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MULTI-NUTRIENT BIO-BASED FERTILIZERS FROM SEWAGE SLUDGE AND DERIVED PRODUCTS

Turolla A, Esposito L, Boniardi G, Canziani R

Department of Civil and Environmental Engineering (DICA), Politecnico di Milano, Piazza Leonardo Da Vinci 32, 20133, Milano, Italy

POLITECNICO MILANO 1863

E-mail: andrea.turolla@polimi.it

SPOKE, WP AND TASK

- **Spoke 8**: New models of circular economy in agriculture through waste valorization and recycling
- **Work Package 3**: Nutrient and organic matter recovery from wastes to reduce the use of agrochemicals and closing waste cycle
- **Task 8.3.1**: Nutrient recovery from wastes to produce mineral fertilizers and promoting water recovery

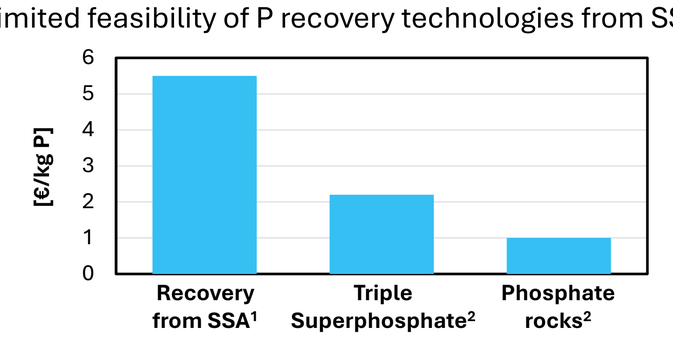
BACKGROUND, GAP AND GOAL

Background

Sewage sludge ash (SSA) as a promising solution to phosphorus (P) supply concern

Gap

Limited feasibility of P recovery technologies from SSA

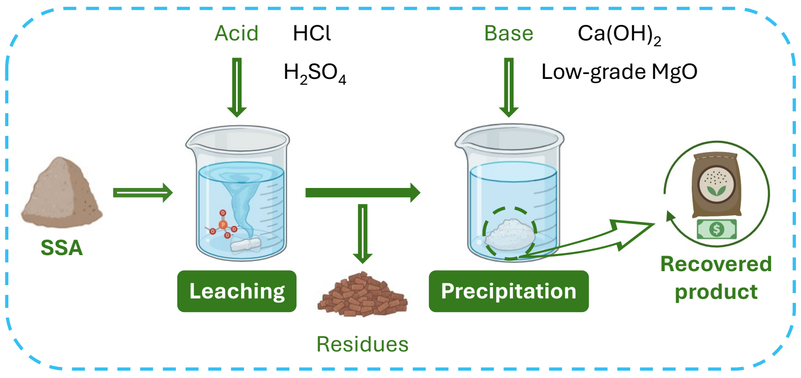


Goal

Develop an innovative technology for recovering P from SSA to produce multi-nutrient secondary raw materials for manufacturing bio-based fertilizers

WORKFLOW

Recovery technology



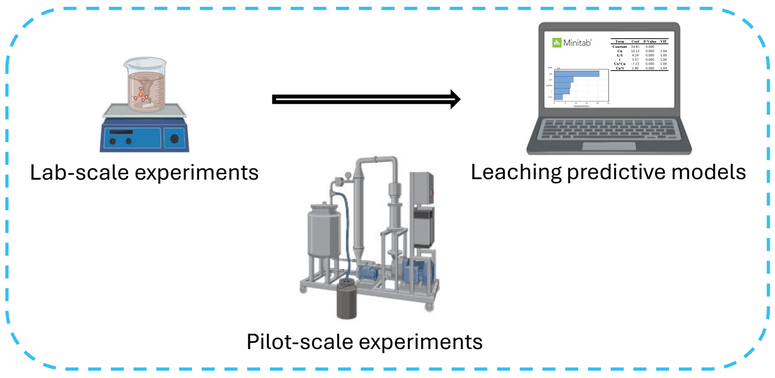
Multi-objective optimization

Key Performance Indicators

min
- OPEX
- Acid consumption
- Base consumption
- Residues formation

max
- $P_{recovered\ product}$
- $\eta_{recovery}$

Data collection



RESULTS

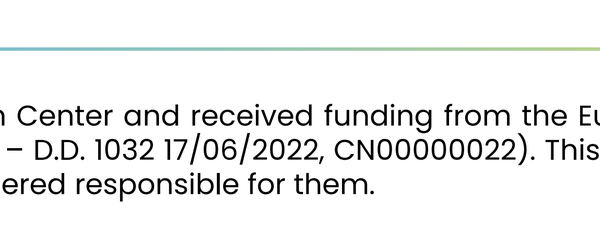
Optimal recovery configuration

Leaching: HCl (0.8 N, 10 L/kg, 0.5 h) – precipitation: $Ca(OH)_2$

Optimal recovery configuration		
OPEX	6.2	€/kg $P_{recovered}$
Acid consumption	11.7	kg/kg $P_{recovered}$
Base consumption	4.9	kg/kg $P_{recovered}$
Residues formation	12.8	kg/kg $P_{recovered}$
$P_{recovered\ product}$	12	%P
$\eta_{recovery}$	84	%

Key measures for process feasibility

Use of recycled reagents and recovery of residues



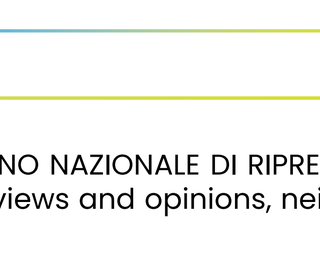
Small pilot-scale validation

Recovered product:

- P: 4 – 8%
- Mg: 1 – 16%
- K: 900 – 3000 mg/kg

EU 2019/1009:

compliant



REFERENCES AND ADDITIONAL MATERIALS

(1) L. Egle, H. Rechberger, J. Krampe, M. Zessner, Phosphorus recovery from municipal wastewater: An integrated comparative technological, environmental and economic assessment of P recovery technologies, Science of the Total Environment 571 (2016) 522–542. https://doi.org/10.1016/j.scitotenv.2016.07.019.

(2) IndexMundi.

- G. Boniardi, E. Paini, T. Seljak, A. Azzellino, A. Volonterio, R. Canziani, A. Turolla, Optimization of phosphorus wet acid extraction from sewage sludge ashes: Detailed process insight via multi-variate statistical techniques, J Clean Prod 458 (2024) 142491. https://doi.org/10.1016/J.JCLEPRO.2024.142491.
- G. Boniardi, K. Close, A. Turolla, R. Canziani, A. Oehmen, Assessment of three different approaches for integrating phosphorus recovery from sewage sludge and derived products in existing wastewater treatment plants, Bioresour Technol 402 (2024) 130822. https://doi.org/10.1016/J.BIORTECH.2024.130822.
- G. Boniardi, L. Esposito, M. Pesenti, A. Catenacci, A. Turolla, Optimizing phosphorus precipitation from acidic sewage sludge: use of Mg-rich mining by-products for enhanced nutrient recovery, Published soon.
- L. Esposito, G. Boniardi, M. Frigerio, M. Guembe, I.X. García-Zubiri, D. El Chami, R. Canziani, A. Turolla, Development of a multi-objective support tool for optimizing phosphorus recovery from sewage sludge ash: a step towards process feasibility, Published soon.

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