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Catalytic oxidation of cation exchanger KU-2×8 with an aqueous solution of hydrogen peroxide

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Abstract

During the operation of nuclear power plants, spent ion-exchange resins are formed, which are heterogeneous radioactive low-level waste in the form of particles from a cross-linked organic polymer. Such resins may not always be regenerated. Therefore, the disposal of spent ion exchange resins is currently one of the primary problems at nuclear power plants. Conventional technologies for the processing of waste resins are relatively expensive. In addition, there are difficulties with transportation and storage of waste, and the disposal of spent ion exchange resins is a complex process. In the present study, an attempt has been made to solve the problem of spent ion-exchange resins utilization on example of the sulfonic acid cation exchanger's KU-2×8 oxidative degradation with the Fenton reaction. The decomposition of the cation exchanger was carried out with 20% hydrogen peroxide in the temperature range 323-353 K in the presence of a catalyst – low concentration copper(II) sulfate (0.001-0.009 mmol/l). The influence of process temperature and catalyst concentration on the reaction rate was estimated. When determining the rate of the cation exchanger KU-2×8 heterogeneous oxidation reaction with hydrogen peroxide in the presence of a catalytic additive, the spherical shape of the sorbent granules, the surface area of which changed during reaction, was taken into account. It was shown that with a reaction temperature increasing from 323 to 353 K, the rate constant of cation exchanger's oxidative decomposition have increased by a factor of 20-37. The activation energy values of the sulfonic acid cation exchanger's KU-2×8 decomposition with hydrogen peroxide in the presence of copper(II) sulfate are 89.7-115.2 kJ/mol, which indicates that the process is in the kinetic mode. It was established with electron-microscopic studies that the beads of the cation exchanger KU-2×8, when decomposed in H_2O_2 solution in the presence of a catalyst can stick together, change their shape and volume, and their surface becomes covered with cracks. The studies performed showed almost complete catalytic decomposition of cation exchanger KU-2×8 in a hydrogen peroxide solution at 323-353 K after 420-220 minutes, which allows accelerating the oxidation at relatively low temperatures.

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