# MATRICES FOR $^{129}$I IMMOBILIZATION - 9303

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## ABSTRACT

$^{129}$Iodine holds a particular place among other long-lived fission products. This radionuclide presents a serious threat for biosphere because of very large half-life value ($T_{1/2}$ = 1.57x10$^7$ years) and high mobility in different mediums.

Substantial characteristic of iodine compounds intended for final disposal or preparing of targets for $^{129}$I transmutation is chemical and thermal stability. Relaying on correlation of various iodine compound characteristics, one might say that an unambiguous choice between these materials was very difficult to do. None of compounds being considered fulfills all design requirements.

The object of this work was to conduct investigation of literary data on $^{129}$I compounds suitable for long-term storage or final disposal. At the same time the low-soluble palladium iodide is known from the literature: and it can be used as a compound for long-term storage and/or final disposal of iodine radionuclides. The use of technogeneous "reactor" palladium for these purposes seems quite reasonable in this case. (It is evident that the use of natural palladium is impossible due to its high cost and deficiency).

In the paper literary data on $^{129}$I compounds and the results of experiments on synthesis of cermets on palladium metal base (with palladium iodide inclusion) are presented. The data on leaching rate of iodine are also presented.

## INTRODUCTION

$^{129}$I yield resulted from $^{235}$U fission reaction by thermal neutrons was found to be 0,7 - 0,75%. The evaluation of $^{129}$I amount accumulated in spent uranium fuel gives various results: according to Japanese data this value amounts to 5.6 kg per year for PWR reactor with 1 GW capability [1], while French specialists report another information, 4 kg per year [2]. Iodine

Iodine chemical behavior during spent fuel dissolution is highly complex and it may be described by following reactions:

- iodine comes into solution in the form of I$^-$ and IO$_3$,
- I$^-$ ions are oxidized with nitric acid into I$_2$, and IO$_3$ ions and reduced with nitrous acid and NO$_2$ into I$_2$ [3],
- I$_2$ releases from the solution and comes in gaseous phase, iodine evolution decreasing with the rise of solution acidity [4],
- a part of iodine remains into insoluble residues, forms colloidal particles of AgI and PdI$_2$ in solution (reaction products with silver and palladium), or deposes onto the walls of the dissolver [5, 6].

Thus, during fuel dissolution iodine distributes among solution, gaseous phase and insoluble residues.

$^{129}$I management at French, English and Russian reprocessing plants consists in its transferring in the form of I$_2$ into gaseous phase at the stage of spent fuel dissolution in nitric acid, followed by molecular iodine recovering from the gaseous phase by means of countercurrent washing of gaseous wastes with alkaline solution in washing column. Decontamination factor for iodine removal from gaseous wastes at the stage of alkaline washing was as large as 100. (The introduction of chemosorption on iodine filters, involving porous materials (minerals) in gas-cleaning systems makes it possible to rise $^{129}$I decontamination factor up to 1000 [2, 4].)

Alkaline solutions containing NaI, NaIO$_3$, NaNO$_3$, Na$_2$CO$_3$, NaHCO$_3$ resulted from this operation are considered as liquid wastes and dumped into ocean as, to take an example, it is done at French plants [7]. In any case such a practice doesn't meet enhanced requirements for preservation of the environment which necessitate the cessation of iodine-containing solutions discharge in the ocean and the improvment of gas-cleaning system efficiency.

The technique of iodine-containing washing solutions processing depends on the concept of iodine management adopted by the country and consists in iodine incorporation into appropriated matrices

suitable for ultimate disposal or transmutation. If required, iodine may be recovered from Ag-containing sorbent by means of "dry" or "wet" technique, alternatively the spent sorbent itself may be incorporated into appropriated matrices [8, 9].

From washing solution iodine may be recovered in various ways, to cite an example, with the use of copper powder and azurite mixture [10]. Nevertheless, the problem of iodine removal from aqueous washing solutions and/or solid sorbents and its incorporation into appropriate matrices may be considered as no less important one.

