

Chapter 1

Introduction

Abstract This chapter presents the main topics that will be discussed in the book.

Keywords Porcelain tile · Coffee industry · Coffee hush ash · Properties

Porcelain stoneware tile is the class of ceramic coatings of highest added value in the market of floors and coatings due to its excellent technical characteristics. This condition allowed manufacturers of porcelain stoneware tiles to invest in technology for control and automation of the manufacturing process of their products. Strict criteria in the selection and purchase of raw materials have also been established. The commercial value of a product, in any situation, is crucial for its marketing; however, in relation to porcelain stoneware tile, product quality is also critical to its acceptance in the consumer market.

Seeking better competitiveness, manufacturers invest in research to better understand the factors and processes that influence the properties of the final product and to control them in order to obtain the desired microstructure. The challenge is to produce porcelain stoneware tiles in an economically viable way, and within the quality standards required by regulatory agencies.

Many researchers concentrated efforts to find a flux material, with technical and economic feasibility to allow its use in the manufacture of porcelain stoneware tiles. Flux material play an important role in the final microstructure of the ceramic coating. During firing, these materials form a liquid phase that fills the pores, decreasing porosity and water absorption, promoting the thermodynamic conditions for the growth of mullite crystals in acicular shape and contributing to increase the mechanical strength. However, to promote the desired effects, it is necessary that the liquid formed during burning has adequate amount and viscosity characteristics. Currently, feldspar is the flux material most widely used by porcelain manufacturers, since it is responsible for obtaining products with excellent technical and aesthetic properties. Costs with the purchase of feldspar significantly contribute to the final product price. According to some studies, some flux materials can keep the technical properties or even improve them, but compromise the

aesthetic of the product, restricting its use only in glazed porcelain tiles. When the aesthetic factor is essential, such as the manufacture of polished porcelain tiles, the proportion of feldspar in the ceramic mass can reach 50 % by mass. Flux materials that allow decreasing this ratio without impairing the technical properties and favorable regarding the availability and costs of acquisition are well accepted by manufacturers. Thus, many industrial and agricultural wastes have potential to be investigated in order to assess its use in ceramic masses in general and also in the manufacture of porcelain stoneware tiles. Thus, the environmental is also favored, since besides the recovery of waste, once discarded, the extraction of a natural raw material is reduced.

Brazil is the largest coffee producer in the world, responsible for over 30 % of world's production. The process of coffee processing produces waste and the main and of largest amount produced is the coffee bark. Domestic production generated approximately 2,668,780 tons of coffee husks in the 2011 harvest, since for each kg of processed coffee 1 kg of husk is obtained. Coffee husk ashes are obtained when the husks are burned to generate heat for drying the fruit. These ashes are produced in large amounts by farms that use mechanical dryers, and use coffee husks as fuel. Coffee husk ashes are usually discarded by farmers randomly, without proper treatment and in places near the farms, often at roadsides, rivers and streams. Coffee husk ash has large amounts of potassium oxide (K_2O), and to a lesser extent, calcium oxide (CaO) and magnesium (MgO). Together, these alkali oxides and earth alkaline account for almost 95 % of the material, giving it flux characteristic, that is, it melts at lower temperature when compared to clay minerals.

The aim of this book is to show the possibility of reducing the consumption of feldspar in the production of porcelain stoneware tiles by adding coffee husk ash byproducts as flux material in the industrial ceramic mass. This book is divided in nine chapters (Introduction, Porcelain Tile, Solid Waste Materials, Coffee Industry in Brazil, Using CBA in Ceramic Formulations, Theoretical Analysis of Crystalline Phases, Physical and Mechanical Properties of CBA incorporated Materials, Mullite and Leucite formation), where results and discussion about this probability were shown.

The raw materials investigated were collected directly in a manufacturer of glazed porcelain tiles located in the municipality of Dias d'Ávila, state of Bahia. The compacting pressure, firing temperature and holding time parameters were the same as those used in the company. For comparison purposes, a standard mass (SM) with raw materials in the same proportion used by the company and with no addition of the coffee waste were analyzed.