Improving metal extraction from MSWI fly ash through different experimental conditions for the electrodialytic treatment method

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Municipal solid waste incineration (MSWI) in Denmark

- In Denmark households and industry waste incinerated
- Reduces volume by 90 % and weight by 80 %
- Combined heat and power plant
- MSWI produces about 117.000 tons fly ash and 1.2 mio. tons bottom ash in Denmark

Hazardous fly ash for safe disposal in Norway

Non-hazardous bottom ash for construction works
Secondary resources

Raw fly ash

Treated fly ash as secondary resource

Salts and metals
Experimental samples

ARGO, Roskilde

ARC, Copenhagen
Aim of the study

It was investigated if metal extraction rates are influenced by improving experimental conditions, with focus on Cd, Cu, Cr, Pb, Sb, Ti and Zn
The electrodialytic treatment of a fly ash suspension

• Acidification at the anionexchange membrane (AN) is the basis for acidification of the material suspension

Cathode: \[ 4 \text{H}_2\text{O} + 4 \text{e}^- \rightarrow 2 \text{H}_2 (g) + 4 \text{OH}^- \text{(reduction)} \]

Anode: \[ 2 \text{H}_2\text{O} \rightarrow \text{O}_2 (g) + 4 \text{H}^+ + 4 \text{e}^- \text{(oxidation)} \]
**Electrodialytic experiments**

Washing experiments – cell A, prewashed ash L/S 0-5-15-50, ARGO ash  
Set-up experiments – cells A-C, prewashed ash L/S 15, ARC ash  
Reuse experiments – cell A, prewashed ash L/S 15, ARC ash  

All experiments lasting 28 days, 50 mA direct current
Washing experimental series

• No washing results in unstable experiments due to too high salt concentrations and electrical conductivity in the suspension
• Washing at too high L/S resulted in too low electrical conductivity in the fly ash suspension
• Optimum pre-wash L/S 15, which also resulted in 100 % Cl removal
Set-up experimental series

- Highest metal extraction rates in experiments with 3 C and 3/2 C 1 h set-ups
- Pb highest with 2 C set-up

Sb and Ti not measured in the 3C, 2C and 3/2 C 1 min experiments
Reuse experimental series

- Similar metal extraction in the reuse experiments, experimental liquids can be reused efficiently
Comparing extraction

The graph compares the extraction percentages of Cd, Cr, Cu, Pb, and Zn for different processes: ARGO (exp. L/S 15), ARC (exp. 3C), and Previous results.

- Cd: ARGO (exp. L/S 15) shows the highest extraction, followed by ARC (exp. 3C) and Previous results.
- Cr: ARGO (exp. L/S 15) and Previous results are comparable, while ARC (exp. 3C) shows a lower extraction.
- Cu: All processes show high extraction rates, with ARGO (exp. L/S 15) slightly higher than ARC (exp. 3C) and Previous results.
- Pb: Similar to Cr, ARGO (exp. L/S 15) and Previous results are comparable, while ARC (exp. 3C) shows a lower extraction.
- Zn: ARGO (exp. L/S 15) shows the highest extraction, followed by ARC (exp. 3C) and Previous results.

Research Paper:
Electrodialytic remediation of municipal solid waste incineration fly ash as pre-treatment before geopolymerisation with coal fly ash

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Conclusion

• Pre-washing recommended for stable experiments

• Extraction potentials: Cd, Cu, Zn > Cr, Pb > Sb, Ti

• Robost method regardless of experimental set-ups and fly ash sample