Microbial transmutation of Cs-137 and LENR in growing biological systems

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This article presents the results of long-term investigations of stable and radioactive isotopes transmutation in growing microbiological cultures. It is shown that transmutation during growth of microbiological associations is 20 times more effective than the same process in the form of 'clean' microbiological culture. In this work, the process of controlled decontamination of highly active reactor isotopes (reactor waste) through the process of growing microbiological associations has been studied. The most rapidly increasing decay rate of Cs^{137} isotope, which occurred with the 'effective' half life $\tau^* \approx 310$ days (involving an increase in rate and decrease in half life by a factor of 35) was observed in the presence of Ca salt in closed flask with active water containing Cs^{137} solution and optimal microbiological association.

Keywords: Low energy nuclear reactions, microbiological association, radioactive isotopes, reactor waste transmutation.

Introduction

THE process of transmutation of stable and active isotopes in biological systems is one of the most mysterious phenomena in modern nuclear physics. The hypothesis about the possibility of nuclear transmutation of isotopes in physical, biological and geological systems at low energy has been frequently discussed during the last decades[1–4]. There are no reasons to consider the process of isotopes transformation in growing biological systems as separate and different from the general laws of physics. All observed isotopic effects (in case they are real and supported by adequate and reliable measurements) can be characterized as the 'regular' process of transmutation of isotopes and elements, which occurs in biological systems, and the efficacy of which is determined precisely by the specific characteristics and behaviour of such systems.

While analysing the problem of transmutation of isotopes in growing biological cultures (especially the case of transmutation with the generation of isotopes of such chemical elements which are not required by a growing culture in normal conditions), many additional specific questions arise. The most important among them: 'Why does a growing culture need this kind of process? How is the process accomplished? Can this process be controlled?'

In our opinion, the process of transmutation is evolution's answer to the global dilemma – how is it possible to combine development and adaptation of biological objects, each one of which contains a genetically predetermined set of elements, with a random character and dissimilar distribution of elements in the outer environment, as well as constant environmental changes? This process occurs in places where there is competition based on the stereochemical analogy (at least in transporting and fermentation systems). The area where this competition takes place determines the area where transmutation itself is performed. Can we point to a specific spot, or set of conditions, where this ingenious nuclear reaction process takes place? Possibly, there could be many such places or sets of conditions (otherwise, reactions could be such rare events that they would be impossible to detect). Also, it may be noted that transmutation occurs with a higher probability in structural parts of biological objects, which are subjected to dynamic influences (zone of growth, transport systems, dynamic response systems, etc.).

Transmutation of stable isotopes in growing microbiological systems

About 25 years ago we have studied the process of transmutation of stable isotopes in growing 'one-line' (one type, 'clean') microbiological cultures like *Escherichia coli* or *Saccharomyces cerevisiae* in two kinds of nuclear reactions[5,6]

$$Mn^{55} + d^2 = Fe^{57},\ Na^{23} + P^{31} = Fe^{54}.$$

The Mossbauer spectrum of Fe^{57} isotope of *S. cerevisiae* culture, grown during 72 h in D_2O in the presence of Mn^{55} isotope[2,3,5], is shown in Figure 1 *A*.

It was shown that the transmutation process during the growth of such microbiological cultures had taken place, but its effectiveness had been low. Expressed in relative

