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Electrokinetic Decontamination of Concrete

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PI.2 Electrokinetic Decontamination of Concrete

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Introduction:

The U.S. Department of Energy has assigned a priority to the advancement of technology for decontaminating concrete surfaces which have become contaminated with radionuclides, heavy metals, and toxic organics. This agency is responsible for decontamination and decommissioning of thousands of buildings.

Electrokinetic extraction is one of the several innovative technologies which emerged in response to this initiative.

This technique utilizes an electropotential gradient and the subsequent electrical transport mechanism to cause the controlled movement of ionics species, whereby the contaminants exit the recesses deep within the concrete.

Objectives:

The primary mission of this PRDA was to demonstrate the feasibility of this approach as a means to achieve "release levels" which could be consistent with unrestricted use of a decontaminated building.

The secondary objectives were:

- To establish process parameters;
- To quantify the economics;
- To ascertain the ALARA considerations;
- To evaluate wasteform and waste volume.

Observations to Date: The work carried out to this point has achieved promising results to the extent that ISOTRON® has been authorized to expand the planned activity to include the fabrication of a prototype version of a commercial device.

This prototype unit includes a carpet-like surface pad which carries out the extraction step.

The extraction pad is connected via tubing and power cable bundle to the electrokinetic separation module (ESM). This ESM recycles the liquid electrolyte (which is circulated from the extraction pad). The ESM apparatus carries out an electrodialysis separation of radionuclides from the electrolyte.

Current project planning calls for this equipment to be operated at the DOE's K-25 Site during the months of October and November 1995.

Approach:

The technology for electrically forcing

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contaminants through concrete has a precedent in work carried out under sponsorships of the U.S. Department of Transportation. In this application, an electrical gradient is used to prevent corrosion of steel reinforcing within bridge decks. The mechanism provides a means to remove de-icing salts from concrete, and at the same time, the intense cathodic polarity applied to the rebar prevents subsequent corrosion.

The technology for electrically forcing radioactive contaminants through concrete was studied by Dr. William Bostick and colleagues during 1993-1994 with positive results, however, the early work was designed to favor use of electroosmotic transport of contaminants.

The first phase of ISOTRON®'s work focused on study of the fundamentals of dissolution (and subsequent "freeing" of these contaminants from the concrete matrix). Only after the contaminants are solubilized within the concrete matrix, can they be transported.

The development of complexants that could selectively solubilize the "target" contaminant metals was seen to be a strategically vital aspect of this program.

For almost ten years, ISOTRON® scientists have worked on electrical migration of radionuclides through soils, groundwater, concrete, and polymeric materials. This experience provided the requisite insight needed to deal with the technological challenges of dissolution kinetics, as well as transport kinetics related to contaminants in concrete.

ISOTRON® scientists are highly focused on this subject of radionuclide desorption from mineral surfaces. This work involves cooperation with recognized experts in USA, including scientists at Oak Ridge National Laboratory and Los Alamos National Laboratory. The ISOTRON® specialists are also working in close collaboration with Russian scientists who are specialized in this field. Over the past four years, this USA/Russian scientific collaboration regarding this electrokinetic technology involved scientists from the Russian Firm "Radon", Russia's largest processor of radioactive waste materials, Russian Institute (VNIPIPT), Russia's Institute of Mining and Metallurgy (located in Moscow), Russian Institute of Agricultural Radio-Ecology (located in Obninsk), and the Russian organization ENERGOPOOL which is a nuclear equipment design organization (located in Moscow). This collaboration also involves Former Nuclear Weapons scientists from the installations Chelyabinsk, Mayak, and Arzamas.

The ISOTRON® staff and collaborators have, in general, approached this program with an emphasis on understanding the sorption mechanisms which are at work within the concrete matrix and which result in the "capture" of contaminants. Conversely, the technology related to ligand enhanced dissolution has emerged as a significant factor in the efficiency of the process. The selective desorption or dissolution of contaminants is recognized as an important consideration in process optimization.

The optimization of the electrolyte design has been approached with the following success criteria:

1. <u>The electrokinetic transport</u> rate of target contaminants (higher is better).

2. <u>Dissolution kinetics</u> – the ISOTRON® studies have shown that the cleanup rate is controlled by the kinetics of complexant aided dissolution. (Theoretical analysis reveals that this extraction process may be either transport controlled or dissolution controlled.)