THE CRITERIA OF QUALITY AND ECOLOGICAL SAFETY OF HARDENED RADIOACTIVE WASTE.

Tatjana Dovbysheva
Belarusian Politechnic Academy Str. Gudro, 23-20, Minsk, 220121, Belarus.
Tel.:375 172 014569, Fax: 375 172 102280, e-mail:tdovbysheva@bntu.by or tdovbysheva@yahoo.com

## Abstract

At present the problem of sustainable management and salvaging of radioactive waste is very important both for the countries, producing cheaper electric power and the countries a territory which have been subjected to radioactive contamination.
It is evident that in the near future the production of the electric power by Nuclear Power Stations will not stop because of economic reason. Therefore the problem of the treatment of the high radioactive waste is still very important nowadays.

The sustainable management of the radioactive waste with different degrees of radioactivity consist of scientific and economic aspect. The latter is related to the great expenses for radioactive waste utilization.
At present the concept of neutralization of high radioactivity waste is limited to solving two problems:
maximum of the concentrating of liquid high radioactive waste and maximum of the reducing of volume of hard radioactive waste (compacting).
· immobilization of concentrate of radioactive waste in compounds, that ensure reliable fixation of radioactive waste.

### Introduction

One of the priorities in the creation of system disposal of radioactive waste is an establishment of transdisciplinary criteria for determination of quality and ecological safety of hardened radioactive waste.
It is necessary to know because it allow to have an opportunity to predict a probable condition of the buried radioactive waste their prospective influence on a condition of an environment through the certain time intervals. This knowledge will allow to take into account prospective influence of this buried radioactive waste on an environment.

### Criteria of quality of hardening radioactive waste

In these paper there are several examples of quality criteria for high radioactive glass similar materials, of cement and bitumen compounds with low and average radioactivity level. They are based on the results of scientific researches and review of existing of international and of national the documents regulatory . ( Table 1).

Table1. Criteria of quality of hardening radioactive waste

| The Criterion of quality high radioactive waste | The high radioactive glass simillar waste | The radioactive grouting waste | The radioactive waste in bitumen compounds |
|---|---|---|---|
| Allowable radioactivity of hardening radioactive waste for □,□ nuclides | - | $3.7*10^7$ Bq/g | $3.7*10^7$ Bq/g |

| | | | |
|---|---|---|---|
| for □-nuclides | - | $3.7*10^4$ Bq/g | $3.7*10^4$ Bq/g |
| The rate of leaching of radionuclides | $10^{-5}$- $10^{-6}$ /cm$^2$day. for $^{137}$Cs<br>$10^{-6}$ g/cm$^2$*day for $^{90}$ Sr<br>$10^{-7}$ g/cm$^2$*day for Pu | $<10^{-3}$ g /cm$^2$day for $^{137}$Cs<br>$<10^{-3}$ g /cm$^2$day. for $^{90}$ Sr | $<10^{-3}$ /cm$^2$day for $^{137}$Cs<br>$<10^{-3}$ /cm$^2$day for $^{90}$ Sr |
| The thermal stability | The absence of changing of a structure and watertight integrity as a result keeping at temperature before 450 $^0$C | The absence of change after 30 cycles of freeze and thawing at temperatures $-40^0$ C+$40^0$ C | The self-ignitation >400C |
| Radiation Stability | The absence of changing of a structure and of a watertight before activity $10^8$ Bq/g for b,g-nuclides<br>$10^{18}$a- Bq/cm$^3$ | The Unchangeable mechanical toughness after irradiation<br>$10^6$ Bq/g | The Increasing a volume less than 10 % after irradiation<br>$10^6$ Bq/g |
| The rate of outgassing | Is not allowed | Is not allowed | Is not allowed |
| The mechanical strength<br>for compression<br>for bending | <br>0.9-1.3 кgc/mm$^2$<br>4.0-4.7 кgc/mm$^2$ | <br>not less 50 кgc/cm$^2$ | <br>-<br>- |
| Thermal constant:<br>the coefficient of thermal broadening<br>the coefficient of heat conduction | <br>8-15*$10^{-6}$ 1/ $^0$C<br>0.7-1.6 Wt/mK<br>T~ 20-500 $^0$C | <br>-<br>- | <br>-<br>- |

Apparently from the table that the method of vitrification of high radioactive waste conforms to the most the strong requirements of decrease of negative influence on an environment. In the result the use of this method :
the speed of leaching radionuclides become less in comparison with methods of cementation of radioactive waste and method of keeping radioactive waste in bitumen compounds
also to absence of allowable radioactivity in hardening radioactive waste.

But this method is rather expensive.
At present the scientists are using not only traditional methods of treatment such as coagulation, precipitation, adsorption etc. for solving the problems of safety burial place of high radioactive waste.
Several perspective modern methods such as method of oxidize catalysis, electronic- beam technologies, UV- a radiation, ultrasound and etc. could be used preferable for solving the problem of radioactive waste.
Radioactive waste recovering problem, especially for ones with specific activity and long lived isotopes of transuranium elements, and has not been solved yet in the framework of securing the ecological safety.
Currently, there are two proposals for radioactive waste salvaging that are discussed.
The first one is disposal in deep geological layers which must been overlayed overhand and from below by water-stop clayey substances - must meet the greater objections.

