Lignin is the new reagent-based solution in mining (LIGNOMIN)

Presenter
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Partners
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March 2023 – February 2026

SWEDISH MINING INNOVATION

Med stöd från
VINNOVA Sveriges innovationsmyndighet
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FORMAS
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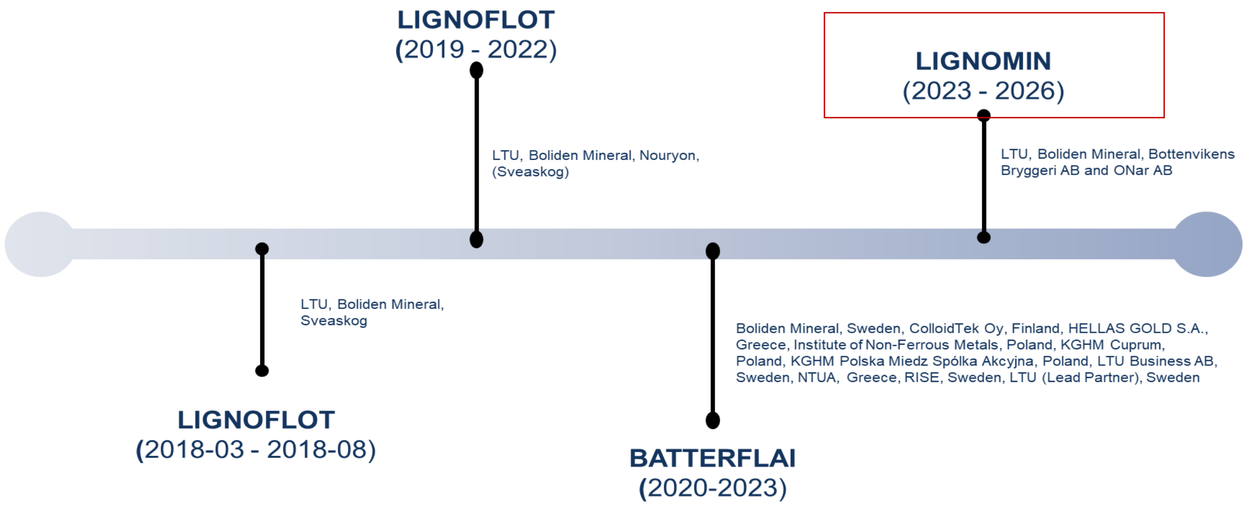
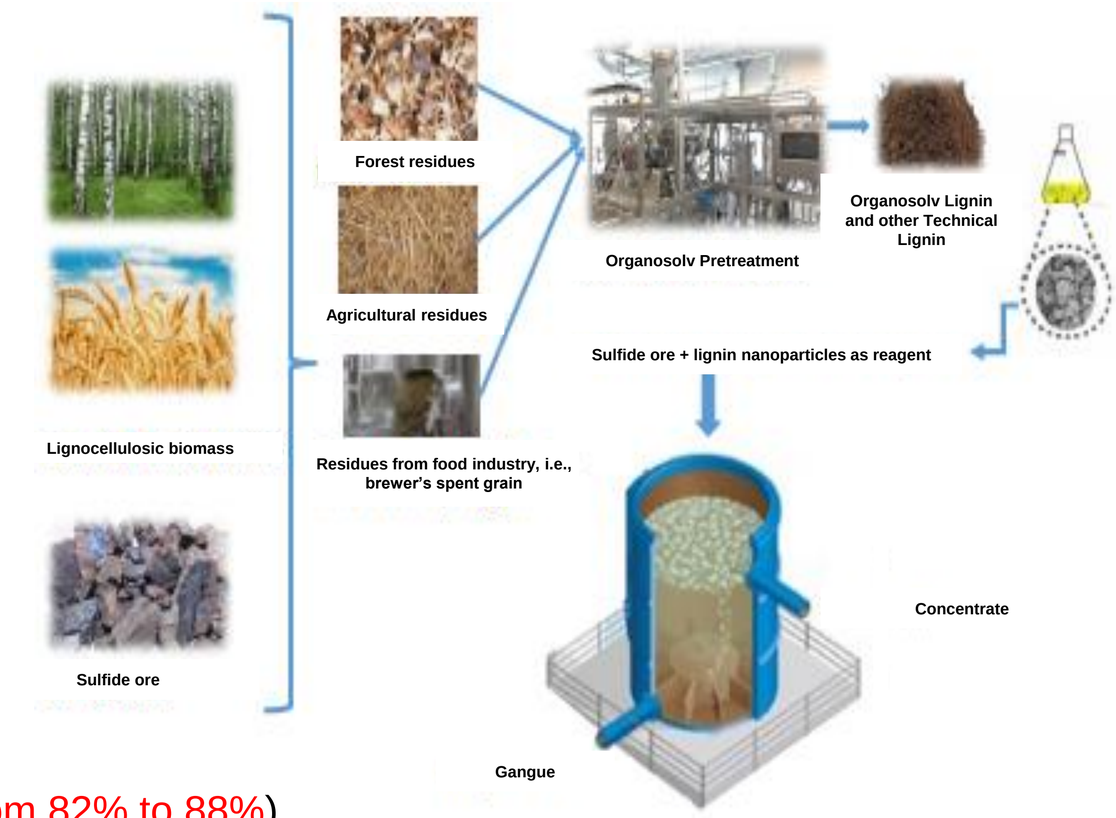
LIGNOMIN - Advancing the use of Lignin-Based Flotation Reagents as a Replacement for Xanthate with Enhanced Performance in Sulfide Ore Flotation