The object of this work was to conduct investigation of literary data on $^{129}$I compounds suitable for long-term storage or final disposal. Also in the paper the results of experiments on synthesis of cermets on palladium metal base (with palladium iodide inclusion) are presented.

## RESULTS OF EXPERIMENTS AND DISCUSSION

Presently the problem of radioiodine management receives higher attention in connection with increasing stringency of requirements for environmental protection. Higher iodine mobility inside the burial and beyond it imposes its safe isolation consequently searching of appropriate matrices for $^{129}$I fixation is being continued in many countries.

Previously the possibilities for incorporation of slightly soluble iodine compounds and iodine-containing sorbents into cements, bitumen and easily melted glasses were being studied with the aim to improve the safety of iodine immobilization. It was shown that iodine lixiviation rate from the concrete (containing $Ba(IO_3)_2$) was $2,6 \cdot 10^{-6}$ g/m$^2$·day, and from bitumen (equally with $Ba(IO_3)_2$) – $8 \cdot 10^{-7}$ g/m$^2$·day. Iodine lixiviation rate from phosphate glasses is of the same order of magnitude ($2.6$-$6 \cdot 10^{-6}$ g/m$^2$·day) [11].

Comparatively recent is a process proposed for the incorporation into easily melted phosphate glass of radioiodine caught by Ag-containing filters [12]. Iodine extraction from the adsorbent is conducted through AgI evaporation under vacuum (5 mm Hg) at 300°C. The glasses of $AgI$-$Ag_2O$-$P_2O_5$ composition were prepared at 350°C. The highest compression strength (900 kg/cm$^2$) was noted for glass of $3\ AgI$-$Ag_4P_2O_7$ composition containing 50 mole % (64 mass.%) AgI. Under reducing conditions iodine lixiviation rate at 35°C was initially as low as $6 \cdot 10^{-8}$ g/cm$^2$·day and further decreased to $3 \cdot 10^{-9}$ g/cm$^2$·day.

Along with the studies of Ag-phosphate glasses the experiments were conducted on iodine incorporation into Pb-borosilicate glass in the form of $BiPbO_2I$, which provides uniform iodine distribution throughout the matrix. Vitreous frits of composition $B_2O_3$:$SiO_2$:$PbO$ = 30:10:60 (mole %) were mixed with $BiPbO_2I$ and melted at 520 °C for 30 minutes. [13].

French scientists examined the potentialities of ceramics of apatite structure application for radioiodine immobilization [14]. This material is produced by $PbI_2$ sintering in orthovanadatophosphate medium $[Pb_3(VO_4)_{1,6}(PO_4)_{0,4}]$ at 700°C and pressure of 25 MPa. Orthovanadatophosphate is not only involved in iodine-containing ceramics but, when sintering, it creates protection barrier about it as well. The experiments on iodine-apatite ceramics lixiviation in aqueous medium at 90°C revealed that initial lixiviation rate was as low as $2 \cdot 10^{-7}$ g/cm$^2$·day.

Hydroxyapatite proposed by Japanese scientists, was designed to be used as a matrix material for multilayer (stratified) technique for iodine immobilization. Specifically, it involves: iodine-containing material (entire iodine-trapping filters or zeolite with adsorbed iodine); protective layer of $SiO_2$ and matrix-forming material. In author's opinion the use of slightly soluble hydroapatite as matrix material would provide radioiodine safe fixation for several millions years [15].

Furthermore, the studies on radioiodine incorporation into sodalite-like matrix are being resumed [16]. Sodalite $[Na_8(AlSiO_4)_6Cl_2]$ offering relatively low solubility in aqueous solutions holds chlorine atoms within the holes of its frame structure. Iodine-sodalite is produced by heating of $SiO_2$, $NaAlO_2$ and NaI stoichiometric mixture in Ar atmosphere at 850°C for two hours. This ceramics solubility is within the range of $10^{-4}$-$10^{-5}$ mole/l.

Rather high corrosion stability may be expected for compounds, obtained by Japanese specialists through hot pressing (25 MPa, 750°C) of iodine-containing filters with copper powder [13]. Iodine lixiviation from such a material would be determined by copper matrix corrosion rate. It is found that under anaerobe conditions matrix corrosion rate is about 4 μ/year.

