

Influence of raw materials composition on firing shrinkage, porosity, heat conductivity and microstructure of ceramic tiles

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Abstract. In this work some new raw material compositions from alumina, conventional brick-clays and sawdust were mixed, compacted and heat treated by the authors. Depending on raw material compositions and firing temperatures the specimens were examined on shrinkage, water absorption, heat conductivity and microstructures. The real raised experiments have shown the important role of firing temperature and raw material composition on color, heat conductivity and microstructure of the final product.

1. Introduction

In the last years in the convectional ceramic industry several works have shown the important roles of bio-original pore-forming additives both in technological processes and quality of final products [1-6]. The microstructure of the convectional brick-clays was examined and detailed described in the above works under paining the importance of the gaps between the solid particles of the used materials. To improved the thermal insulation of convectional brick-products waste materials were used by [7]. To predict the thermal performance of lightened fired clay-bricks organic additive materials were used by [8, 9]. Using sawdust and other bio-origin waste materials the relations between the microstructures and drying properties of ceramic-bricks and roof tiles were examined in [10, 11]. Their experiments have shown that the drying temperature i.e. intensity of drying influence essentially on dried and fired bricks and ceramic roof tiles.

The aims of this work are the development of porous ceramic tiles with increased thermal insulating properties using mixtures of convectional Hungarian brick-clays, alumina powders and sawdust.

2. Materials and experiments

For the laboratory experiments the basic materials was convectional grey brick-clay from Leier Mátradereske in Hungary. The other ceramic raw material was MARTOXID KMS-94 alumina powder from Martinswerk in 0, 20, 40, 60, 80, 100 m%. To alumina-clay mixtures sawdust pore-forming additives of fraction 0-2 mm were added in 0, 2, 4, 6, 8 m%. Before the experiments the ceramic raw materials were dried at 110 °C during 24 hours. After the drying the powders of brick-clays and alumina were measured in proportion as it is sown in Table 1 and mixed. Thereafter 0, 3, 6, 9 and 12 grams of sawdust were added and mixed again. From the so prepared batches of 150, 153, 156, 159 and 162 grams powder mixes ceramic disc of 20 mm diameters were pressed at 220 MPa uniaxial compression equipment and method. Before firing each discs have 5 grams weights.



Table 1. The raw material mixtures

Quantity [g]		
Clay	Al ₂ O ₃	Sawdust
150	0	0 3 6 9 12
120	30	
90	60	
60	90	
30	120	
0	150	

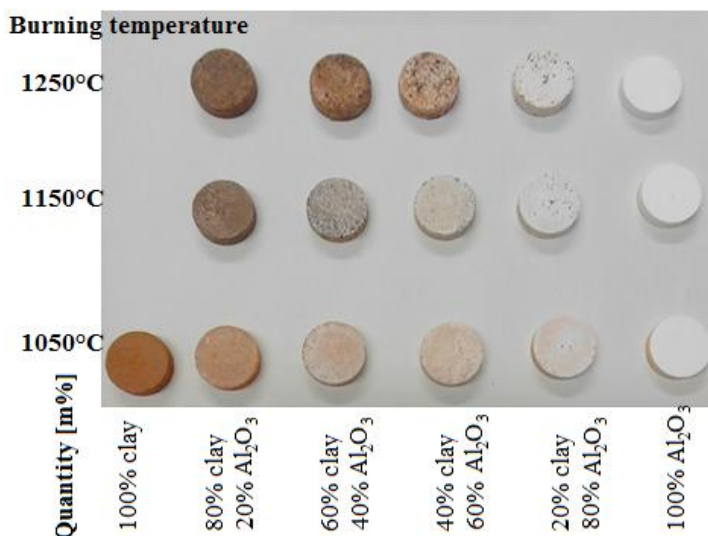


Figure 1. Influence of raw material composition and firing temperature on color of specimens

After compacting the ceramic disc specimens were divided to 3 groups by 10 pieces in each and heat treated (fired) at temperature of 1050 °C, 1150 °C and 1250 °C in laboratory chamber kiln. In Figure 1 are shown how the raw material composition and firing temperature are influenced on color of prepared for testing specimens.

The diameters and weights of each specimen were measured before and after firing. The water absorption and firing shrinkage were also measured and determined on each specimen.

3. Results and Discussion

The firing shrinkages of specimens as function of alumina proportion and sawdust containments at different firing temperatures are shown in Figure 2, Figure 3 and Figure 4 and the water absorptions are shown in Figures 5-7. The water absorption of fired at different temperature specimens determined by Archimedes method.

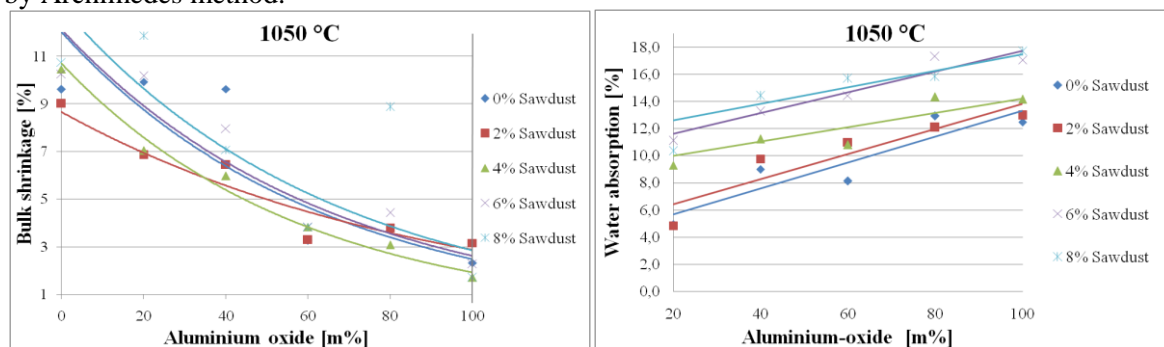


Figure 2. The bulk shrinkage and the water absorption of the test specimens burnt at 1050 °C