- OLP and xanthate mixture increased Cu recovery (from 82% to 88%) with improved selectivity (from GI 11 to 14) in the previous upscale tests.

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Some of the papers published related to the project

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Enhancing froth flotation performance of iron oxide apatite ore tailings through synergistic utilization of organosolv lignin particles and tall oil fatty acid-based collector

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ARTICLE INFO

Keywords:
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ABSTRACT

Beneficiation of the tailings from Iron Oxide Apatite (IOA) ore has become an important topic in the field of mineral processing as phosphate rock is considered as critical raw material by the European Union. Driven by the strong call for sustainability and green technology, this paper introduces the application of novel and bio-based organosolv lignin particles (OLP) as a reagent for apatite flotation. In the artificial mineral mixture flotation tests, OLP addition or replacement to tall oil fatty acid-based collector (TOFA) was shown to improve flotation kinetics and recovery. In this study, it was demonstrated that one of the widely used commercial TOFA collectors could be replaced with OLP by 70 %. The replacement led to an increase in recovery (+2%) and only a minimal decrease in P grade (−0.3 %) for the rougher-cleaner flotation tests in one of the two feed types tested. The influence of OLP and other reagents on apatite floatability has been investigated through Hallimond tube tests and laboratory scale batch flotation tests as well as zeta potential measurements and spectroscopy tests to further understand the possible mechanism and synergism of reagents in the apatite flotation system.

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Article

Characterization of Organosolv Lignin Particles and Their Affinity to Sulfide Mineral Surfaces

Kateřina Hrůzová, Krzysztof Kolman, Leonidas Matsakas, Henrik Nordberg, Paul Christakopoulos, and Ulrika Rova*

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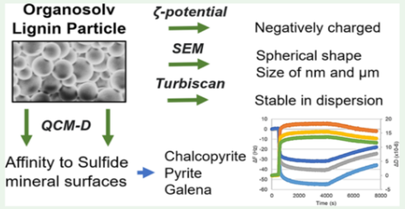
ABSTRACT: Organosolv lignin nanoparticles have been recently evaluated for their use in mineral froth flotation as a flotation reagent, and as a result, the recovery of the target minerals was improved and the selectivity of the process was increased. However, the mechanism of lignin activity in mineral froth flotation is not known. Therefore, this study is the first step in understanding the interaction of organosolv lignin with the mineral surface. As such, the organosolv lignin was characterized by GPC and ^{31}P NMR, where the structural differences between the birch and spruce lignins were determined. The molecular size and lignol unit composition were evaluated. Subsequently, the morphology and size of the organosolv lignin particles were examined for all 4 produced types: BN, BM, SN, and SM. The ζ potential was measured in the pH range of 2−11. All particles had a high negative charge, which indicated good stability of the dispersion in the alkali range. The stability of their colloidal dispersion was observed under increasing concentrations of mono- and divalent cations, and electrostatic repulsion was identified as the main stabilization mechanism. Finally, QCM-D was used to study the interaction of the lignin particles with the mineral surfaces of chalcopyrite, pyrite, and galena, which gave insight into the possible mechanism during the flotation process.