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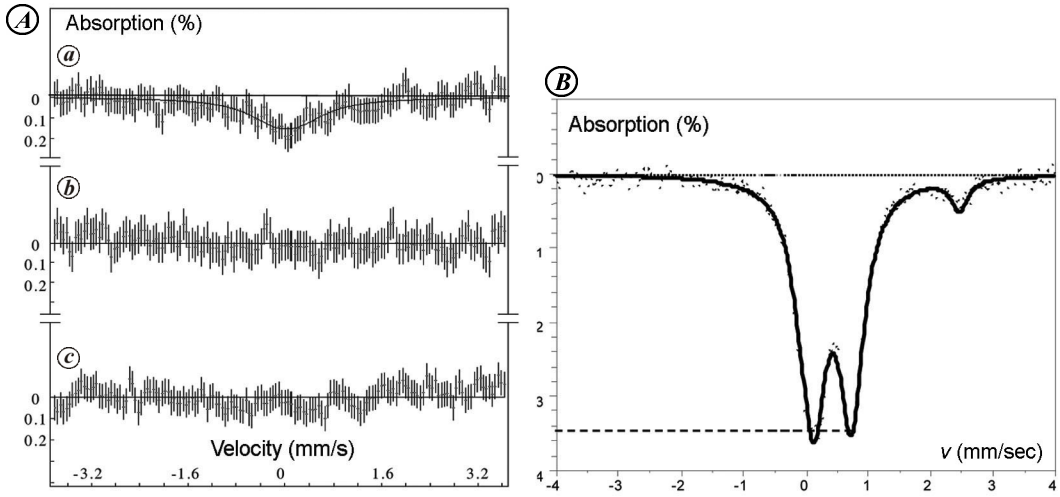

Figure 1. ***A***, Mossbauer spectra of Fe^{57} isotope of *Saccharomyces cerevisiae* culture grown in nutrient medium in the presence of (***a***) D_2O and Mn^{55}; (***b***) H_2O and Mn^{55} and (***c***) D_2O without Mn^{55}. ***B***, Mossbauer spectrum of MCT grown in nutrient medium in the presence of D_2O and Mn^{55} isotope.

units (defined by the ratio between accumulated number of $N(Fe^{57})$ of Fe^{57} nuclei to the number $N(Mn^{55})$ of Mn^{55} nuclei), the rate of Fe^{57} production $\lambda = N(Fe^{57})/N(Mn^{55}) \times \Delta t \approx 10^{-8}$ s^{-1} (synthesized Fe^{57} nuclei per sec and per Mn^{55} nucleus) in the case of the reaction with light isotope[2,3,5] d^2, and $\lambda \approx 10^{-10}$ s^{-1} in the reaction for the middle range mass isotopes Na^{23}, P^{31} (refs 2, 3, 6) The low relative amplitude of Mossbauer resonance ($\Delta J/J \approx 0.2\%$) in these experiments was the result of low absolute and relative concentration of newly formed Fe^{57} isotope in the grown culture.

There are two main reasons for low effectiveness of nuclear transmutation in 'one-line' microbiological cultures: (a) the relatively low efficiency for creating these reactions is the result of the narrow interval of optimal functional individual characteristics for initiating nuclear activity in any 'one-line' type of culture; (b) during the growth of a 'one-line' culture, we hypothesize that processes involving forms of auto-intoxication of nutrient media by metabolic products take place. This hypothesis is consistent with forms of growth impairment.

In contrast to these 'one-line' cultures, during the last 15 years we have investigated microbiological associates that include several types of different cultures. The base of MCT (microbial catalyst-transmutator) compound that was used is the microbe syntrophin associations of thousands of different kinds of microorganisms that are in the state of complete symbiosis and grow as a total correlated multisystem[2,3,7–9]. The MCT compound involves special granules that include: concentrated biomass of metabolically active microorganisms (microbe syntrophin association); organic sources of carbon and energy, phosphorus, nitrogen, etc. gluing substances that keep all components in the form of granules stable in water solutions, for a long period of time, subjected to some, or possibly many, external conditions.

The results of the Mossbauer measurements[2,3,7–9] of the optimally dried biological substances (MCT compound) grown during 20 days in nutrient medium in the presence of D_2O and Mn^{55} isotope are presented in Figure 1 *B*. In this experiment the large amplitude of the Mossbauer resonance ($\Delta J_{max}/J_{transmut} \approx 3.4\%$) at the same mass of investigated dried biological substance was observed and measured. The total mass of Fe^{57} isotopes created was about 10^{-5} g per 1 g of dried biological substance, which is about 20 times more than the mass of Fe^{57} nuclei created in 'one-line' grown and dried cultures. The efficiency had increased, in particular, because the association had been allowed to grow during a 20-day period. 'One-line' cultures cannot be grown for such a long period of time in heavy water because of 'self-intoxication' of the medium by the metabolic products.