Presently, the improvement of traditional cement materials is being continued along with searching of novel matrices for radioiodine immobilization. So, a cement composition was proposed [17] which exhibits higher sorption characteristics in regard of iodine after being hydrated (alumina cement/$CaSO_4 \cdot 2H_2O$ = 100/155).

At the same time by our opinion for the synthesis of compounds suitable as materials for prolonged storage or final disposal of iodine-129 (or manufacture of targets for subsequent iodine-129 transmutation), it seems very promising to use fission products contained in irradiated fuel [18]. The low-soluble palladium iodide is known in literature; it can be used as a compound for iodine radionuclides immobilization. The use of technogeneous "reactor" palladium for these purposes seems quite reasonable in this case. (It is evident that the use of natural palladium is impossible due to its high cost and deficiency). So, for immobilization of I-129 one can use the "reactor" palladium, the accumulation of which in spent WWER is about 1 kg per ton.

At the first stage the conditions of $PdI_2$ deposit manufacture from nitrate-acid solutions have been studied. A precipitate of $PdI_2$ was obtained by mixing of solutions of KI and $Pd^2$ in nitric acid. The value of $Pd^{2+}/2I^-$ ratio varied during the experiments from 5 to 50% of palladium excess relative to stoichiometry of reaction. The yield of palladium iodide precipitates was almost the same in the majority of these experiments (98,1 – 98,6%). The specimens obtained were transmitted for elemental, disperse and phase analyses. Electron-microscopic photos of the specimens are given in fig. 1.
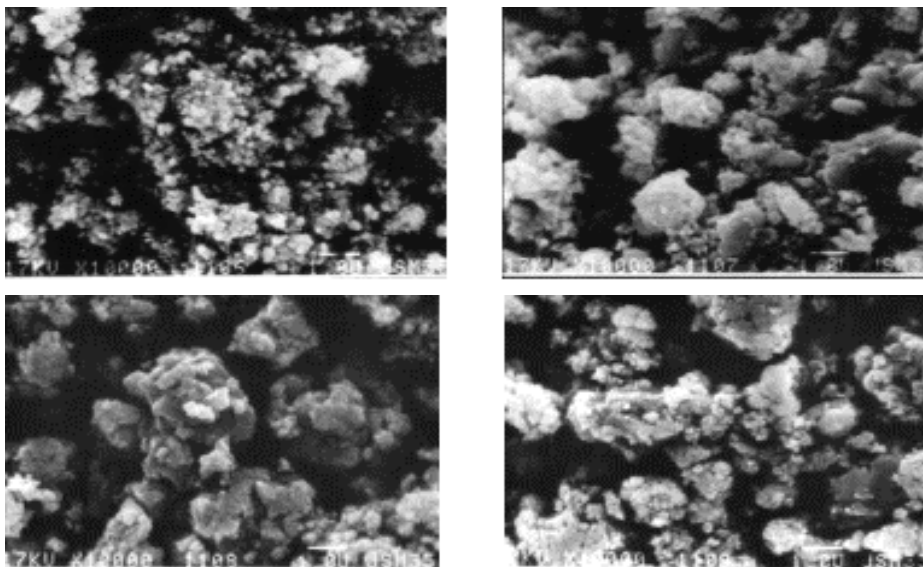


Fig. 1. Electron-microscopic photos of the $PdI_2$ specimens.

Within the limits of experimental error I/Pd ratio value for all specimens agrees with stoichiometric ratio for $PdI_2$. The other elements have not been detected, whereas the occurrence of non-analysable elements in amounts below 2-6% is possible.