KEYWORDS: *organosolv lignin, nanoparticles, microparticles, surface chemistry, mineral surfaces, QCM-D*

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Organosolv lignin particles as an ecological reagent in the Kupfershiefer copper ore flotation

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Abstract: Mineral separation relies heavily on the process of flotation. This study explored the feasibility of using organosolv lignin nanoparticles and microparticles (OLP) as a greener alternative to xanthates in the flotation process for mineral separation. Xanthates are widely used but pose environmental and health risks. The efficiency of OLP as collectors was compared to collectorless flotation, resulting in approximately 50% copper recovery, indicating that OLP may not be a suitable replacement for xanthates. Further tests were conducted using a mixture of xanthates and OLP (birch nano and spruce micro) with varying substitution levels (20%, 30%, and 40%). The results demonstrated that increasing the dosage of OLP led to a decrease in flotation efficiency for copper. TOC analysis of the products revealed that high dosages (160 g/t) of birch nano and spruce micro as sole collectors showed beneficiation and selective recovery against copper. While OLPs did not prove effective as collectors, the study highlights their potential as substitutes for maltodextrin in selective flotation of the final concentrate. Two out of four tested OLPs were recommended for pilot scale testing.

Keywords: collector, particles, total organic carbon, organosolv, lignin

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Short Communication

Organosolv lignin hydrophobic micro- and nanoparticles as a low-carbon footprint biodegradable flotation collector in mineral flotation

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ABSTRACT

Flotation is a key step during mineral separation. Xanthates are the most commonly used collectors for recovering Cu, Ni, and Zn from sulphide ores. However, xanthates are fossil-based and toxic for the environment. The aim of this study was to evaluate the use of lignin nanoparticles and microparticles as sustainable and environmentally friendly collectors. Lignin particles demonstrated good selectivity toward Cu (chalcopyrite), with total recoveries exceeding 80% and grades of up to 8.6% w/w from a Cu-Ni ore in rougher flotation tests. When floating Zn-Pb-Cu ore, lignin nanoparticles could reduce the use of xanthates by 50%. Moreover, they outperformed xanthates alone, achieving total recoveries of up to 91%, 85%, and 98% for Cu, Pb, and Zn, respectively. These results prove the potential of lignin as a flotation collector.

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Project Goals

- Validate the results from the LIGNOFLOT project by assessing lignin-based flotation reagents in a continuous-circuit flotation studies.
- Assess the potential of other sources such as abundant agricultural and agro-industrial residues as well as available technical lignin for lignin nanoparticle production
- Demonstrate the industrial feasibility of the novel lignin reagent-based solution, based on partial or total replacement of fossil-based xanthate collectors with biobased, biodegradable, and nontoxic alternatives.
- Demonstrate the impact of LIGNOMIN as a strategy to increase metal recovery and at the same time reduce the environmental impact of the mining sector.
- Develop technology and business models that can promote industrial use of the LIGNOMIN concept.

