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Selective ion exchangers for Fukushima waste effluent purification

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Two inorganic ion exchangers manufactured by Fortum company, Finland, and developed in collaboration with the Laboratory of Radiochemistry, University of Helsinki, have been selected for the radionuclide removal in a new purification system of Energy Solutions, USA, to be commissioned at the Fukushima power plant in 2012. The system will purify approximately 200,000 m3 of highly contaminated effluents obtained due to pumping of sea water into damaged reactors after tsunami had destroyed controlled water circulation in the reactors. The two ion exchangers are CsTreat® for radioactive cesium removal and SrTreat® for radioactive strontium removal. The former is based on a transition metal hexacyanoferrate and the latter on a sodium titanate. These unique ion exchange materials are produced as granules suitable for column use.

CsTreat® and SrTreat® have been utilised in several industrial radionuclide removal processes during the last twenty years [1]. CsTreat® has been in use at Loviisa NPP since 1991 for the decontamination of high-salt (ca. 200 g/L NaNO3/KNO3) evaporator concentrates and about 1,600,000 litres have been purified with only 230 liters of CsTreat® material with a decontamination factor over thousand [2]. Most recent application of CsTreat® took place in the decommissioning of Dounreay Fast Reactors in the UK [3].

The selectivities of CsTreat® and SrTreat® are much higher than that of common organic resins or other radionuclide-selective inorganic materials. For example, the selectivity coefficient of CsTreat® over sodium (kCs/Na) is 1,500,000, which is four orders of magnitude higher than for zeolites and two orders of magnitude higher than for a silicotitanates [4], both of which have been used in the Fukushima waste effluent treatment. As processing capacity for trace level radionuclide removal is mostly governed by the selectivity, CsTreat® can offer superior performance compared to other Cs-selective materials.

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