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One step low temperature thermochemical process in air at atmospheric pressure to denitrate a simulated HLLW without or with addition of an aluminoborosilicate glass powder

A novel method published as patent WO2021019319 [1] was applied to denitrate a 3 M nitric acid stream of uranium, lanthanides, metals and non-metals which simulates the high level liquid waste (HLLW) arising from heavy water reactor (HWR) spent fuel reprocessing [2]. Once the denitration of the simulated HLLW was demonstrated a second and third set of tests were run by adding 50 wt.% or 90 wt.% of the German SG7 aluminoborosilicate glass powder to the HLLW in order to denitrate the mixture for obtaining the high level waste (HLW) form material.

Once the 3 M nitric stream of nitrates or oxides of uranium and lanthanides, metals and non-metals was prepared, polyacrylonitrile (PAN) fibers dissolved in concentrated nitric acid were added. Denitration takes place in just one step by thermally treating the nitric steam without or with added glass powder in air at atmospheric pressure and temperatures between 185℃ and 225℃ to obtain a homogeneous nanoparticulated loose dry ash.

The thermochemical process which was developed at inactive laboratory scale merges in a low temperature single step in air at atmospheric pressure all steps from concentration, denitrification, glass mixing, milling to drying and reduces, in this way, the formation of radioactive volatile compounds as well as the generation of secondary waste streams.

The glass, glass-ceramic or ceramic matrix –in our work the German SG7 aluminoborosilicate glass –in the form of a powder with a particle size in the range of 1-100 µm is added and mixed to the nitric stream to render the HLW form material which can subsequently be cold pressed and sintered or hot pressed at temperatures in the range of 610-825℃, or melted at temperatures in the range of 1100-1500℃. The resulting material from the thermochemical process is a dry ash of porous nanometric particles which presents a homogeneous elemental distribution for both the HWR HLLW components and the German SG7 aluminoborosilicate glass.

Results to be reported include scanning electron microscopy, energy dispersive spectroscopy, X-ray diffraction, thermogravimetry and differential thermal analysis.

[1] WO2021019319. BEVILACQUA, A.M.; FERNANDEZ ZUVICH, A.; SOLDATI VALENTE, A.L.; PÉREZ FORNELLS, S.G.; ZOLOTUCHO, H.A.; GONZÁLEZ OLIVER, C.J.R.; SILIN, N. METHOD FOR OBTAINING NANOPARTICULATED ASHES OF ACTINIDE, LANTHANIDE, METAL AND NON-METAL OXIDES FROM A NITRATE SOLUTION OR FROM A NITRATE, OXIDE, METAL AND NON-METAL SUSPENSION.

[2] Ph.D. Thesis. A.M. Bevilacqua. Inmovilización de residuos líquidos de alta actividad simulados en vidrios sinterizados. Instituto Balseiro,ARGENTINA (1992).

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