Co-hydrothermal carbonization of stabilized organic fraction and landfill leachate for activated carbon production

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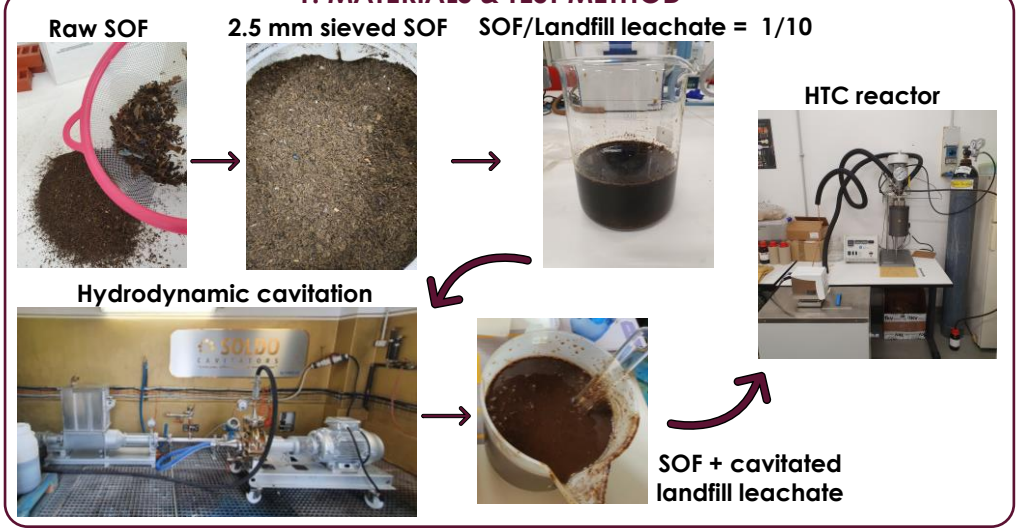
ABSTRACT

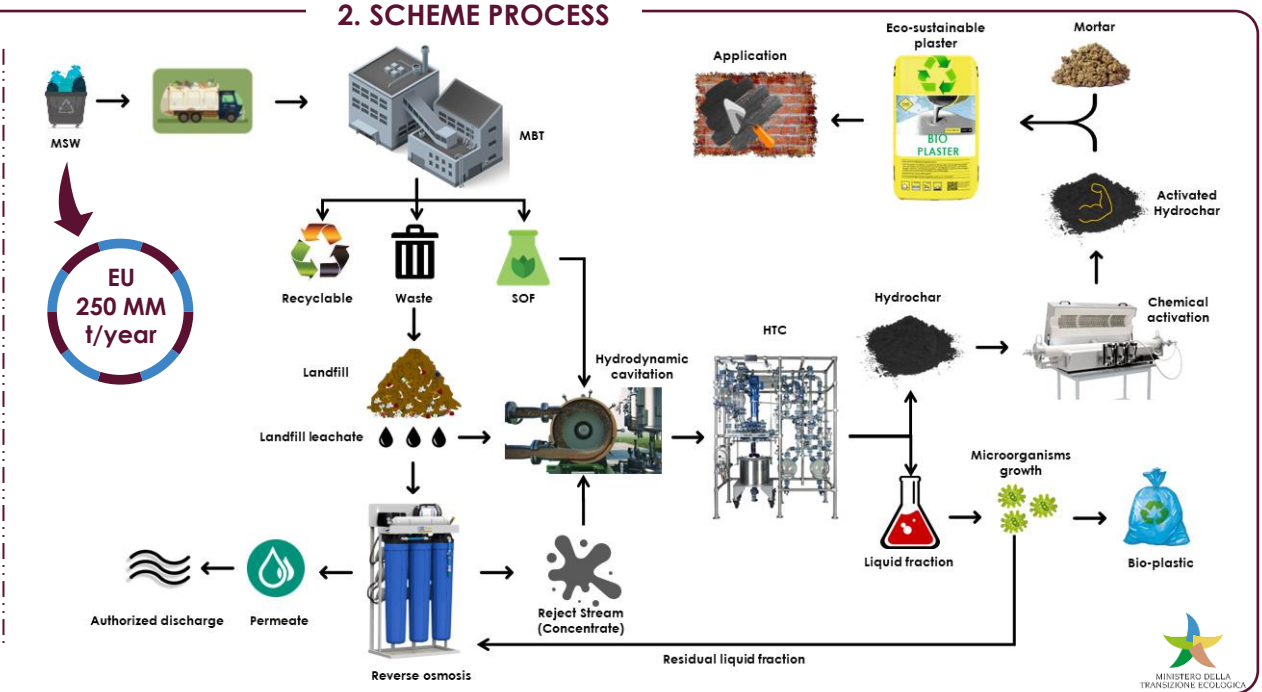
The problem of **municipal solid waste (MSW)** management is becoming an issue more and more relevant. The growth in consumption, urbanization and economic development of recent decades has determined an increase in the production of municipal solid waste (MSW). **Hydrothermal carbonization (HTC)** is an emerging path to address the concerns arising from the management of municipal waste, promoting a **from-waste-to-resource action plan**. This work arises from the project **"ECOPLASTER - Biostabilized for Ecosustainable Building"** funded in 2022 by the **Ministry of Ecological Transition**. It aims to provide preliminary results on the application of the **HTC** process to the **stabilized organic fraction (SOF)** of the MSW for **hydrochar production**. The hydrothermal carbonization of SOF blended with **landfill leachate** was performed in a stirred mini-batch reactor with a volume of 600 ml. The HTC was performed at **different process temperatures** (200, 250 and 270 °C) and **residence times** (1, 3 and 6 h), while the solid-to-liquid ratio was maintained at 1/10. The solid fraction of the process was dried and undergo to **chemical activation** in a tube reactor in order to increase the **porosity and surface area**. The proximate and ultimate analysis of hydrochar before and after the activation along with porosity and morphology structure were examined. Additionally, the **yield** of both the HTC and activation process was determined. Furthermore, the influence of **hydrodynamic cavitation (HC)** to enhance the homogenization of SOF and landfill leachate before the HTC process was studied. The preliminary results showed that the hydrochar from HTC of the stabilized organic fraction blended with landfill leachate is a valid mixture for the production of **eco-sustainable plasters** to be used in the **building sector** in a **circular economy** approach.