For thermal stability determination the differential thermal analysis of palladium iodide was carried out also (Fig. 1).
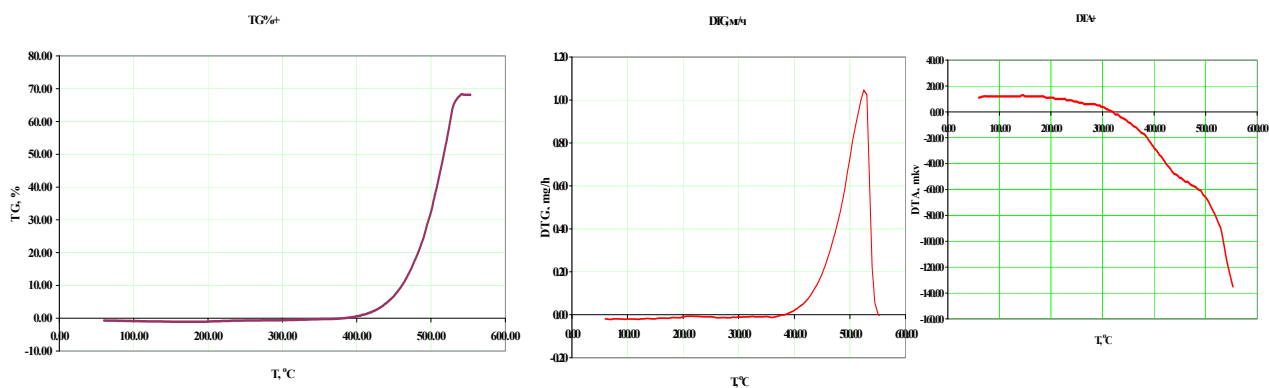
Fig. 1. DTA-curves for $PdI_2$ specimen.

An endothermic spike for $PdI_2$ decomposition was observed in the course of specimen heat-treating, its origin lying at $400^oC$ and the maximum occurring at $525^oC$. Reference data for decomposition temperatures are generally given for maximum's area. In our case the temperature corresponding to maximum is essentially higher than reference value for palladium iodide decomposition temperature ($375^oC$).

Another objective of researches conducted was palladium iodide ($PdI_2$) solubility determination with the use of radiotracer $I^{125}$ (half-life period 60 days). $^{125}I$ was added as the "marker" during $PdI_2$ specimen's synthesis. The value of $PdI_2$ solubility was found to be as low as 2,5 mg/l.

At the next stage of the work we have prepared the specimens containing palladium iodide being incorporated into metal palladium matrix.

(A pressing plant was used for preparation of Pd-based pellets containing $PdI_2$ as a filler. Along with the press this plant comprises HF generator, forevacuum chamber and a pump station. The press-molds were made of graphite AG-1500. Pressure operations were conducted under argon atmosphere.) Weighted portion (3-4 g) of working mixture (metal palladium and palladium iodide) was poured into press-mold (mold-mortise diameter = 11 mm). The mold was inserted inside the inductor. The chamber was evacuated by means of forepump and further filled with argon.)

Powder pressing was conducted for 1 hour at given temperature and pressure. Determination of pellet elemental composition was carried out by electron-probe microanalysis technique, which is based on comparison of characteristic X-ray spectra of the specimen to be analyzed with those of references of known compositions. This technique sensitivity is about 0.5 mass. %.

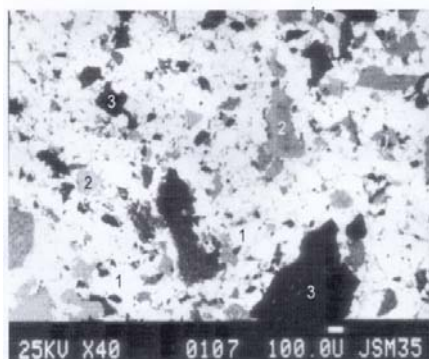Specimen's characteristics are presented in Tables 1-2 and in Fig 2.



Fig. 2. The results of electron-microscopic analysis for $Pd+PdI_2$ (50%) pellet. (Phase structure, specimen Reflected electrons: 1- $PdI_2$, 2-Pd, 3- mixture: PdO, $PdO*H_2O$, $Na_2Pd_3O_4$. ($S/S_0$: 1 - 62%, 2 - 23%, 3 - 15%.) 1 consists of grains ~ 40 $\mu$, borders concern to a phase 2.)

