THE MATHEMATICAL MODEL FOR STUDYING THE PROCESSES OF HEAT AND MASS TRANSFER OF CRYSTALLIZING SOLUTIONS

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Evaporation of crystallizing solutions is widely used in technological schemes of enterprises in various industries. Film evaporators, in comparison with other types, are distinguished by a greater intensity of heat exchange processes and a short contact time of the solution with the heat exchange surface, which is essential when evaporating crystallizing solutions.

At present, theoretical studies of the processes of film flow of crystallizing solutions, taking into account the features of the flow of three-phase liquids and crystallization processes, are practically absent.

A mathematical model for studying the processes of heat and mass transfer in the evaporator with a falling film was proposed. Mathematical modeling is quite useful tool for investigation considering such factors as the complexity of the simultaneous processes (heat transfer during boiling, crystallization on a solid surface and in a volume) and the high cost of experimental studies. The creation of the mathematical model of a film flow of a suspension with a crystalline component is significantly complicated due to the mutual influence of the processes of boiling and scale formation (crystallization on the heating surface). When considering these processes, it is necessary to take into account the nature of the formation, growth, and destruction of the crystalline phase and the vapor phase. The process of chaotic motion of the solid phase in the falling film also has a significant effect on the boiling process: the formation, growth and destruction of vapor bubbles that appear on the heat exchange surface and their carry out toward the evaporation surface.

Evaporation of the liquid phase and crystallization of the solid phase leads to a change in the concentration of these phases. Due to the small thickness of the film, the turbulent influence of vapor bubbles floating up to the evaporation surface, and the chaotic movement of the solid phase, it can be assumed that the change in concentrations occurs only along the length of the film, while the concentrations remain constant in the cross section of the film. The processes in a continuous medium are described by a system of differential equations of motion, continuity, energy, and heat transfer. In addition, differential equations are added for changing the mass content of the solid phase in the suspension, changing the concentration of the liquid phase, changing the saturation concentration of the solid phase, i.e. crystallizing component, conservation of the masses of the liquid and solid phases.

The developed model can be used to study the influence of various factors on the processes of evaporation of crystallizing solutions in a falling film.