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The Expansion Kinetics of Cellular Glass in the Thermoplastic State under the Hydrated Mechanism of Gas Formation

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Abstract—The problems of extending cellular glass in the pyroplastic state under a hydrated mechanism of gas formation are considered. It is established that the use of water vapor allows varying the product's properties over wide limits and get ecologically safe materials. It is shown that the volume of gases released during the reaction and the viscosity of the melt are the factors determining the extension of cellular glass. The kinetic characteristics of the extension of the cellular structure of glass in the thermoplastic state are determined.

Keywords: foam glass, hydrated mechanism of gas formation, expansion kinetics, technology
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INTRODUCTION

The synthesis of the cellular material from waste glass is an effective recycling method [1]. Cellular silicate glass or foam glass possesses a complex of characteristics making the material in demand in innovative products and constructions, and the use of cullet as a raw material allows solving problems of the ecological safety of the municipal economy in a complex manner [2]. The widespread interest in foam glass has led to the creation of new industries, as well as to extensive theoretical and applied research in the field of the directed production of a material with a set of predetermined properties. To date, B.K. Demidovich's monographs [3, 4] are considered to be the most complete and significant contributions related to the problem.

These works show that the formation process of a material's cellular structure bears a complicated character that is extended in time. The general rate of the foam formation and growth depends on multiple factors such as the rate of the chemical reaction of the gas formation, the viscosity of the melt, the gas permeability of the semi-manufactured product, and the thermal conductivity of the material. These parameters depend on the temperature and the constitution of the original composition and can vary during the process, which leads to many more difficulties in interpreting the results and predicting the parameters for obtaining the required results, especially during the growth of volume production to an industrial scale. As a result, only a limited number of articles describe the kinetics of the formation of a cellular structure in a glass melt.

The method of quasi-homogeneous approximation can be successfully used for the case of the calculation of the properties of the raw powder composition [5], when the real inhomogeneous disperse material is represented by a homogeneous one, and the real physical properties of single components are replaced by the effective properties of the entire raw composition. The construction of the theoretical model is considerably complicated under the onset of the gas formation in the layer of the mixed material. In this case, there are only partial solutions, for example, the kinetics of the extension of granular foam glass can be described in the form of a generalized equation of the chemical reaction applied to reactions involving solid substances [6]. Models of different stages, generalized in the review [7], have been suggested for the process of obtaining block foam glass; however, the limitation of these models of being bound to a specific reaction of the gas formation, the properties of the particular mixed material, and the separate stages of the process do not allow us to put them into practice for designing industrial equipment.

Obtaining the experimental kinetic dependences is considered much more effective for solving this problem. In this investigation the problem of determining the kinetic characteristics of an extension of the cellular structure of glass under the thermoplastic condition is stated bearing in mind the possibility of the further using the obtained data under the calculation of the production characteristics of industrial equipment.