In micrographs, presented in Figure 2 one can clearly see three phases (1, 2, 3) non-uniformly distributed throughout pellet surface. Phase 1 (white areas) consists mainly of palladium iodide (30% Pd and 70% I, as determined by means of XRM). Phase 2 comprises metal palladium, whereas a phase 3 composition is more complicated and corresponds to the mixture of PdO, $PdO·H_2O$, $Na_2Pd_3O_4$. It should be noted that palladium iodide is X-ray amorphous constituent of pellet material.

Table I. The results of X-ray morphological analysis for $Pd+PdI_2$ pellet.

| Phase number | Composition, % | | | | |
|---|---|---|---|---|---|
| | Na | Al | Si | Pd | I |
| 1 | 0 | 1,1 | 0 | 28-32 | 68-72 |
| 2 | 0 | 0 | 0 | 98.5 | <0.05 |
| 3 | 1.5 | 0 | 0.3 | 75-88 | <0.5 |
| Average | 0.3 | 0.8 | 0.3 | 52 | 46 |

Table II. The results of X-ray diffraction analysis for $Pd+PdI_2$ pellet.

| Composition | Pd | PdO | $PdO \cdot H_2O$ | $Na_2Pd_3O_4$ | X | $PdI_2$ |
|---|---|---|---|---|---|---|
| % | 25 | 1-3 | 1-3 | 1-3 | 3-5 | 65 |

Iodine lixiviation rate for some specimens was determined. (The content of iodine and palladium in solutions were determined with using ICP mS procedure.)

Lixiviation rate (R) was calculated from the formula:

$R = M_n / S \cdot t_n,$

where: R: lixiviation rate, $kg/m^2 \cdot day$; $M_n$: amount of an element being leached for $t_n$ days, g.

S: specimen open surface area, $m^2$

The results of lixiviation rate estimation are given in Table 3.

Table III. The rate of iodine lixiviation from Pd-base metalloceramic compositions.

| t, days | I, mg/l | R, $g/sm^2 \cdot day$ |
|---|---|---|
| 26 | 1.4 | $9.0 \cdot 10^{-5}$ |
| 78 | 0.8 | $1.6 \cdot 10^{-5}$ |
| 210 | 0.56 | $4.2 \cdot 10^{-6}$ |

After being contacted with distillated water for 200 days they exhibited iodine lixiviation rate about $(4 - 5) \times 10^{-8}$ $kg/m^2 \cdot day$.

In the second set of experiments the pallets were manufactured with using cool pressing technique. The content of palladium iodide was 30, 50 and 70 masses % accordingly. For the purpose chemical stability comparison the pallets on the base of copper and palladium iodide were manufactured.

The results of determination of iodine leaching-out rate from the specimens are given in Fig. 3.
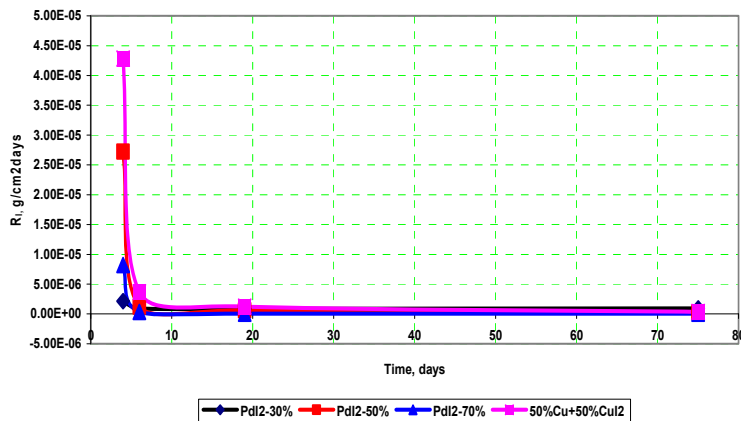


Fig 3. Leaching-out rate of iodine from the specimens on the base of palladium and copper.

