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Using of waste pomace from winery industry to improve thermal insulation of fired clay bricks. Eco-friendly way of building construction

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HIGHLIGHTS

- The specimens were manufactured in partnership with a brick factory.
- In accordance with standards the maximum amount of additive is limited to 5%.
- This percentage reduces the wall thermal transmittance by up to 10%.
- Bricks did not show any defect, such as efflorescence, cracks or bloating effects.
- A new way for recycling waste pomace from wine industry is shown.

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ABSTRACT

This paper studies fired clay bricks made by using waste pomace from wine industry as an additive in brick production. The aims are both, studying bricks properties and showing a new way of pomace recycling. Several test specimens were made by using different percentage of additive. These samples were subjected to the corresponding assays in order to determine the maximum additive percentage to be added according to standards. It has been confirmed that the amount of pomace that might be added is limited to 5%, whereby brick's water absorption and compressive strength comply with standards. Therefore masonry structural requirements are preserved at the same time that collaterally a better insulation of the buildings enclosure is achieved by reducing its thermal conductivity up to 25%.

1. Introduction

Bricks are the most commonly construction materials used for building enclosures and several researches have been conducted in order to obtain new types of blocks. Bricks are specially required to have adequate physical and mechanical properties as well as a good insulation behavior. Fired clay bricks are mostly used to form the enclosure, so the masonry does not support the structure loads just its own weight therefore its main target is the isolation. Buildings thermal energy, required for heating and air conditioning of buildings, accounts for approximately 40% of the overall energy consumed in the world. This represents 36% of the global CO_2 emissions [1] and previous studies estimate that 50% of this energy is lost through the walls [2]. From this point of view, the main part of the overall energy required to achieve the thermal comfort target parameters is determined by the quality of their envelopes.

On the one handbrick industry has been focused on new blocks development with less thermal conductivity. Some of these researches are related to new bricks geometries (internal or external) [3–5] as well as to the use of insulated materials within the hollow bricks [6,7].

On the other hand, researchers have found in brick industry, a new way of waste recycling by using the high temperatures produced during the firing process.

It has been determined that certain types of waste produce a porosity increase in the fired clay matrix which reduces the thermal conductivity of fired clays [8–11]. However other bricks properties are also modified by these pores formers therefore the added percentage of such waste is limited.

One of these potential wastes is the grapes skin of, so-called waste pomace (WP) or grape marc. This is a waste obtained from

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the wine refinery process which represents around 62% of the total waste produced from this industry [12]. It is generated after pressing the grapes in white wine production, or after fermentation and maceration process in case of red wines. In fact this is a complex lignocellulosic material with a chemical composition that highly varies depending on the grape variety.

This waste has been commonly recycling by different ways. The simplest one involves its use as adsorbent for metal effluent decontamination [13]. It also may be used for plants or mushrooms substrates by composting [14–16].

Other more complex treatment is extracting which produces sustainable wood adhesives [17–19]. Some researchers have also been focused on its application as bio fuel by fermentation, based on its high heat value (HHV) [20–22].

In this case, its potential use as an additive for clay bricks is investigated and results are compared with those obtained on previous similar research by waste pomace addition from olive mill solid residue [11].

2. Preparation of the test specimens

Fired clay bricks manufacturing involves several stages which influence future bricks properties (see Fig. 1). In order to guarantee the feasibility of this addition, research was carried out in partnership with a local brick factory where critical processes were performed.

Clay was collected from the outlet of ageing pit, where matter is homogenized before being introduced into the manufacturing process. Clay chemical composition influences over physics, mechanics and thermal properties of fired clay bricks [23]. Despite previous research [24] has demonstrated, that clays used for brick manufacturing have similar chemical composition, results may vary if clay composition and production process are highly different to the shown in this paper. In Table 1 both clay composition, used in this research and the one reported by a previous research, are summarized [11].

WP was provided by a local winery firm placed located near to the brick factory and left for a week in a hopper. At this place, the organic matter may be degraded and homogenized, in the same way as it will be done in the industrial scale. WP Elemental composition was determined by an elemental microanalyzer LECO CHNS 932 and a VTF-900 following ASTM D5428. Heat values were carried out by a LECO AC600 in accordance with ISO 1928:2009 (see in Table 2).

Due to the nature of the additive, neither crushing nor grinding was necessary. In spite of the WP particle size distribution was not measured, the grain size was controlled by screening with a whit a 1 mm nominal opening metal sieve.

Due to the high financial cost of loading reduced extrusion blend load and taking into account that produced bricks might have no commercial value, specimens were formed in laboratories facilities and then these were drying and firing at factory's facilities.

Clay and additives were oven-dried at 110 °C and then both were dosed at dry state. This was made to remove all moisture adding the exact weight of additive and clay.

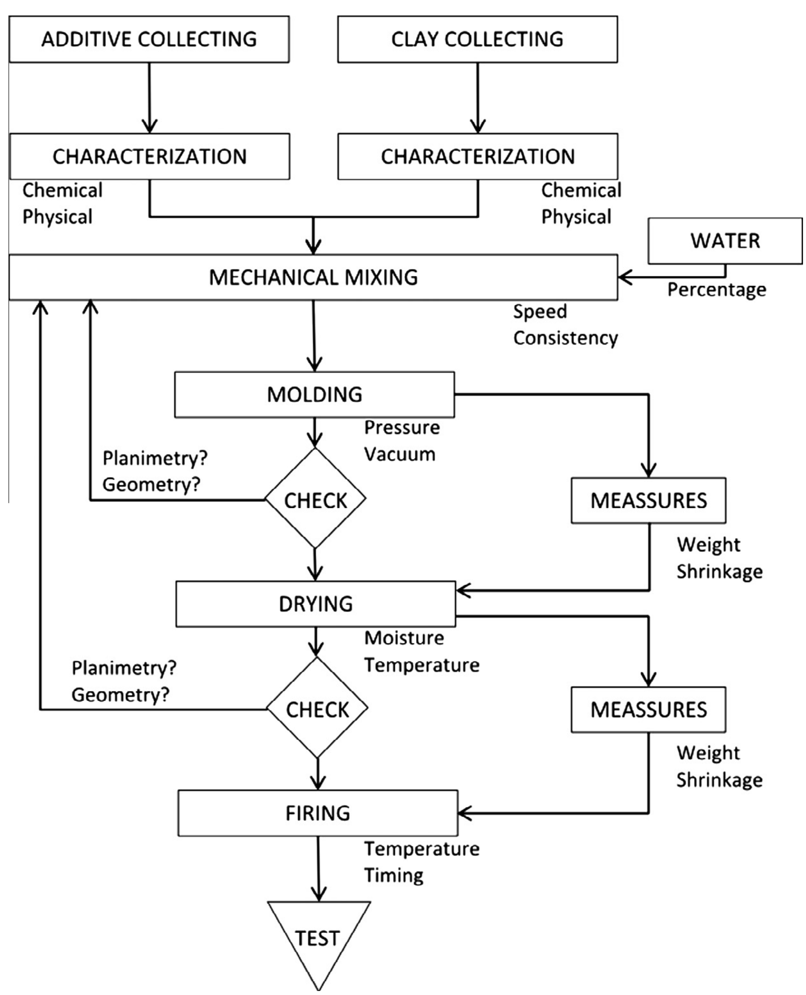

Fig. 1. Methodology followed for manufacturing bricks.