The relative efficiency rate λ of such forms of transmutation is: $\lambda \approx (0.5–1) \times 10^{-6}$ (synthesized Fe^{57} nuclei per sec and per single Mn^{55} nucleus).

For verification of these results, additional studies of the isotopic ratio of the same dried biological substances were conducted by TIMS (Thermal Ion Mass Spectroscopy, Finnigan MAT-262). The results of TIMS measurements are presented in Figure 2.

Here $X = Fe^{54}$; Mn^{55}; Fe^{57}. The process of increasing (↑) concentration of Fe^{57} isotope is accompanied by decreasing (↓) concentration of Mn^{55} isotope. The amount of Fe^{57} isotopes created is approximately the same in the case of both Mossbauer resonant gamma-spectroscopy and TIMS measurements (concentration of Fe^{57} isotopes created increases by a factor of 2–3). Decrease in the amount of additional Mn^{55} isotope in the transmutation flask is synchronized with the creation of Fe^{57} isotopes in the same flask. This appears to provide proof (a 'form of acknowledgement' or a 'footprint') of nuclear synthesis

in processes associated with a 'growing', biological system.

Controlled decontamination of intermediate and long-lived active isotopes

The most important step of the study was related to the process of direct controlled decontamination of a highly active water mixture of selected different intermediate and long-lived radioactive nuclides (e.g. active reactor isotopes) by action of the same growing microbiological MCT systems. The process of decontamination (deactivation) of radioactive waste through the action of growth in microbiological systems is connected with transmutation of active nuclei to different stable isotopes during growth and metabolic processes involving MCT granules.

Controlled decontamination of intermediate lifetime reactor isotopes

We studied the process of accelerated decay of activity of reactor water from first contour of VVER type of reactor at Kiev Institute of Nuclear Research[7,9]. The water with total activity about 10^{-4} Curie/l (3.7 MBq/l) contained highly active isotopes like Na^{24}, K^{40}, Co^{60}, Sr^{91}, I^{131}, Xe^{135}, Ba^{140} , La^{140}, Ce^{141} and Np^{239}. The results of the investigation of the time-dependent activity $Q(t)$ of the same reactor Ba^{140}, La^{140} and Co^{60} isotopes in the experiment on transmutation (flask with water and MCT, Q_{cultures}) and in the control (flask without MCT, Q_{control}) are presented in Figure 3.

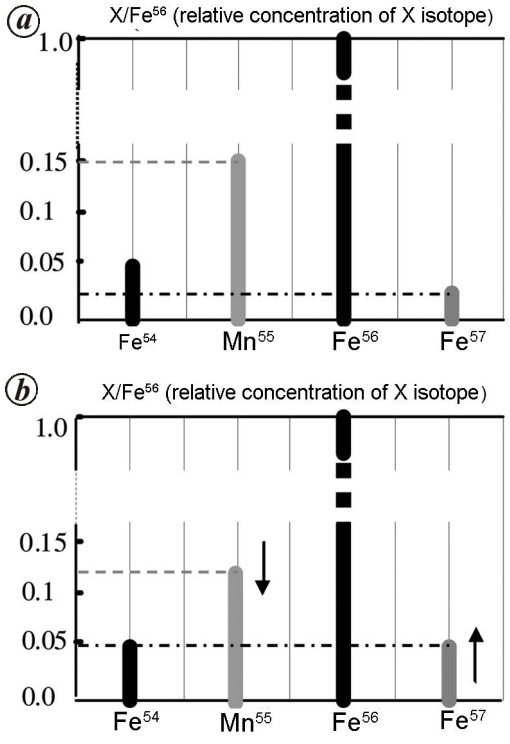

Figure 2. Mass spectrum of iron region of microbiological associations (dried biological substances) that were grown in control nutrient medium with H_2O and Mn^{55} (***a***) and in experimental nutrient medium with D_2O and the same amount of Mn^{55} isotope (***b***).