Presented data point out to the large chemical stability of compositions on metallic palladium base. Initial leaching-out rates of iodine come to level $2 \cdot 10^{-5}$ - $8 \cdot 10^{-6}$ $g/sm^2$ day.

During further aging, leaching-out rates go down and come to $8 \cdot 10^{-8}$ - $9 \cdot 10^{-7}$ $g/sm^2$ day depending on palladium iodide content. In the case of palladium based composition lower leaching-out rates are observed in comparison with copper based compositions.

With the purpose of studying the possibility of matrix composition $(PdxPdI_2)$ chemical stability strengthening the pressed pellets were subjected to a chemical "palladiaizing".

The specimen $PdxPdI_2$ with $PdI_2$ content of 50 mass. % was treated. Traditional composition generally used for palladium plating was applied for palladium coating production. (Operation conditions were as follows: the electrolyte composition (g/l): palladium chloride – 3÷5, 25% aqueous ammonia – 15÷30, sodium hyposulfite – 10÷30, sodium thiosulfate – 0,025÷0,035; temperature, °C – 40-60.)

The pellets being noticeably porous, the determination of palladium layer depth basing upon the mass of deposed metal didn't provide sufficient precision. Consequently, palladium plating was conducted for 2 hours at 50°C, so as to obtain palladium layer about 10 micrometers in depth (calculated for

overall geometric surface of the pellet). These operational conditions were established after preliminary experiments on palladium deposition on platinum foil.

After specimens rinsing with water and drying the calculated depth value was ~ 6 mcm. Pellet's appearance remained essentially unchanged after this treatment. These specimen structure and chemical stability were being studied.

Morphological and phase analyses of the specimen were carried out. Three phases have been found in the specimens: phase 1 consisting essentially of palladium iodide; phase 2: metal palladium; phase 3: the mixture of hydrated palladium oxides with possible admixture of a complex ion. As seen from RMA data coating depth was only 0,3 – 0,4 μ.

Encapsulated pellets were subjected to leaching using static method. Experimental procedure differed from that described above in that the sampling was carried out without renewal of the solution over pellets.

Table IV. The rate of iodine lixiviation from Pd-base metalloceramic compositions.

| The pallet content | t, days | I, mg/l | R, g/sm$^2$·day |
|---|---|---|---|
| 50 % Pd + 50 % PdI$_2$ | 26 | 1.4 | $9.0 \cdot 10^{-5}$ |
| | 78 | 0.8 | $1.7 \cdot 10^{-5}$ |
| | 210 | 0.56 | $4.2 \cdot 10^{-6}$ |
| (50 % Pd + 50 % PdI$_2$)Pd | 26 | 0.45 | $2.9 \cdot 10^{-5}$ |
| | 78 | 0.59 | $1.2 \cdot 10^{-5}$ |
| | 210 | 0.12 | $9.1 \cdot 10^{-7}$ |

The presence of protective superficial palladium coating gives rise to considerable increase of chemical stability. Palladium content in the solution decreases by 6 orders of magnitude and that of iodine — by 3 – 5 times.

When we discuss the item connected with development of matrices for [129]I immobilization one have remember about transmutation process as an alternative to the existing methods of management of radioactive wastes comprising long-lived radionuclides.

The requirements to materials intended for preparing of targets for [129]I transmutation are essentially the similar to those applied for TPE transmutation (chemical and mechanical stability to heating and irradiation, compatibility with cladding and heat carrier).

Considering that rather low [129]I transmutation degree is expected to be achieved upon a single transmutation cycle (several percent), a complete [129]I transmutation would need several cycles, that is to say that iodine should be recovered from irradiated target and further directed again to transmutation. Thus, reasonably simple and easy-to-implement techniques for target production and processing are to be developed yet.

Japanese scientists gathered and classified literature data on characteristics of various iodine compounds with the aim of selection the most promising ones for transmutation purposes. In Table 5 these compounds are tabulated and their essential characteristics to be taken into consideration when selecting chemical form for the target are given [19].

