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Sorption behavior of Sr(II) and Am(III) ions from industrial waste water by low cost natural materials of the biological origin

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Waste waters that contain radioactive metal ions like Sr(II) or Am(III) are dangerous for the environment. There are several methods to remove them from waste water using ion exchange resins, chemical precipitation or reverse osmosis. Very often sorption, precipitation or complexation is combined with ultrafiltration in one hybrid process of enhanced ultrafiltration. Small ions bound by macromolecular agents form complexes, which can be retained by UF membrane. The hybrid complexation-UF method is effectively applied in several plants processing α-bearing radioactive waste streams. Multiple installations are under operation in nuclear centers and much effort was done to implement ultrafiltration for radioactive wastes processing. All these methods, however, are highly energy consuming thus expensive.
Alternative method of eliminating the radioactive metals from waste water is sorption by low cost natural materials of the biological origin. The major advantages of sorption over conventional treatment methods include: (i) low cost, (ii) high efficiency, (iii) minimization of chemical and/or biological sludge, (iv) no additional nutrient requirement; (v) easy regeneration of biosorbent, and (vi) possibility of metal recovery [1,2].
Chitosan is derived from an inexpensive material: chitin. The latter is the second most abundant polymer in nature and can be found in the skeletons of insects and shellfish.
Calcium alginate is a water-insoluble, gelatinous substance that can be produced through the addition of aqueous calcium chloride to aqueous sodium alginate. The parental substance - alginic acid - is a naturally occurring hydrophilic polysaccharide obtained from various kinds of brown seaweeds.
In presented studies, sorption of americium(III) or strontium(II) was studied as a function of contact time, initial pH of water and mass of the sorbent, respectively.
Water was collected in the Institute of Nuclear Chemistry and Technology (Warsaw). Post-decontamination liquids were simulated by dissolving citric acid in the water to obtain 1 M solution prior to the radionuclide addition.
Decontamination Factor - the ratio of specific activity prior to and after decontamination [3] has been found above 95 % for Sr(II) on calcium alginate, while ca. 50 % on polyamino polysaccharide - chitosan.
An attempt to revitalize of the Am(III)- and Sr-loaded sorbents was done by shaking the material at room temperature with different types of desorbing agents.
Thermogravimetric analyzes of the materials show that commercially available products decompose at about 600 0C (calcium alginate) and 700 0C (chitosan) and the residue after ignition as mass is about 5-10 % of the initial material. In contrast, the sorbents obtained in our laboratory decompose at only ca. 200 0C. This means that energy necessary to reduce the mass of the potential solid wastes formed from the latter calcium alginate may be considerably smaller than from the commercial sorbents.

Conclusions:
Laboratory obtained beads of calcium alginate seem to be a better sorbent than the materials commercially available.
Calcium alginate is more effective than chitosan in binding strontium(II) potentially present in the aqueous solutions

Studies were performed in frame of the Strategic Project Technologies Supporting Development of Safe Nuclear Power Engineering Domain 4 Development of spent nuclear fuel and radioactive waste management techniques and technologies.

Bibliography

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[3] http://www.euronuclear.org/info/encyclopedia/d/decontaminationfactor.htm

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