POROUS CERAMIC ALUMINOSILICATE MATRICES FOR CONDITIONING OF LIQUID RADIOACTIVE WASTE

Description
A novel porous material was designed on the basis of hollow aluminosilicate microspheres of stabilized composition isolated from fly ash from combustion of power-station coals. A broad range of stabilized products allows the properties of the porous matrices to be modified according to their functionality.

Porous acid-resistant and heat-proof matrices were designed for conditioning liquid radioactive waste (including localization and concentration of radionuclides and their solidification in crystalline forms during processing of high-level radioactive waste from production of actinide and Cs-Sr fractions in the UNEX process), solutions from processing of high- and intermediate-level wastes from interim decay storages, and mixed radioactive waste of laboratory- and pilot-scale volumes. Use of the matrices enables elimination of outdoor storage pools for low-level radioactive waste.

Technical specifications
Apparent density: 0.3-0.6 cm³/g (depending on modification)
Total porosity: 75-90%
Open-cell porosity: 40-70%
Compression strength: 1-4 MPa
Chemical composition (wt.%): 65-68 SiO₂; 19-20 Al₂O₃; 3.2-3.7 Fe₂O₃; 1.6-2.6 CaO; 1.9-3.2 MgO; 2.0-2.9 Na₂O; 1.8-2.2 K₂O; 0.2-0.4 SO₃; 0.2-0.6 TiO₂
Acid resistance (State Standard # 473.1-81): 97.8% in HNO₃; 93.9% in HCl; 95.5% in H₂SO₄; 93.4% in H₃PO₄.

The material is nontoxic and flame- and explosion-proof.

Technical appraisal and economic benefits
In contrast to conventional inorganic porous materials, the porous ceramic aluminosilicate matrices (PCAM), having high buoyancy, are spontaneously distributed over the pool water surface to form a multifunctional surface layer, which enables removal of the liquid phase and solidification of the pool contents without dust formation and biosphere pollution. Matrices with high open-cell porosity exhibit a high level of saturation in processes of multicycle

Porous ceramic matrices of various modifications.
treatment with radioactive waste solutions. Use of matrices with an added selective adsorbent of $^{137}$Cs decreases the volume of Cs-containing radioactive wastes by a factor of 1500. Unlike for porous glasses and fire clays such as light chamotte, the open-cell and closed-cell porosity of the matrices developed can be modified over wide ranges. In contrast to microporous adsorbents, PCAM can easily be dehydrated at low temperatures. Compared to porous materials based on synthetic hollow or porous microspheres ($\text{Al}_2\text{O}_3$, $\text{SiO}_2$, $\text{ZrO}_2$), PCAM are considerably cheaper and are easier to produce.

**Application areas**
- Transportation and processing of different-activity liquid radioactive wastes to obtain solidified compounds for long-term storage and disposal;
- processing of toxic liquid wastes, including chlorine-containing organic components;
- production of different-purpose composite materials;
- supports for catalysts, adsorbents, and ion exchangers;
- reusable heat-resistant aerosol filters;
- regenerable traps for absorption of petroleum, petroleum derivatives, and surfactants from a water surface;
- filters for electrochemical water treatment;
- heat- and acid-resistant light fillings for mass-transfer apparatus;
- heat-insulating materials.

**Development stage**
Large laboratory lots and a pilot lot of PCAM of different modifications have been obtained. PCAM have been tested in conditioning different-activity radioactive wastes at the Mining Chemical Plant (Zheleznogorsk, Krasnoyarsk region), the Khlopin Radium Institute (St. Petersburg), the Idaho National Engineering and Environmental Laboratory (Idaho Falls, United States), and the Fluor Fernald (Cincinnati, USA).

**Patent situation**
Patents were granted in Russia (2001, 2002, and 2003) and the United States (two patents, 2002).

**Commercial offers**
Delivery of a pilot lot of porous matrices;
Delivery of porous matrices at a negotiated price;

**Estimated cost**
From 30 to 600 rubles/dm$^3$ for different modifications of matrices

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