When evaluating iodides as potential chemical forms for targets along with the other characteristics melting points of metals entering into iodide composition should be accounted for. This is related to fact that in the course of transmutation [129]I is converted into gaseous xenon, thus metal/iodine ratio will increase, so causing formation of a separate metal phase. Melting point of some metals (Na, K, Rb) is considerably lower than output heat-carrier temperature, that is to say that liquid metal phase may be produced while irradiating the targets made of NaI, KI or RbI.

The possibility exists of $M(IO_3) \rightarrow M_5(IO_6)_2$ reaction occurrence, when irradiating iodates. This reaction is accompanied by oxygen evolution, which may cause cladding material oxidation and pressure rise inside the target. Furthermore, elemental iodine is generated in the course of this reaction. Consequently the materials offering high corrosion resistance should be chosen when designing target construction.

Table V. Physico-chemical characteristics of some iodine compounds [19].

| Compound | $T_{melt.}$, K | $T_{melt.}$ of metal entering into compound composition, K | Number of I atom in the unit of volume, $10^{22}/см^3$ | Features specifying chemical stability |
|---|---|---|---|---|
| $MgI_2$ | 907 | 922 | 1,84 | Fluidification under moisture action |
| KI | 954 | 336,35 | 1,14 | Slight fluidification under moisture action |
| $CaI_2$ | 1052 | 1112 | 1,62 | Fluidification under moisture action, photosensitivity |
| $VI_2$ | 1023 | 2175 | 2,07 | Hygroscopic |
| $CrI_2$ | 1066 | 2130 | 2,05 | Hygroscopic |
| $FeI_2$ | 860 | 1809 | 2,06 | Fluidification under moisture action |
| $NiI_2$ | 1070 | 1726 | 2,25 | Fluidification under moisture action |
| CuI | 868 | 1358 | 1,78 | Stability under air and light action |
| RbI | 929 | 312,65 | 1,01 | Hygroscopic |
| $YI_3$ | 1270 | 1799 | 1,76 | Fluidification under moisture action |
| $MoI_2$ | 1305[*] | 2896 | 2,21 | Fluidification under moisture action |
| $BaI_2$ | 984 | 1002 | 1,52 | Fluidification under moisture action |
| $LaI_3$ | 1051 | 1193 | | Hygroscopisity |
| $CeI_3$ | 1033 | 1071 | 1,97 | Fluidification under moisture action, photosensitivity |
| $KIO_3$ | 833 | | 1,09 | |
| $Ca(IO_3)_2$ | 823[*] | | 1,40 | Stability under air and light action |
| $Zn(IO_3)_2$ | 873[*] | | 1,47 | |
| $Sr(IO_3)_2$ | 783[*] | | 1,39 | |
| $Ba(IO_3)_2$ | 813[*] | | 1,24 | Hygroscopic |
| $NbOI_2$ | ~ 773[*] | | 1,85 | Stable in air |

[*] decomposition

The analysis of cited compounds in regard of long-lived radionuclides generation potentiality in the course of transmutation has been done with consideration of neutron capture reaction only. As a consequence, these data are of approximate values. Nevertheless, these data allow concluding that in the case of NaI, $MgI_2$, $VI_2$, $CrI_2$, RbI, $YI_3$, $LaI_3$ and $Sr(IO_3)_2$ long-lived radionuclide generation is quite unlikely.

An essential iodine compound characteristic to be accounted for when choosing the target form is its chemical stability. As seen from Table 5 the most part of iodine compounds is hydroscopic, tends to fluidization and is sensitive to light action.

Unfortunately to day there are very few experimental studies on the impact of high radiation and thermal fields on iodine compounds stability.

Relaying on correlation of various iodine compound characteristics, the authors of [20] concluded that an unambiguous choice between these materials was very difficult to do. None of compounds being considered fulfills all design requirements.

Several substances offer good indices according to one of criteria, but don't meet the requirements of another ones. Reasoning from characteristics tabulated in Table 5, it was suggested that CuI, $MoI_2$ and $Ca(IO_3)_2$ might be considered as promising materials for target preparation. (The results of this experiment revealed that $PbI_2$ should be eliminated from the list of candidates for target production due to its low melting point and high corrosion activity of the melt.) At the same time CuI would not apparently be suitable for this purpose because of large swelling and high corrosion activity.

