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Kinetics of interaction of magnesium oxide with NaCl–H_2SO_4–H_2O solutions

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Abstract

The kinetics of the interaction of magnesium oxide powder with NaCl–H_2SO_4–H_2O solutions was studied using a thermographic method modified in relation to the task. A device was used that provides a record of the temperature in the reactor with an accuracy of 0.10 °C with a frequency of 5 sec and a record of the signal on the computer in the form of a graph in the coordinates "temperature-time", as well as in a tabular form. The composition of the solutions was changed in the range of total (NaCl+H_2SO_4) concentration from 0.1 to 2.0 mol/l and, changing within the interval, the H_2SO_4 concentration from 0 to 2 mol/l. Of the two possible reactions, the reaction is more thermodynamically preferable with the formation of magnesium sulfate than with the formation of magnesium chloride.

With an initial solution volume of 100 ml, the amount of magnesium oxide responded to the formation of sulfate, the amount of oxide being introduced with an excess of 53%. The experiments were carried out at the initial temperatures of the solution in the reactor, equal to 23.8, 34.3, 45.1, and 51.0 °C. Subsequent analyses of the composition of the solution and measurement data used for the compilation of material and heat balances. On the basis of heat balance you performed the determination of the kinetic equation by analyzing the curves of the "temperature-time". It is found that the increasing part of the curve in the region from the initial to the maximum temperature is approximated by a polynomial of degree 3, and the falling part of the curve of the graph is linear. The dependence of the reaction rate (1) on the solution composition and temperature was determined by mathematical processing of both parts of the graph. It is also determined that the type of speed dependence on the degree of transformation does not meet the known kinetic models of heterogeneous processes. It is found that due to the exothermicity of the process its kinetics is controlled by convective heat exchange. On the basis of the research, kinetic parameters are established: the speed constant equal to $9.87 \cdot 10^4$ mol/sec, the order of H_2SO_4 concentration in the solution equal to 0.311, the activation energy equal to 18.61 kJ/mol and the dependence of the speed on the degree of transformation in the form of an equation that determines the deviation from the kinetic model of the compressing nucleus.

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