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Utilization problems of spent ion-exchange resins of nuclear power plants

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Abstract

Significant amounts of low-level spent ion-exchange resins required for utilization have accumulated at nuclear power plants in the Russian Federation. Utilization based on their specific character is distinguished by relatively high economic costs. A comparative analysis of technologies and methods of spent radioactive ion-exchange resins reprocessing of nuclear power plants is carried out. The forecast of an increase in the number of spent ion-exchange resins, which are liquid radioactive waste from the operation of nuclear power units, is presented. The main goal of this research is to solve the problem of spent ion-exchange resins utilization by the most environmentally safe way with minimal formation of solid radioactive residue. The technologies of cementation, bitumenization, vitrification, polymer matrix fixation, deep decontamination, thermal reprocessing of spent ion-exchange resins, as well as utilization methods combining all the mentioned above technologies for spent ion exchanger reprocessing are considered. The technological features of each method are described; both their advantages and main disadvantages are defined, as well as the prospects for their practical use. The requirements providing reliability of storage are analyzed for ion-exchange resins before their delivery for storage, disposal or further reprocessing. These requirements include both spent ion exchange resin dehydration and carrying out of technological operations leading to the destructuring of the ion exchange resin polymer matrix or irreversible changes on the surface of their grains, and, consequently, to the loss of the propensity of ion exchange resins to swell when contact with water. The conclusion is made about the prospects and efficiency of spent radioactive ion-exchange resins utilization by oxidative decomposition with an aqueous solution of hydrogen peroxide (H_2O_2) in the presence of catalytic additions of transition metals salts and the subsequent microbiological destruction of the organic phase in an aqueous organic solution using special strains of bacteria-destructors. The reaction of the transfer of IOS into the liquid phase can proceed at ambient temperature, and the subsequent microbial treatment of the solution leads to a complete decomposition of the organic phase into simple chemical components.

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