We observed accelerated utilization (decrease of radioactivity) of radioactive La^{140} and Ba^{140} isotopes in the flasks that contained MCT during the time of the experiment (30 days). The studied La^{140} isotope has lifetime $\tau_{\text{La}} = 40.3$ h and is nonstable daughter isotope of Ba^{140} radioactive isotope that has a lifetime $\tau_{\text{Ba}} = 12.7$ days and the following decay $Ba^{140} \rightarrow La^{140} + \beta^- + \tilde{\nu}$. Initial activities of the Ba^{140} and La^{140} isotopes (on the tenth day after removal from the active zone of reactor) were $Q_{Ba^{140}} \approx 1.46 \times 10^{-7}$ Curie/l (5.4 kBq/l) and $Q_{La^{140}} \approx 2.31 \times 10^{-7}$ Curie/l (8.5 kBq/l). The possible reaction of Ba^{140} isotope transmutation is

$$Ba^{140} + C^{12} = Sm^{152} + \Delta E,\ \Delta E \approx 8.5\ \text{MeV}.$$

This reaction is energy favourable and the reaction energy is positive. The biological reason of such reaction is the following. The Sm^{2+} and Ca^{2+} ions are chemically alike and have approximately the same ionic radii of divalent state ($R_{\text{Sm}} \approx 1.2$ A, $R_{\text{Ca}} \approx 1.06$ A). The substituted element Ca is among several vitally necessary elements. Ions of created Sm^{2+} elements can substitute Ca^{2+} ions while microbiological cultures are growing[10]. Probability of such substitution during the process of growing the biological culture is high because the initial concentration of Ca element in MCT is low.

Controlled decontamination of long-lived reactor Cs^{137} isotope in biological cells

The investigation of controlled decontamination of the long-lived reactor Cs^{137} isotope[2,3,7–9] was carried out

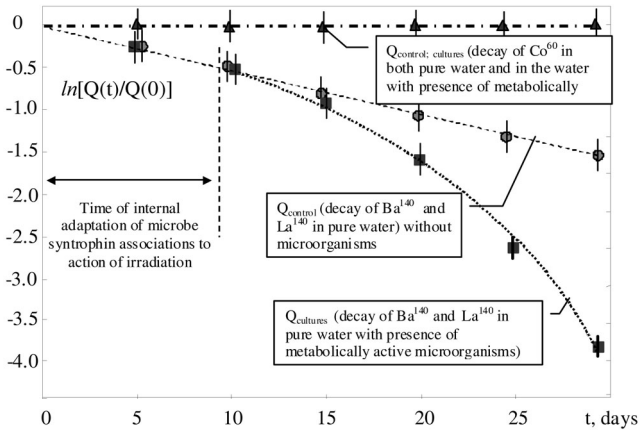

Figure 3. Activity $Q(t)$ of the same reactor Ba^{140}, La^{140} and Co^{60} isotopes in the experiment on transmutation (activity Q_{cultures} in pure reactor water in the presence of MCT) and in the control (activity Q_{control} in the same water without MCT).

using identical distilled water, but with a process that involves Cs^{137} with an activity of 2×10^4 Bq. In the experiments, eight identical closed glass flasks with very thin walls and with 10 ml of the same active water in each were used. The MCT compound was placed in seven glass flasks. In six different flasks, different pure K, Ca, Na, Fe, Mg and P salts as single admixture were added to the active water. These chemical elements are vital for any culture. Each of these specific replacements completely blocks all possible transmutation channels, in which any of the biochemical analogues of the specific chemical element can be used. Two additional flasks were used for control experiments: one flask contained the active water and MCT (but without additional salts) and the other had only active water (without salts and MCT).

The cultures were grown at 20°C. Activity of all closed flasks was measured every 7 days by precise large-sized Ge detector. The results of investigation of change in relative activity $Q(t)/Q(0)$ of the isotopes are presented in Figure 4.