In such a way our experimental results clearly showed the feasibility of obtaining metalloceramic compositions for transmutation based on metal "reactor" palladium and palladium iodide compounds. (Melting temperature (1552° C), mechanical strength and also chemical inertness permit to use palladium as target's material.) Neutron-absorption cross-sections of Pd are notably higher in comparison with constructional materials of reactor active zone (zirconium iron or nickel). However container's influence isn't catastrophically and neutron flow reduction in immediate vicinity will average about 15 – 20 %.

In the nuclear fuel vicinity the capture cross-section (averaged on PWR neutron spectrum) will be about 32.4 b for Pd matrix and about 16.6 b for iodine. Far from fuel, in by water coolant-moderator it should be as 42.0 b and 26.7 b accordingly.

While palladium irradiation some long-lived nuclides (silver, gadolinium) could be accumulated. According rough estimate during one year of irradiation it could be accumulated about 0.1% atoms of silver and gadolinium that give a few curies per gram of palladium.

Accordingly neutron physical characteristic of Pd are severely limited but inestimable advantage connected with simple reprocessing of Pd-based targets after irradiation (transmutation) give grounds to consider this material as very promising. (The most special palladium feature, which differs this element from the other platinoids, is its capacity to be dissolved into nitric acid.)

And the studies are being conducted now in searching for optimum conditions of metalloceramic compositions pressing and protective coating application.

## CONCLUSIONS

There are several conceptions of $^{129}$I isolation: dissemination in ocean waters; transmutation; pumping of iodine-containing slurries in clayey geological formations by stratum hydro rupture technique; prolonged monitored storage or a final disposal of slightly soluble iodine-containing compounds.

At present the time of radionuclide potential hazard is considered as necessary service life of engineering barriers when selecting matrices for radioactive waste immobilization. As it was determine relative hazard of long-lived radionuclides at various time lags and they revealed that within 1000 years the most radiation hazard id due to $^{99}$Tc, $^{129}$I, $^{239}$Pu, $^{240}$Pu, $^{241}$Am and $^{243}$Am. And it was shown that more than $10^5$ years are needed for decay of $^{99}$Tc, $^{129}$I, $^{239}$Pu.

The most substantial characteristic of iodine compounds intended for final disposal or transmutation is chemical and thermal stability.

By now a lot of investigations have been carried and numerous litterature data are available concerning the synthesis of a large range of various materials for $^{129}$I immobilization or transmutation but one can concluded that an unambiguous choice between these materials was very difficult to do. None of compounds being considered fulfills all design requirements.

At the same time for the synthesis of compounds suitable as materials for prolonged storage or final disposal of iodine-129, it seems very promising to use fission products contained in irradiated fuel.

Again, for immobilization of $^{129}$I one can use the "reactor" palladium, accumulated in spent fuel in a great deal. There are two reasons to use of technogeneous "reactor" palladium for these purposes. First of all the low-soluble palladium iodide is known from the literature: and it can be used as a compound for long-term storage and/or final disposal of iodine radionuclides. From other hand at present it the major part of palladium together with the raffinate comes at vitrification stage and it is necessary to emphasize a related with the difficulties arising at this stage. A negative effect of PGM presence is determined by the formation of separate metal phase, which not only worsens the conditions of glass melting but also shortens considerably the service life of the equipment.

It ought to note that reactor" palladium contains long-lived radioactive isotope $^{107}$Pd (half-life $6{,}5 \times 10^5$ years) and its presence doesn't expect for possibility its use in traditional areas.

At the same time, the use of palladium in radwaste reprocessing technology (where the presence of palladium radioactive nuclide would not be an interfering factor; moreover there would not be any need of palladium profound decontamination from other fission products.) may also play a crucial role in forming the demand for this metal. These preliminary experimental results allow conclusion that the use of 'reactor' palladium as a material for I-129 immobilization seems to be quite justified.

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