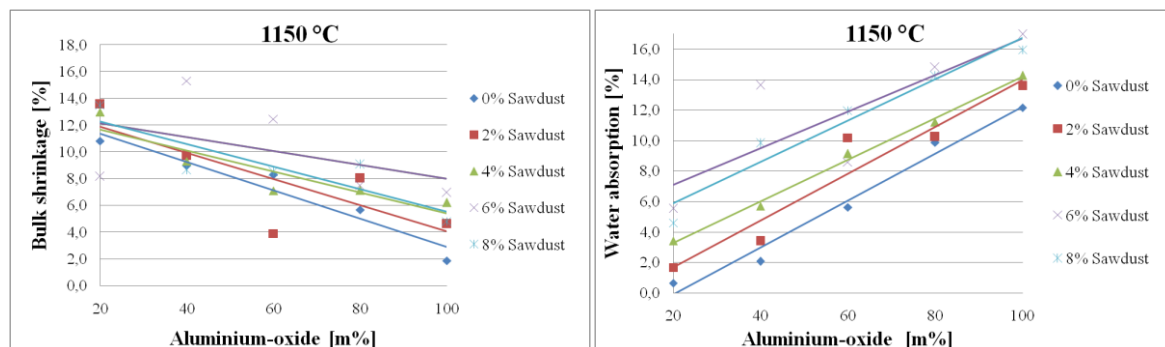


Figure 3. The bulk shrinkage and the water absorption of the test specimens burnt at 1150 °C

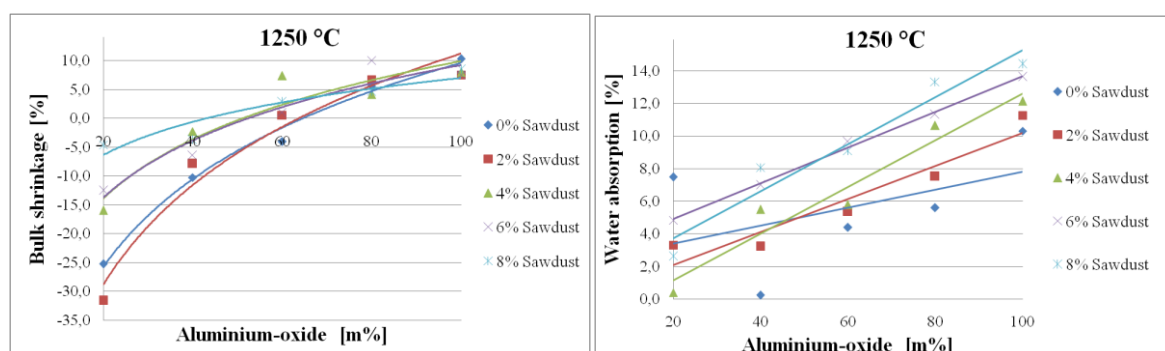


Figure 4. The bulk shrinkage and the water absorption of the test specimens burnt at 1250 °C

Generally the fired ceramics [12-14] convection brick clays have porous microstructures. These microstructures very strong depend on quality and quantity of the used pore forming additives light sawdust, rice husks, sunflower husks and others. From the works [1] and [15] it is well known that the thermal conductivity of fired ceramic bricks strong depends on the quantity and geometrical sizes of mixed in pore forming additives. The thermal conductivities of fired specimens were measured with instrument of C-THERM TCi and are shown in Figures 4.

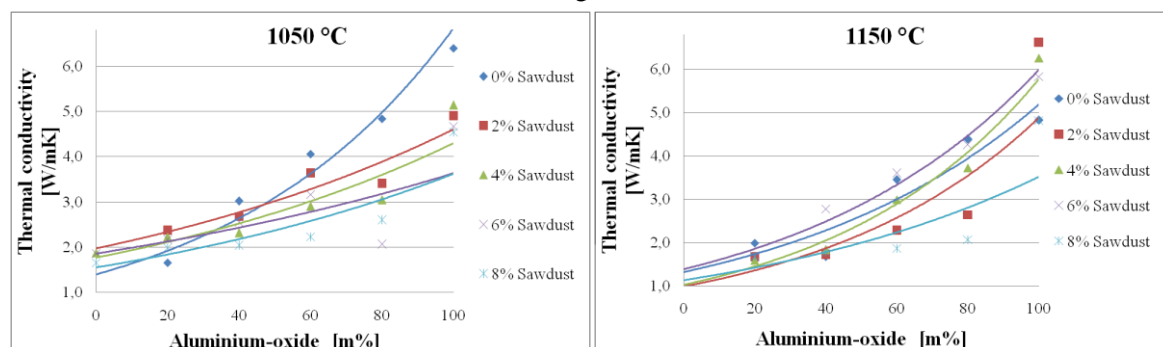


Figure 4. The heat conductivity of the test specimens burnt at 1050 °C and 1150 °C

4. Conclusions

The raw material composition and firing temperature are influencing very strong on microstructure, firing shrinkage, water absorption and heat conductivity of fired ceramic tiles. The realized experiments have shown that the water absorption, therefore the porosity are very strong depended on the volume of alumina in the raw materials mixtures. The thermal conductivities of prepared ceramic someplace have increased considerable with increasing the containment of alumina in the raw materials mixtures.

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