The second one is the space disposal.
However, the absence of reliable geological term forecast long term, the possibility of loss of tightness itself warm up containers under their interaction with liquid substances including a surrounding rock alongside with other disadvantage factors will be able to obstruct a procedure of final of special system for disposal of radioactive waste in the geological layers, salt disposal and reverse-well disposal of mines.
Possible perspective ways of processing and disposal of radioactive waste is presented nucleus transmutation_ and nuclear disposal in outer space. But transmutation_does not ensure wholly conversion of nuclear waste. Besides there are possible accident with radioactive waste at a moment of the start.
The method of disposal of radioactive waste in space is offering, without possibility of high level waste in upper layers of the atmosphere. For this small dispersed (fine -grained) radioactive waste will to use as fillers an high temperature ceramics or glass- ceramics materials, with radioactive waste form 70 %.
For countries, which have been subjected to radioactive contamination the problems to reclamation and clearing of the soil from radionuclides are very important.. Therefore the problems of development of new technologies of recycling of low- level radioactive waste with maximal concentrating and compacting in small volume are very important nowadays and also concentration of radioactive waste in compound providing reliable fixation of the radionuclides
At present, radioactive pollutants are basically defined basically by radioisotopes $Cs^{137}$, $Sr^{90}$, $Pu^{239}$ , $Pu^{240}$. The area of the territory, where density of pollution by $Cs^{137}$ exceeds 37 kBq/$m^2$ , totals 46,450 $km^2$. Figure 1,2,3.
As a result of the windy carrying of the soil, polluted by radionuclides, occurs a pollution by the radionuclides of the roofs, of the sewers of buildings and particularly of the ventilation equipment in spring-summer period of every year. So it is necessary to do decontaminating work
As result of efforts to decontaminate various industrial and municipal commodities, significant volumes of radioactive decontamination solutions (containing predominantly Cs $^{137}$ and Sr-$^{90}$ ) were generated.
These solutions included surface active substances, complexing agents, and ions of salts of heavy metals..
Earlier these radioactive decontaminated solutions has been utilized by cementation in the blocks with following burial in the repositories.
But in some years in result of leaching in sour soils the contents of radionuclides in the environment began to increase the quite strongly
At present the greater amount of repositories for burial high radioactive waste are on the territory of Belarus. It is impossible to enlarge their quantity hereinafter.

**References**

1.Ampilogova N. Simanovak L. Trapeznikov A. Decontamination of work innuclear`s energy. Edition number 1. Vol/1 Atom Press Moscow.1982, p.256
2. Dovbysheva T. Gorbonos P, Novikov G Clearing fulfilled of radioactive solutions from salts .XV Mendeleev Congress Obninsk symposium Edition number 2,Vol.1,1993 p.95-98
3. Mitsusuka, F. Tomita, N. Sasaki, M. Toyohara, M. Saso. H. Irie, Development of Immobilizing Techniques Using Cement Material for L/ILW» Toshiba [Engineering] Corporation, Japan.
4 Yoshida K., M.Kikuchi, M. Matsuda, K. Ueda, T. Niahi,. Advance Radioactive Waste Treatment System- HITACHI ALIM-RAD» T. Hitachi Ltd. Japan.
5. Wagh A.S., D. Singh, R.V. Strain, S.-Y. Jeong Stabilizing Low-Level Radioactive Wastes with Chemically-Bonded Phosphate Ceramics» Argonne, Illinois, USA.
6. Sing D., A.S.Wang, M. Tlustochowicz, K.C. Lobring Stabilization and Solidification of Cesium-Containing Waste Streams in Novel Phophate Ceramics». Argonne, Illinois, USA;

7. Chemielevski. M. Harazimowicz, G. Zakrewska- Trznadel, J. Palige Membrane Processes for Liquid Radioactive Waste Treatment» A.G. from Institute of Nuclear Chemistry and Technology, Warsaw, Poland.
8. Muntean N., S. Ramboiu Unilization of Indigenous Adsorbent Materials for the Decontamination of Radioactive Waters with High $^{134}$ Cs Content from Medical Centre and Health Services and Management Cluj-Napoca, Romania.
9. Zhang Z., S. Luo, X. Fang. A New Combined Separation Technique for Radioactive Waste Treatment China Institute of Atomic Energy, China;.
10.T. Dovbysheva. Complex Way of the Direction of the Decision of Problems of Salvaging of Radioactive Waste. Proceedings of the 7th International Conference on Radioactive Waste Management and Environment Remediation, Nagoya, Japan, September 26-30, 1999.
11.T. Dovbysheva. Transdicplinary Solution of the Problems of Salvaging of Radioactive Waste. Proceedings of the International Transdisciplinarity 2000 Conference, Zurich, Switzerland, ETU, V. 2, p. 308-310, 2000.
12T. Dovbysheva. Chemical Pricesses for Radioactive Treatment. Proceedings of the XXI International Mineral Processing Congress, Rome, Italy, V. B13, p.38-41, 2000.