We have observed increased rates of decay (more precisely – accelerated rate of utilization) of Cs^{137} isotope in all experiments with MCT and in the presence of different additional salts during 100 days. In the control experiment (flask with active water but without MCT), the 'usual' law of nuclear decay applies, and the half life was about $\tau \approx 30$ years. The most rapidly increasing decay rate, which occurred with effective half life $\tau^* \approx 310$ days (involving an increase in rate, and decrease in lifetime by a factor of 35 times) was observed in the presence of Ca salt. In the presence of an abnormal (redundant) quantity of potassium in the nutrient medium, the process of cesium transmutation became weak and the half life of the decay was 10 years.

A possible reaction of radioactive Cs^{137} isotope utilization is

$$Cs^{137} + p^1 = Ba^{138} + 5.5 \text{ MeV}.$$

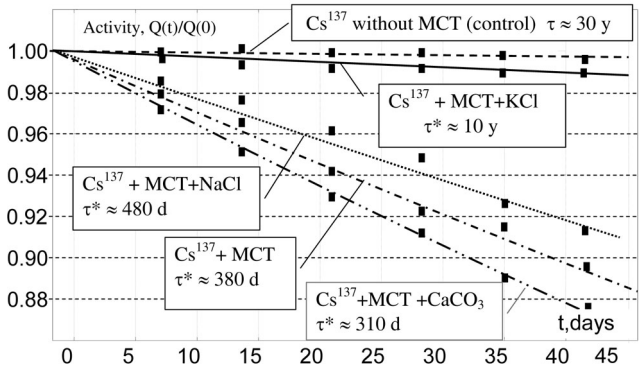

Figure 4. Accelerated deactivation (accelerated rates of decay) of Cs^{137} isotope in 'biological cells' in the presence of different chemical elements.

The result of this reaction is the creation of a stable Ba^{138} isotope. What is the reason for increasing the efficiency of transmutation by increasing the concentration of calcium?

These phenomena are probably connected with general problems of metabolic processes involving microbiological cultures: optimal growth of microcultures takes place when a balanced relation of microelements occurs. The phenomenon of low energy transmutation of chemical elements and isotopes in biological systems and creating conditions for sustaining it is based upon the heuristic proposition that if some of the required elements or microelements are not present in the living environment (or nutrient media), then, given that certain pre-requisites are met, it will be synthesized as a result of the transmutation. In fact, such an approach unambiguously suggests that the ratio of all the necessary elements in each type of living organisms is fixed.

These results reveal a non-trivial nature of interactions of different microelements. By changing the make-up of the nutrient medium, it is possible to control the growth of a culture. Lack of at least one of the microelements in the nutrient medium hinders the development of the entire biological system.

Conclusion

In our opinion the process of isotope transmutation in biological systems occurs according to strict laws of physics, but it is induced by certain features of the structure of growing biological objects. The physical aspects of transmutation are related to general LENR problem[2,3]. Our point of view with respect to explaining this general problem has been presented in books[2,3] and articles[11–17]. According to us, in the case of dynamic (growing) biological systems, self-controlled process of formation of coherent correlated states (CCS) is most effective. This process is possible at natural monotonic deformation of intermolecular potential wells during the growth of any biological system and leads to suppression – for a brief time – of the influence of the Coulomb barrier on the effectiveness of nuclear reactions[11–17]. It has been shown that in real nuclear physical and biological systems usage of CCS leads to very sharp growth (up to factor 10^{30}–10^{100} and more) of Coulomb barrier penetrability at very low energy of particles.

Using processes of low energy transmutation of radioactive isotopes in biological systems (including utilization and deactivation of reactor isotopes like Cs^{137} and synthesis of rare isotopes), provides principal foundation for eliminating the most debatable aspects in existing technologies, associated with processing spent nuclear fuel, and offers new solutions for problems, which could not be resolved by traditional methods of chemical technologies.

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