Team members: Aya Malih, Abderrahmane Goulla, Farouk Lemyesser
Supervisor: Dr. Asmae Khaldoun
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Fired Clay Bricks

RENEWABLE ENERGY, BIOCLIMATIC CONSTRUCTIONS & SUSTAINABILITY CONFERENCE

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جامعة الأخوين
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AL AKHAWAYN UNIVERSITY

Abstract:

In this project, we reviewed different paper tackling the usage of additive in the brick making process. The addition of certain additives to bricks affects various different properties that are relevant to today's sustainable building practices. We also tackle some methods used to evaluate the impact of these additives, chief among them is thermogravimetric analysis.

Introduction:

During firing of fired clay brick, a series of transformation occurs which determine the final properties of the fired brick product. The main factors involved in manufacturing fired bricks are the microstructure of the material, the firing temperature and profile, as well as the additives used. These factors will affect the quality of the final product. There are many tests performed to measured these properties, and we will try to present some of them

Conclusion:

The main takeaways we get from this project, is that the usage of additives in brick making process has a lot of advantage. It offers a good waste management opportunity, offers better performance in many cases. More studies need to be done to help incorporate new techniques in mainstream industry

Additives to enhance brick properties:

The additives that can be incorporated into the brick making process can come from various different sources. Some of these sources are renewable, and some are non renewable, like minerals. These additive change the mechanical, physical, and thermal properties of the brick, and depending on which properties are needed, different additives and different concentrations of them can be considered. Renewable sources of additives include industrial waste, agriculture waste, and even construction waste. For example, additives that were considered in literature are:

1. Agricultural origin: wheat straw, rice husk, and grass ...etc.
2. Industrial origin: resinous wood fiber, sawdust, and glycerin ...etc.
3. Construction origin: limestone dust and sludge.

Brick Making Process:

Brick making process recommendation varies from country to country and in the literature, below we present 2 main processes for making bricks, one from the UK government, and one for the purposes of research and development.

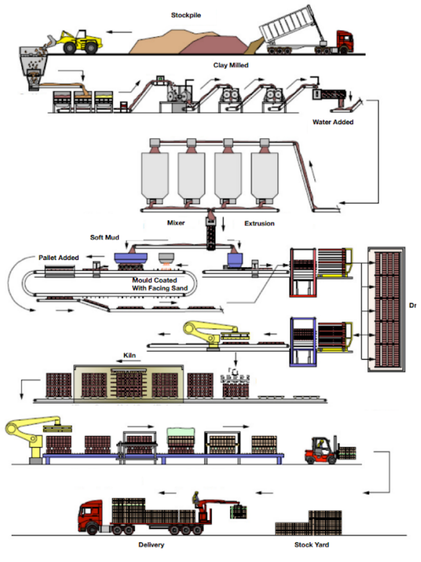


Figure 1: *Recommended brick making process by the UK government*

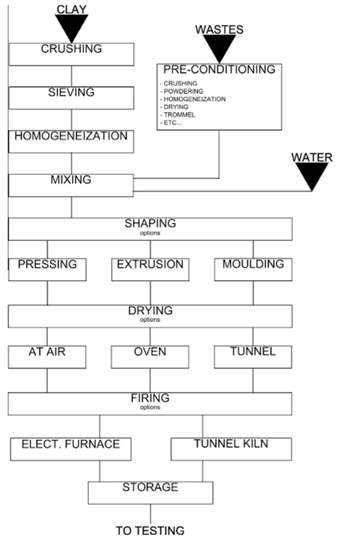


Figure 2: *Recommended brick making process for research*

Tests conducted and properties measured:

Thermogravimetric analysis (TGA)

In this analysis, we continuously weigh a sample while it's being heated and an inert gas is passed over it. Many solids emit gaseous byproducts in certain reactions. In TGA, we romve these gases and we measure the change in the remaining mass of the sample. TGA has many mechanism of change such as

- Weight Loss: decomposition, evaporation, reduction, desorption.
- Weight Gain: oxidation, absorption.

Below is an example of a TGA curve, as well as the device used to perform the test.

