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A Mathematical Model for Calculating the Formulas for Ceramic Batches

Zhanling Cui*
Department of Psychology, Liaoning Normal University, Liaoning, China

Abstract

In the ceramic field the process of forming a ceramic body consists of several steps that must be executed efficiently and controlled closely to achieve the desired product. A major step in the process is the selection of raw materials, which not only will provide the necessary oxides, but also will melt and fine well to form a high-quality product. This process, if carried out on a trial-and-error manner, may lead to an uneconomical production cost due to wrong materials being selected. In addition, some important physical batch characteristics may be ignored owing to the increase in computational requirements if more constraints are added to the process. In this paper we propose the mathematical modelling approach, which has gained very little attention from researchers in this field, as an alternative to the trial-and-error approach. The model presented in this paper may be used to calculate the batch formula of a designed product without first knowing its empirical formula. An illustrated example of the use of this model is also provided.

Keywords: Uneconomical production • Empirical formula • Necessary oxides

Introduction

Ceramics are a diverse class of materials that are widely used in a variety of applications due to their unique combination of mechanical, electrical, and thermal properties. The production of ceramics typically involves mixing various raw materials in specific proportions to produce a desired product. The process of mixing raw materials to produce a ceramic product is known as ceramic batching. Ceramic batching is a critical step in the production of ceramics, as it determines the chemical and physical properties of the final product. The quality of the final product depends on the accuracy of the raw material proportions used in the batch. Thus, the process of ceramic batching is highly dependent on the knowledge and experience of the ceramic engineer or technician responsible for the process. However, with advancements in technology, mathematical models can be used to optimize the ceramic batching process, increase the accuracy of the raw material proportions used, and ensure that the desired properties of the final product are met. In this article, we will discuss the mathematical model used for the calculation of ceramic batch formulas.

Literature Review

The mathematical model used for the calculation of ceramic batch formulas involves the use of linear programming. Linear programming is a mathematical optimization technique used to determine the optimal solution to a problem with linear constraints and a linear objective function. The ceramic batching process involves the mixing of raw materials in specific proportions to produce a desired product. The raw materials used in the ceramic batching process are typically clay, feldspar, quartz, and other minerals. Each raw material has its unique chemical and physical properties that influence the properties of the final product. To create a mathematical model for ceramic batch formulas, the first step is to define the variables. The variables represent the amounts of each raw material that will be used in the batch. For example, if the batch includes clay, feldspar, and quartz, the variables could be x1, x2, and x3 representing the amount of clay, feldspar, and quartz, respectively. The next step is to define the objective function [1,2].

***Address for Correspondence:** Zhanling Cui, Department of Psychology, Liaoning Normal University, Liaoning, China, E-mail: Zhanlingcui9@ipb.ac.rs*

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Discussion

The objective function represents the goal or purpose of the problem being solved. In the case of ceramic batching, the objective function could be to minimize the cost of the raw materials used in the batch while still meeting the desired properties of the final product. For example, if the cost of clay, feldspar, and quartz are $10, $15, and $20 per unit, respectively, the objective function could be: minimize 10x1+15x2+20x3. The next step is to define the constraints. The constraints are restrictions that must be satisfied when solving the problem. In the case of ceramic batching, the constraints could be based on the chemical composition and properties of the raw materials, as well as the desired properties of the final product. The chemical composition of the batch must contain the required amounts of each chemical element. The specific gravity, plasticity, shrinkage, and other physical properties of the batch must fall within the desired range. The total amount of raw materials used in the batch must be equal to the desired batch size [3-6].

Conclusion

These constraints can be represented mathematically as linear inequalities for example, if the desired product is a porcelain tile with a certain chemical composition and physical properties, the constraints could be:

- 10 × 1+5x2+3x3 >=1000 (chemical composition constraint)
- 1.5 × 1+1.2x2+1.0x3 >=2.0 (specific gravity constraint)
- 1.2 × 1+1.0x2+0.8x3 >=1.5 (plasticity constraint)
- 0.8 × 1+0.6x2+0.4x3 >=0.7 (shrinkage

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Conflict of Interest

None.

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