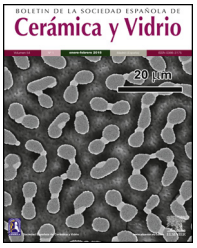
BOLETIN DE LA SOCIEDAD ESPAÑOLA DE
Cerámica y Vidrio
www.elsevier.es/bsecv



Recycling liquid effluents in a ceramic industry

Bruno Araújo de Almeida[a,*], *Margarida Almeida*[a], *Sónia Martins*[b], *Vera Alexandra Maçarico*[b], *António Tomás da Fonseca*[a]

[a] *Department of Materials Engineering and Ceramic, University of Aveiro, Aveiro, Portugal*
[b] *EUROCER, Indústrias de Sanitários S.A., Quinta Peixoto, Carambacha de Baixo, Carregado, Portugal*

ARTICLE INFO

Article history:
Received 28 November 2015
Accepted 8 April 2016
Available online 10 May 2016

Keywords:
Ceramics
Slip casting
Recycling
Liquid effluents

ABSTRACT

In this work is presented a study on the recycling of liquid effluents in a ceramic installation for sanitary industry. The effluents were characterized by X-ray diffraction and inductively coupled plasma to evaluate their compositions. It was also assessed the daily production rate. Several glaze–slurry mixtures were prepared and characterized according to procedures and equipment of the company's quality laboratory. The results show that for most of the properties, the tested mixtures exhibited acceptable performance. However, the pyroplasticity parameter is highly influenced by the glaze content and imposes the separation of glaze and slurry liquid effluents. In addition, it is necessary to invest on a storage plant, including tanks with constant stirring and a new pipeline structure to implement the reincorporation method on the slurry processing.

Reciclaje de efluentes líquidos en una industria cerámica

Palabras clave:
Cerámica
Moldeo en barbotina
Reciclaje
Efluentes líquidos

RESUMEN

Este trabajo presenta un estudio sobre la recuperación de efluentes líquidos en una instalación de cerámica de sanitarios. Los efluentes se caracterizaron por difracción de rayos X y plasma de acoplamiento inductivo para evaluar sus composiciones. También se evaluó la tasa de producción diaria. Se prepararon y caracterizaron varias mezclas de esmalte y pasta cerámica de acuerdo a los procedimientos y equipos de laboratorio de calidad de la compañía. Los resultados muestran que para la mayoría de las propiedades, las mezclas presentan un comportamiento aceptable. Sin embargo, la piroplasticidad está fuertemente influenciada por la cantidad de esmalte y requiere la separación de los 2 efluentes líquidos. Además, es necesario invertir en tanques de almacenamiento con agitación constante y una estructura de tuberías para implementar el método de reciclaje para la producción de nueva suspensión cerámica.

* *Corresponding author.*
E-mail address: brunoalmeida@ua.pt (B.A.d. Almeida).
http://dx.doi.org/10.1016/j.bsecv.2016.04.004