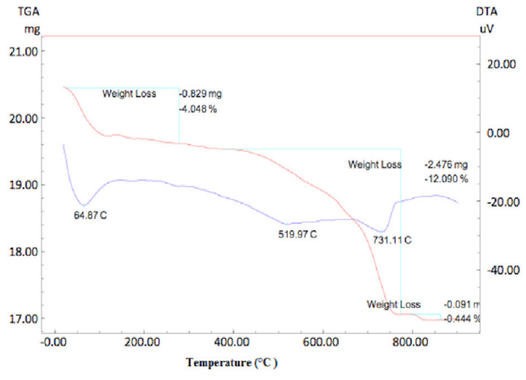


Figure 3: *Example of a TGA curve for weight.*

Figure 4: *Example of a TGA device (Discovery TGA 5500).*

Linear firing shrinkage:

This test is performed with a caliper according to the ASTM C210-95. In it, we measure the length of sample either before and after drying or before and after firing, and sometimes it's done during the whole process. The formula to measure is the following: $\text{Linear firing shrinkage}(\%) = \frac{L_{\text{dried}} - L_{\text{fired}}}{L_{\text{dried}}} \times 100$

In this case, the firing option was chosen, and the results are shown below

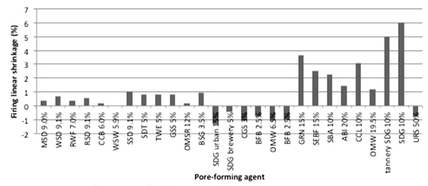


Figure 5: *Linear firing shrinkage for different pore-forming agents*

Bulk density:

It's measured by calculating the ratio of the dry mass to it's volume according to the ASTM Standard C 373-88. It can also offer insight into the apparent porosity.

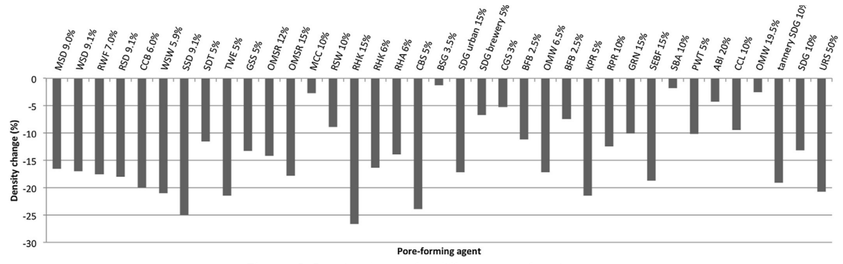


Figure 6: *Density change for different pore-forming agents*

Compression or bending strength:

This test is conducted to ensure good engineering quality of the bricks.

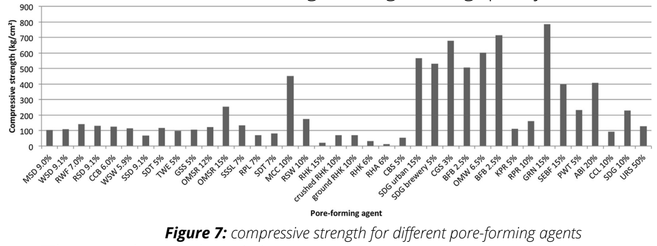
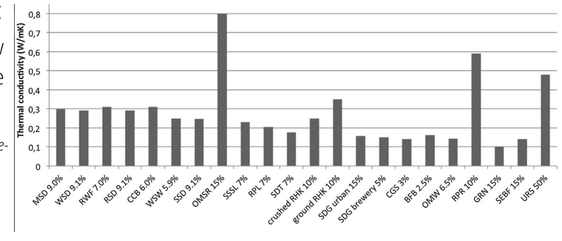


Figure 7: *compressive strength for different pore-forming agents*

Thermal conductivity:

This test is conducted to know the thermal properties of the material

Figure 7: *Thermal conductivity for different pore-forming agents*



References:

- Development of eco-friendly porous fired clay bricks using pore-forming agents. *Journal of Environmental Management 2014, Cecile Bories et al.*
- The UK brick making process, *Brick Development Association.*
- Mineralogical, physico-chemical and technological characterization of clay from Bensmim (Morocco): Suitability for building application, *Construction and Building Materials, Ghita El Boukili, Asmae Khaldoune et al.*