LCM 2023
THE 11TH INTERNATIONAL CONFERENCE ON LIFE CYCLE MANAGEMENT
6-7-8 september, 2023, Lille, France

Preliminary life cycle assessment of CO_2 sequestration in construction materials by accelerated carbonation of mineral waste – The Mineral LOOP project.

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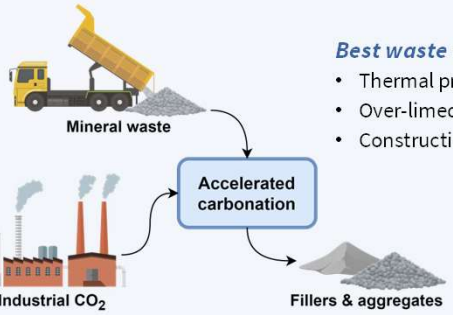
The Mineral LOOP project

Aim

- Produce and commercialize new types of fillers and aggregates obtained from **accelerated carbonation of mineral waste**.

Key environmental challenges

- Circular management of mineral waste streams,
- Reduction of construction-related CO_2 emissions,
- Reduction of primary raw materials consumption.



Best waste for valorization

- Thermal process residues ?
- Over-limed sewage sludge ?
- Construction and demolition waste ?

Life Cycle Assessment (LCA)

- Decision support tool throughout the project.

→ **Preliminary results** for over-limed sewage sludge.

Materials & Methods

Goal

- Assessment of the environmental impact of the Mineral LOOP (ML) recycling process for various carbonatable mineral waste streams.
- Comparison with the environmental impact of the conventional treatment process of each waste stream (reference).

Scope

- Functional unit: treatment of **1 ton of mineral waste** by the Mineral LOOP process (including waste-specific pre-treatments, accelerated carbonation, and post-carbonation treatments).

Methods

- Compliance with the ISO standards 14040 [1] and 14044 [2].
- Environmental Footprint 3.1 impact assessment method (adapted for Simapro) ; Simapro 9.5.0.0 software ; Ecoinvent 3.9.1 database [3].

System boundaries

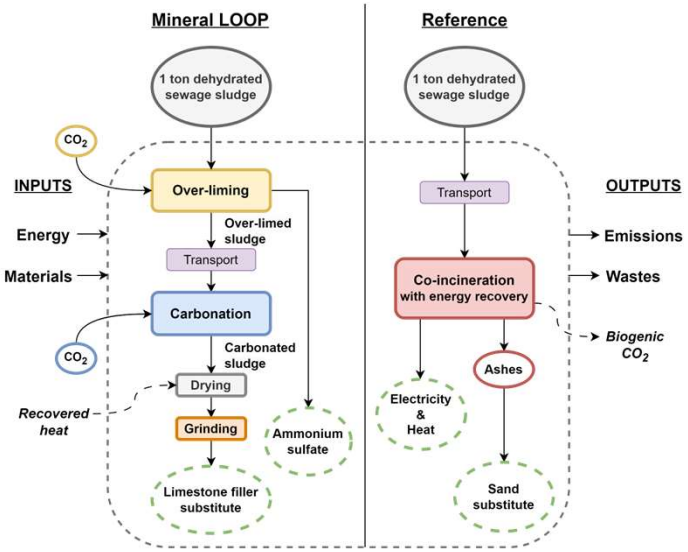


***Fig 1**. Boundaries of the ML system (on the left) and reference system (on the right) applied to the treatment of 1 ton of sewage sludge.*

Preliminary results

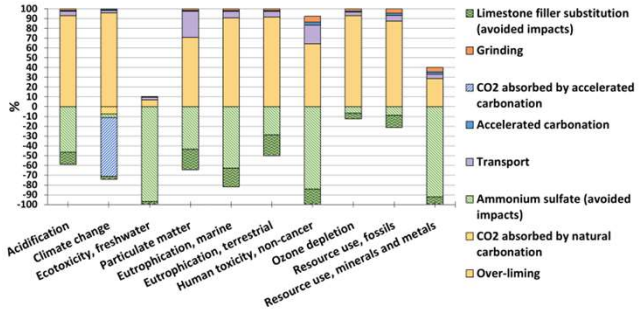


***Fig 2.** Characterization of 1 ton of sludge treated by the ML process (for most impacted categories).*

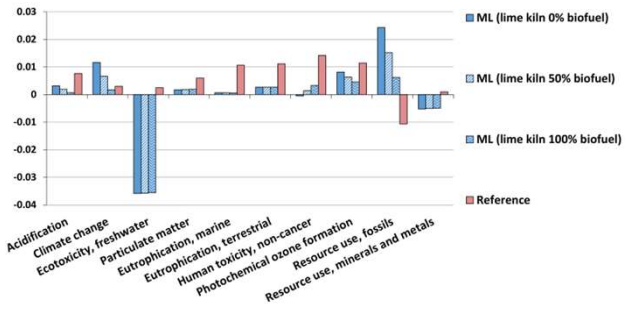


***Fig 3.** Normalized comparison of 1 ton of sludge treated by the ML process (with various rates of biofuel in the lime kiln) in blue and by the reference process in red (for most impacted categories).*

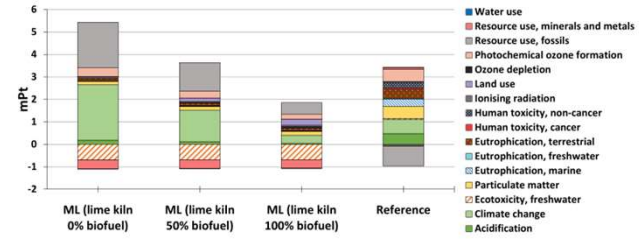


***Fig 4.** Single score comparison of 1 ton of sludge treated by the ML process (with various rates of biofuel in the lime kiln) and by the reference process.*

Conclusions & Recommendations

- The **over-liming** step in the ML process applied to sewage sludge is the main contributor to all impact categories (**Fig 2**). An approach to mitigate its impact is to replace the lime kiln combustible (natural gas) with **biofuel** (wood).
- While showing lower impacts in 8 out of the 10 most affected categories compared to the reference (**Fig 3**), the ML process has a higher global impact than the reference when the lime kiln operates with 50% or less biofuel (**Fig 4**).
- However, by increasing the biofuel rates, the ML process can achieve a **lower global impact** than the reference (**Fig 4**), benefiting from **CO_2 capture**, **recovered heat** utilization for drying, and avoided impacts of **co-products**.
- Therefore, it is recommended to **maximize the use of biofuel** in the lime kiln.

References

[1] ISO 2006a. Environmental management – Life cycle assessment – Principles and framework, ISO 14040. Geneva: International Organization for Standardization
[2] ISO 2006b. Environmental management – Life cycle assessment – Requirements and guidelines ISO 14044. Geneva: International Organization for Standardization
[3] Ecoinvent, Ecoinvent data v3.9.1 : 2023 (http://www.ecoinvent.org)