

THE FUTURE OF HYDROMETALLURGY IN NORWAY

Ole Wærnes

SINTEF Industry

Unit operations in Hydrometallurgy

Most common operations:

- Leaching
- Crystallization / Precipitation
- Filtration
- Solvent extraction
- Ion exchange
- Cementation
- Membrane separation
- Electrolysis

Potential pre-treatment before a leaching process

- Crushing, grinding / milling and fractionation
- Physical mineral separation

Application of Hydrometallurgy

Primary metals extraction and refining

- **Zinc** production: roasting – leaching – electrowinning
- **Copper** extraction: leaching – solvent extraction – electrowinning
- **Aluminium**: alumina from bauxite – Bayer process
- **Nickel & Nickel** – separation
- **Silgrain** - leaching and separation
- **Gold** production - cyanidation process: leaching - electrowinning
- **REE** extraction: leaching of REE minerals for RE oxide production
- **Phosphate fertilizer**: leaching – crystallisation – filtration - Yara

Previous activities (SINTEF / Norway)

- Anortalprosjektet - fremstilling av alumina fra anortositt, 1981-1984
- Utvinning av sjeldne jordartsmetaller fra Rødberg, 1984-1986
- Gjenvinning av FeCl_3 og AlCl_3 fra Silgrainanlegget ved Elkem Bremanger Smelteverk, 1985-1992
- Utvinning av litium fra gruvevann i Polen. Delprosjekt sammen med Central Mining Institute, Katowice, 1992-1993
- Industriell krystallisasjon, 1992-1994
- Separasjon av sulfat og kalsium fra konsentrert magnesiumkloridløsning, 1995-1999
- HYDROPROS, Brukerstyrt FoU prosjekt 1996-2001 (Norsk Hydro, Falconbridge Nikkelverk, Norzink, Elkem)
 - Krystallisasjon (kalsiumkarbonat, nikkelkarbonat, aluminiumklorid, jarositt), Ammoniumnitrat-prosessen, Membranteknikk, Koboltelektrolyse
- Industrial Crystallisation and Powder Technology, 2005-2008
- Foredling av olivinsand til silika og magnesiumsulfat, 2003
- SilMag, Hydro Magnesium, 2008-2009
- Diverse problemstillinger rundt avrenning fra nedlagte gruver

Examples of ongoing activities at SINTEF / NTNU

- Hydromet, BIA/Research Council
- 2 EU projects (REE, recovery from batteries)
- Direct industry projects
 - Treatment and recovery of an acid waste stream
 - Purification / selective leaching of a metal oxide
- Internal financed projects
 - Recovery of valuable metals from industrial waste streams
 - Recycling and characterization of commercial battery packs

New opportunities and challenges need Hydrometallurgical skills

- Green change solutions
 - Circular economy
 - Focus on land fills, waste disposal sites
- Recycling of metals from solid waste and scrap (batteries, magnets, spent catalysts, solar cells, electronic products)
- Utilisation of low grade or complex ores
- Special focus on REE and other critical elements
- Treatment of drainage / pollutions from old mines / mine waste
- Recovery from concentrated or dilute waste streams

Future actions at SINTEF

- Bring together employees with relevant competence
- Together with NTNU secure education of new students / PhD
- Recruitment efforts if necessary
- Active in upcoming EU calls
- Together with industry partners look for new opportunities within the "Green change solutions"
- Hydrochemical process technology (i.e. water based process technology) is a priority area in SINTEF Industry



Teknologi for et bedre samfunn