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Biological Treatment of Radioactive Wastes before Cementation

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The possibility of the preliminary microbiological treatment of the oil- and nitrate containing liquid radioactive waste (LRW) before solidification in the cement matrix was studied.
It was experimentally proved earlier that the oil- and nitrate-containing cement compounds during long-term storage are characterized with the microbiological degradation due to the reaction of biogenic organic acids and gases with the minerals of the cement matrix.
We propose to biodegrade the LRW components before their solidification, thus reducing the total volume of LRW and preventing the destruction of the inorganic cement matrix during the long term storage.
The biodegradation of the nitrate-containing LRW (denitration) is possible by using the radioresistant microflora which can use oxygen from nitrate for cellular respiration converting it to molecular nitrogen form (denitrification). It can also degrade some organic molecules as electron donors for cellular respiration and as carbon source. Bacteria were cultivated for 3-4 days for reducing nitrate concentration from 3 gram to 10 mg per liter. We used two ways of cultivation: anaerobic bioreator-denitrifier and biofilter system. All method are suitable for nitrate removing from low level liquid radioactive waste.
The biodegradation of the oil-containing LRW is possible by using the radioresistant microflora which oxidize the organic components of the oil to carbon dioxide and water. Simultaneously there is the biosorption of the radionuclides by bacteria and emulsification of oil in cement slurry due to biogenic surface-active substances of glycolipid nature. It was experimentally found that after 7 days of biodegradation of oil-containing liquid radioactive waste the volume of LRW reduces by factors varying from 2 to 10 due to the biodegradation of the organic phase to the non-radioactive gases (CH4, H2O, CO2, N2), which are derived from the volume of the liquid radioactive waste. The ussage of an aerobic bioreactor with air mixing and bubbling (at fluidized bed) for high oxygen concentration is the most suitable method for this process.
At the same time, the microorganisms due to sorption processes on the cellular structures are able to extract from the LRW up to 80-90% of alpha-radionuclides, up to 50% of 90Sr, up to 20% of 137Cs. The radioactive biomass is subject to dehydration and solidification in the cement matrix.

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