CONCENTRATION OF LIQUID RADIOACTIVE WASTE USING BIOPOLYMER-ENHANCED ULTRAFILTRATION

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Radioactive liquid wastes originating from production and application of radioisotopes contain radionuclides that are predominantly small metal ions like Sr\textsuperscript{2+} or Co\textsuperscript{2+}. This ions can be removed from radioactive solutions by such membrane methods like reverse osmosis or ultrafiltration if they are large enough to be retained by the membrane. Contrary to reverse osmosis, ultrafiltration is a process that does not need high pressures to be applied. Furthermore, it can involve ceramic or metallic membranes, which are chemically and thermally resistant. They exhibit also high resistivity to ionising radiation that makes them suitable for various applications in nuclear industry. However, when ultrafiltration membranes are applied for retention of metal ions present in low-level radioactive wastes, such small species have to be formerly bound with macromolecular compounds to form complexes that can be easily retained by the membrane.

The sorbents like biopolymers in their natural form are inexpensive and abundant materials. They can be produced by different ways: direct extraction from plants (alginites, cellulose) and animal organisms (chitin, chitosan) or they can be synthesized. In the present work biopolymers were tested as potential sorbents for \textsuperscript{85}Sr and \textsuperscript{60}Co and as complexing agents for Sr\textsuperscript{2+} and Co\textsuperscript{2+} ions in water solutions.

Biosorbents based on alginic acid obtained from marine algae, and its derivatives like sodium or calcium alginites were applied in the experiments. The sorbent had solid, granular (calcium alginate) or dispersed, soluble in water (sodium alginate, alginic acid) forms. In the beginning of experiments sorption conditions of Co\textsuperscript{2+} and Sr\textsuperscript{2+} ions and radionuclides of \textsuperscript{60}Co and \textsuperscript{85}Sr on biosorbents were tested. The influence of pH and ionic strength on the efficiency of sorption was studied. Experiments showed that after 10 minutes of the contact with the biosorbent sorption equilibrium was achieved. The metal complexes formed could be filtered with ultrafiltration membranes, which resulted in high concentration of radioactive substances in retentate. Filtration experiments were carried out with Amicon cell equipped with polysulphone membranes, medium pore size of 10D. Retention of cobalt ions using alginic acid reached 90%, and with sodium alginate ca. 86% at pH 7\textsuperscript{±}8. The retention of strontium ions in the same conditions was 78% and 86%, respectively. Above pH 10 precipitation of hydroxides occurred. The sorption of Co\textsuperscript{2+} on calcium alginate was 80%, and sorption of Sr\textsuperscript{2+} slightly exceeded 80%. Increase of salinity of the initial solution resulted in decrease of Co\textsuperscript{2+} and Sr\textsuperscript{2+} ions retention.

The experiments with \textsuperscript{60}Co solutions of different salinity and with continuous-mode apparatus were performed. The cross-flow system with different ceramic membranes with 1\textsuperscript{±}20 kD medium pore size was used. The highest decontamination factors in ultrafiltration/complexation process were obtained when the membrane 1 kD was applied. For \textsuperscript{60}Co radionuclide at pH=8 decontamination factors were about 10. It was proved that alginate biosorbents can remove radioactive substances from radioactive wastes originating from nuclear industry. In dispersed form they can enhance the ultrafiltration process forming the high-molecular complexes with radionuclides present in the wastes.

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