Introduction

The development of societies was accompanied by political decisions with intent to improve the quality of living of citizens and maintain the environmental balances. The expansion of modern civilization led to an intense growth of wastes, with two main origins: urban areas and industrial regions. The consequences of the rise on the production of wastes are serious, not only from the economic and financial point of view, but especially related to public health. Over the years, community governments legislated and stimulated people to reduce the production of wastes. In addition, several integrated systems are proposed to manage these sub-products: recycling [1–13], composting [1], energetic incineration [1,8,14] and disposal in sanitary landfills [1,8,14,15]. In Europe and Portugal, several directives and laws have been established to encourage and regulate the management and treatment of the industrial residues produced by industries [16–19]. Product manufacturing of ceramic industries causes high volumes of effluents, with variable composition, depending on the areas of the factory where they are generated. Raw materials, ceramic products, decoration or fuel are sources of wastes produced on different stages of the processing. Independently of the origin or type of waste, the effluents must be treated and processed, in order to minimize the environmental impact. The case study present on this document describes Eurocer, a ceramic factory from the Sanitex Group, producer of sanitary ware which generates liquid effluents during the daily work on the plant. In general, the effluents produced on ceramic factories contain the same elements as the raw materials and might be reincorporated in the productive cycle [20]. Even so, the quantitative composition of the effluents might be different when comparing to the slurry. These differences are related with the several places of the plant where they are generated: areas of preparation of glaze, slurry and gypsum molds, glazing areas, casting rooms and technical laboratories. Currently in Eurocer, all the produced effluents are directed and saved in a storage tank, with permanent stirring, ready for posterior treatment. Each day, part of the effluent accumulated is transformed to cakes with $0.92 \times 0.92 \times 0.02\ m^3$ with 30–35% humidity, in a filter press and saved on a specific area for posterior treatment. These cakes are then collected and transported by specialized companies into landfills for disposal, involving a maximum global cost of 250 €/ton. This fact is one of the main reasons for developing a project to study the possibility to treat these effluents internally without intervention of external entities. The treatment of industrial residues can be performed using the recycling technique [1,8,12,13]. With this in mind, the main goal of this work is to assess the possibility to reincorporate the daily produced effluents on the preparation of slurry. Fig. 1 shows a schematic example that illustrates the several stages for the manufacturing of sanitary products and the areas of the plant where liquid effluents are generated in significant volume.

The processing steps on Eurocer are similar to other ceramic factories producing sanitary ware. The process initiates with the milling and mix of the hard and plastic raw materials, with water. After the preparation of the slurry and the glaze is complete and before going for production, both are controlled in the technical laboratory to ensure all the quality requirements. The slurry is then used on the casting process, using gypsum molds, followed by a drying process. After this, the products are glazed in specific shops before going to the firing step. During most of these moments, liquid effluents are produced. The total amount of generated effluents is saved in a tank, with permanent stirring and its volume corresponds to the sum of the partial liquid effluents created on the different areas of the plant: GSPE – glaze and slurry preparation effluents; MPE – molds preparation effluents; CE – casting effluents and GE – glazing effluents. To achieve the mentioned goal, the effluents can be considered as raw materials and must be characterized. In addition, other requirements are mandatory to address a final conclusion on the viability of the reincorporation of the effluents in the slurry: ensure the available amount of effluent for the slurry preparation; characterize the effluent in a daily basis to minimize the properties variation and also, if necessary, perform pre-treatment of the effluents. The main goal of this work is to save the costs that Eurocer currently has with liquid effluents. On one hand, the use of the generated effluents on the preparation of slurry avoids the need of external entities to collect, transport, deposit and

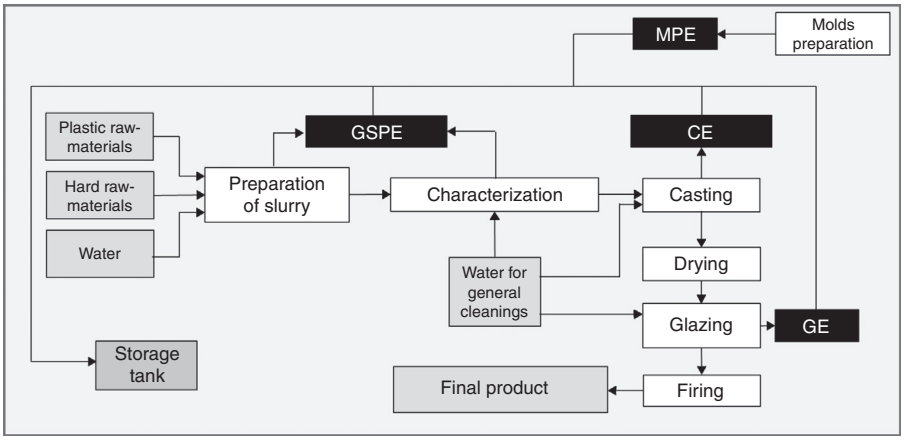


Fig. 1 – Steps of the manufacturing process of Eurocer and effluents generated: GSPE – glaze and slurry preparation liquid effluents; MPE – molds preparation liquid effluents; CE – casting liquid effluents and GE – glazing liquid effluents.