Contribution of biochar-based coating mortars to the hygrothermal behavior and indoor air quality of buildings

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Summary

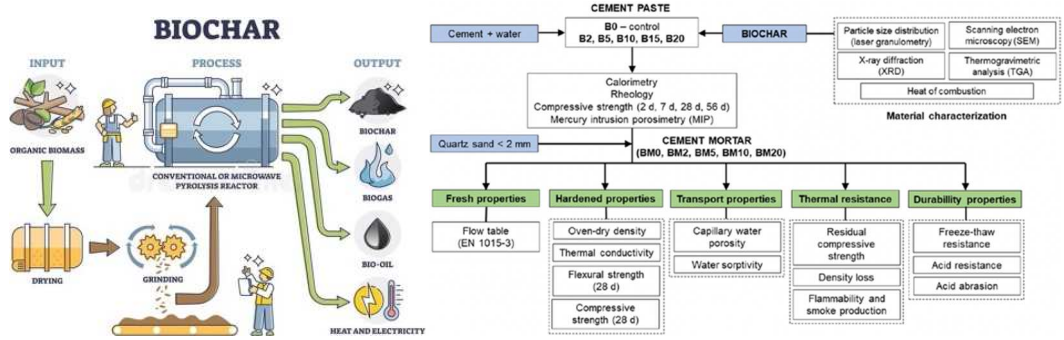
The sustainability of the construction sector is one of the topics that receives more attention from the scientific community, but, in the coming years, the general interest in this topic will be even greater. The reduction of carbon emissions in construction as well as the improvement of indoor air quality in buildings are very demanding objectives of recent European Directives, with which Portugal is obliged to comply. Thus, the formulation of building materials that can promote carbon sequestration, the reduction of carbon emissions, hygrothermal rehabilitation as well as improvements in the indoor air quality of buildings will be an excellent contribution to achieving European goals and enabling us to contribute to the slowdown of the global warming of the earth. In this sense, wall covering technologies tend to evolve to meet such thermal requirements.

The main objective of this research thesis will be to develop lightweight coating mortars, with partial replacement of sand/cement by biochar, produced through the pyrolysis of biomass from agricultural and forestry residues existing in the research poles of a Public Institute. In a first stage, the production and characterization of 6 types of biochar (cereal straw, legumes, wine pruning, olive tree and eucalyptus and pine branches) will be carried out at a laboratory scale and at a pilot or industrial scale. In a second stage, the optimization of the incorporation of biochar in cementitious mortars and the tuning of compositions will be carried out. To retain pollutants, titanium dioxide is the most studied photocatalyst agent due to its chemical inertness, non-toxicity, and low cost. In the next phase, tests will be carried out on the formulated mortars, in their fresh, hardened and durability state. At this stage, the mortars will also be characterized in terms of permeability, drying, assessment of catalytic capacity, reaction to fire, microstructures, toxicological potential, and regulatory and humidity effects. The experimental campaign will be accompanied by the Life Cycle Assessment (LCA) of the mortars studied.

It is hoped that this research thesis can provide an innovative, validated, and patented product with optimized performance and thermal resistance, and minimal risks of environmental impact, natural resources consumption, and toxicity. The national patent of this innovative material will also be an important objective and achievement of this thesis. A matrix of possible applications will be constructed for all biochar alternatives and mortar mixtures evaluated based on the considered performance indicators. Thus, the results of this expanded experimental study can support future research based on scientific knowledge. Even if the characteristics of the patented product are not superior to those of state-of-the-art solutions, the integrated performance of the evaluated products and their contribution to the overall performance of the wall in several dimensions (mechanical, physical, chemical, thermal, environmental, energy reduction and economic) will be characterized.

Keywords

Eco-efficient thermal mortars, biochar, carbon sequestration, thermal performance and humidity regulation, indoor air quality, waste recovery, life cycle assessment (LCA).



Experimental protocol for the characterization of thermal mortars with biochar from agricultural and forestry residues.