World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:18, No:12, 2024

Modeling of Hot Casting Technology of Beryllium Oxide Ceramics with Ultrasonic Activation

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Abstract : The article is devoted to modeling the technology of hot casting of beryllium oxide ceramics. The stages of ultrasonic activation of beryllium oxide slurry in the plant vessel to improve the rheological property, hot casting in the moulding cavity with cooling and solidification of the casting are described. Thermoplastic slurry (hereinafter referred to as slurry) shows the rheology of a non-Newtonian fluid with yield and plastic viscosity. Cooling-solidification of the slurry in the forming cavity occurs in the liquid, taking into account crystallization and solid state. In this work is the method of calculation of hot casting of the slurry using the method of effective molecular viscosity of viscoplastic fluid. It is shown that the slurry near the cooled wall is in a state of crystallization and plasticity, and the rest may still be in the liquid phase. Nonuniform distribution of temperature, density and concentration of kinetically free binder takes place along the cavity section. This leads to compensation of shrinkage by the influx of slurry from the liquid into the crystallization zones and plasticity of the castings. In the plasticity zone, the shrinkage determined by the concentration of kinetically free binder is compensated under the action of the pressure gradient. The solidification mechanism, as well as the mechanical behavior of the casting mass during casting, the rheological and thermophysical properties of the thermoplastic BeO slurry due to ultrasound exposure have not been well studied. Nevertheless, experimental data allow us to conclude that the effect of ultrasonic vibrations on the slurry mass leads to it: a change in structure, an increase in technological properties, a decrease in heterogeneity and a change in rheological properties. In the course of experiments, the effect of ultrasonic treatment and its duration on the change in viscosity and ultimate shear stress of the slurry depending on temperature (55-75℃) and the mass fraction of the binder (10 - 11.7%) have been studied. At the same time, changes in these properties before and after ultrasound exposure have been analyzed, as well as the nature of the flow in the system under study. The experience of operating the unit with ultrasonic impact has shown that at the same time, the casting capacity of the slurry increases by an average of 15%, and the viscosity decreases by more than half. Experimental study of physicochemical properties and phase change with simultaneous consideration of all factors affecting the quality of products in the process of continuous casting is labor-intensive. Therefore, an effective way to control the physical processes occurring in the formation of articles with predetermined properties and shapes is to simulate the process and determine its basic characteristics. The results of the calculations show the whole stage of hot casting of beryllium oxide slurry, taking into account the change in its state of aggregation. Ultrasonic treatment improves rheological properties and increases the fluidity of the slurry in the forming cavity. Calculations show the influence of velocity, temperature factors and structural data of the cavity on the cooling-solidification process of the casting. In the calculations, conditions for molding with shrinkage of the slurry by hot casting have been found, which makes it possible to obtain a solidifying product with a uniform beryllium oxide structure at the outlet of the cavity.

Keywords : hot casting, thermoplastic slurry molding, shrinkage, beryllium oxide
Conference Title : ICC 2024 : International Conference on Ceramics
Conference Location : Istanbul, Türkiye
Conference Dates : December 23-24, 2024