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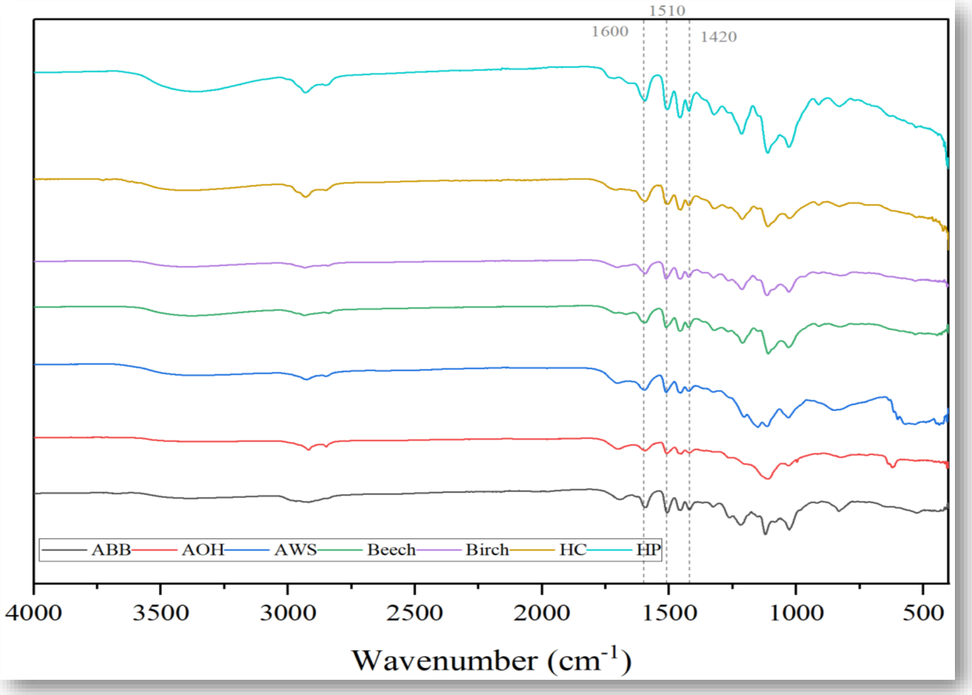
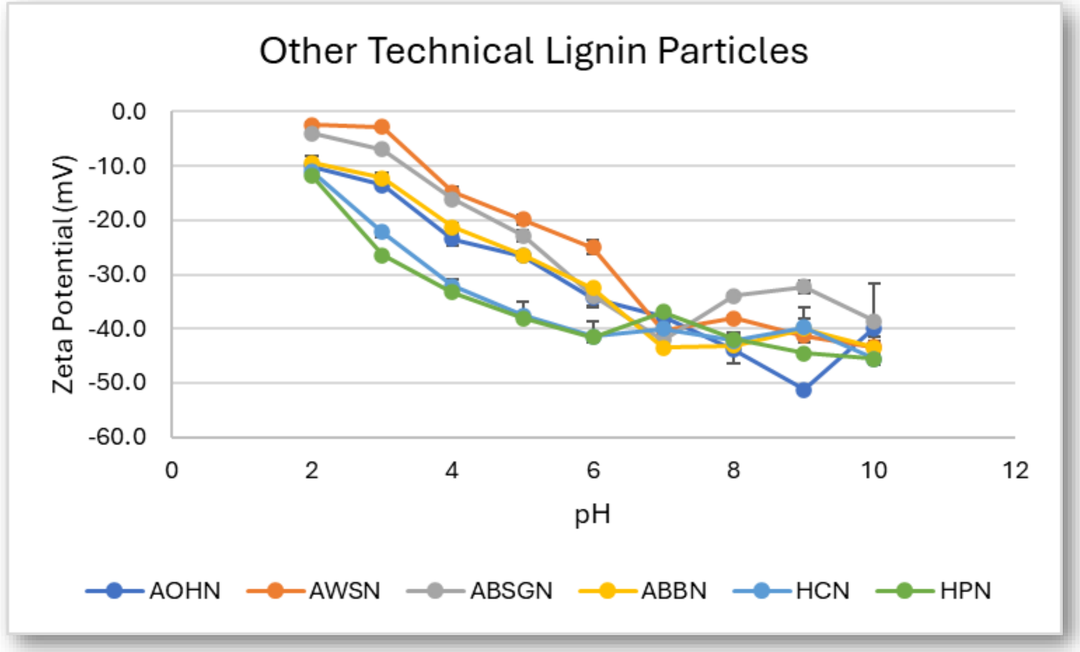
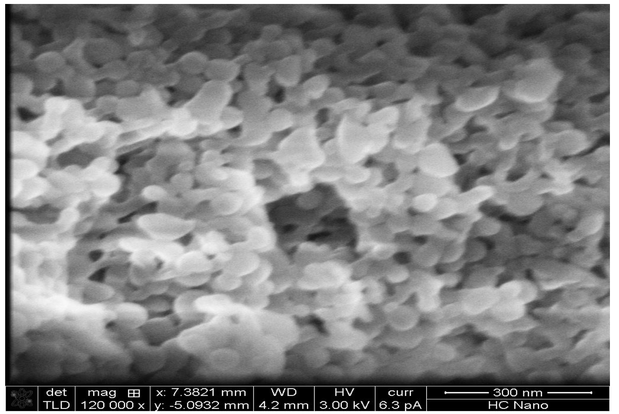
Results so far (Characterization)



Presence of 1600 cm-1, 1510 cm-1, and 1420 cm-1 peaks are associated with the aromatic skeletal vibrations indicating high lignin purity



