!