1. MATERIALS & TEST METHOD



2. SCHEME PROCESS

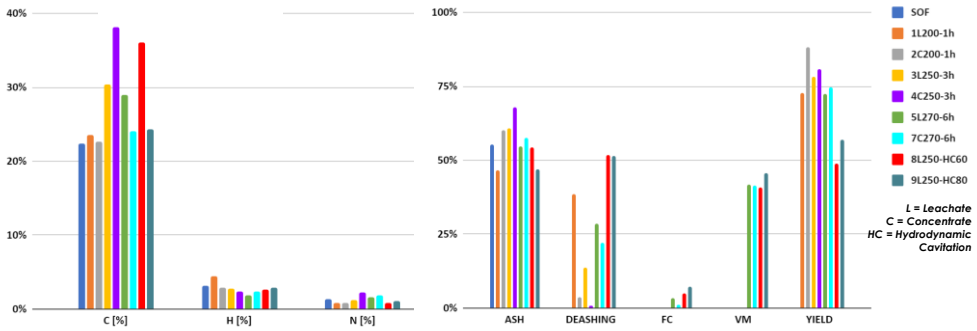
Project partners



3. RESULTS

Solid fraction (Hydrochar)

Liquid fraction



Preliminary results indicate that the tests performed at **250°C** and a residence time of **3 hours** with **landfill leachate** rather than concentrate produce hydrochar with improved characteristics. Even if higher carbon content (+25.3%), the HTC of SOF with **concentrate** promotes the **formation of ashes** (+11.3%) and so **reducing** the **porosity** of hydrochar. The **hydrodynamic cavitation** performed at a temperature set point of 80°C rather than 60°C showed no significant advantages considering the greater energy consumption. HC as pre-treatment of HTC provided **higher** disintegration and **homogenization** of the solid/liquid mixture leading higher carbon and fixed carbon content and **lower ash formation** lending support for producing hydrochar with raised porosity. **Chemical activation** of hydrochar with KOH at a temperature range of 450-900°C will be investigated in further experiments to increase the porosity and surface area.

4. FUTURE PERSPECTIVES

- **Chemical activation** of hydrochar with KOH to **increase porosity**
- Determination of the optimal **mortars/activated hydrochar ratio** for **eco-plaster production**.
- Preliminary application of eco-plaster on **test rooms** - analysis of **thermal**, **thermo-hygrometric** and **acoustic performances**.

≥ 30 g/m²

< 0.13 W/mK

- Determination of the thermal characteristics of the eco-plaster (**thermal conductivity**).
- Evaluation of the environmental and economic sustainability of the eco-plaster – **LCA** and **LCC analysis**.