Good stability of lignin nanoparticles at high pH



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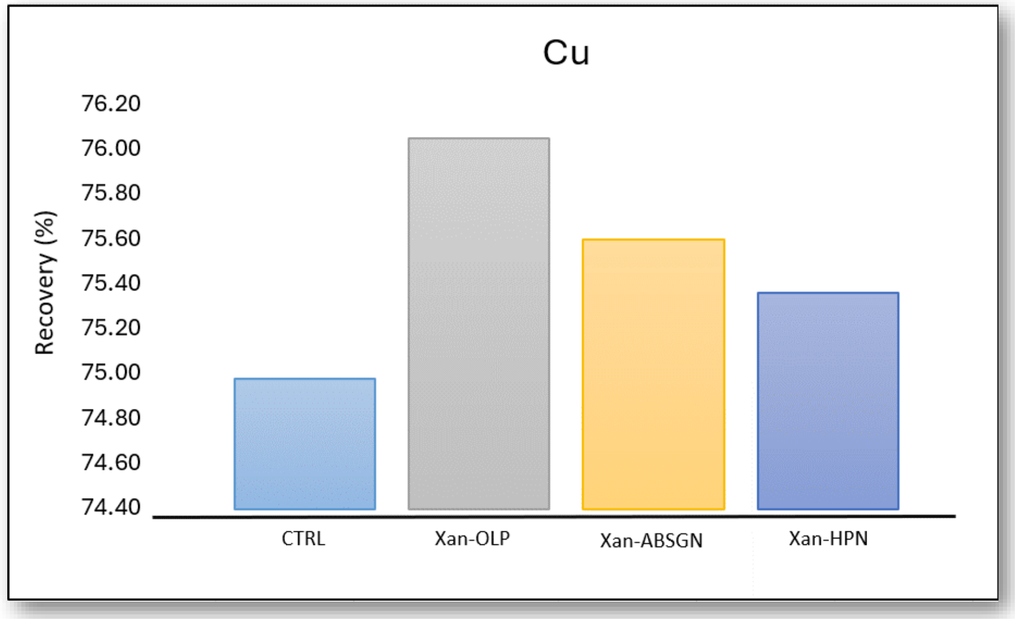
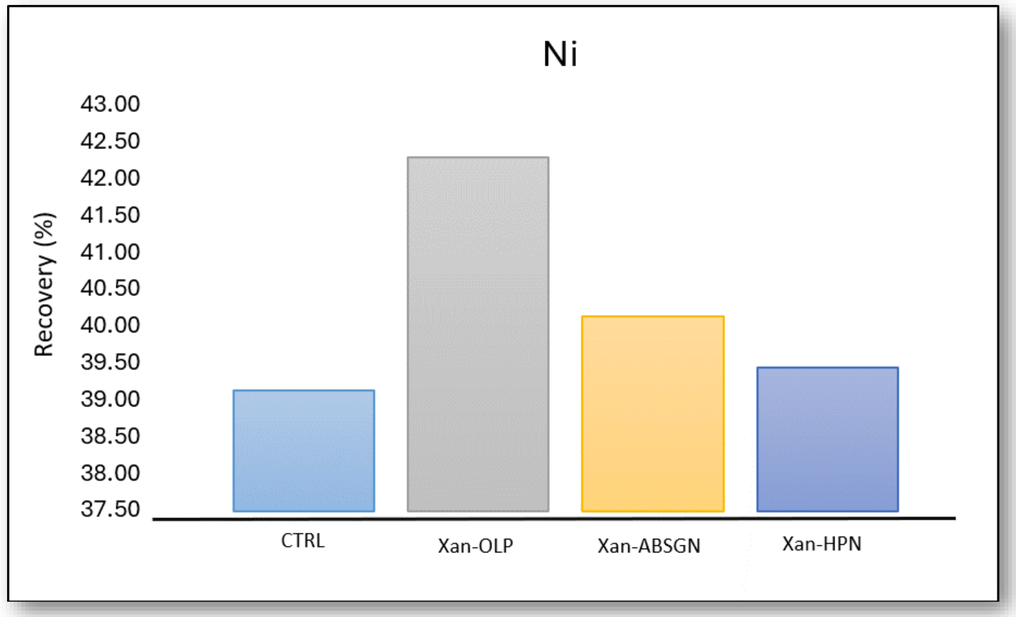
Results so far (Flotation Tests)

Feed: Low-grade Cu-Ni ore





- **Lower xanthate dosage (up to 50% less) is used for the mixtures.**

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Upcoming activities and next step

Laboratory flotation tests using different lignin particles → Pilot scale flotation studies → Conduct E-LCA → Make a go-to-market plan

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Mining innovation for a sustainable future

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