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Research Article

LENR Transmutation of Stable Sr and K Isotopes in Activated Microbiological Syntrophic Anaerobic Association

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Abstract

In our previous works [1]–[5], an effective method for accelerated deactivation of the reactor Cs^{137} isotope during nuclear reaction of transmutation $Cs^{137} + p = Ba^{138}$ in growing microbiological cultures was presented and discussed. In the present study we have attempted to solve the problem of accelerated transmutation of another very dangerous radioactive Sr^{90} isotope. This paper presents the results of investigation of the nuclear reaction $Sr^{88} + p = Y^{89}$ a transmutation to a stable Sr^{88} analog of radioactive Sr^{90} isotope. The research was carried out on the basis of optimal anaerobic syntrophic associations under the stimulated long-distant action of weak undamped thermal waves.

Keywords: Nuclear reaction in biological systems, Biotransmutation of isotopes, Coherent correlated states, Utilization of radionuclides, Microbiological syntrophic association

1. INTRODUCTION

It is well known that among the large number of long-lived reactor radioactive isotopes, there are two that are most dangerous to humans - Cs^{137} and Sr^{90}. These chemical elements (Cs and Sr) are direct biochemical analogs of vital elements K and Ca and are very efficiently absorbed by living organisms in the event the organisms lack these vital elements.

In our previous studies, methods of accelerated deactivation of Cs^{137} isotope were presented, carried out using a transmutation reaction $Cs^{137} + p = Ba^{138}$ stimulated by the growth of microbiological syntrophic associations [1]–[5]. During these studies, we have developed and optimized methods to accelerate this reaction, which is equivalent to reducing the lifetime of this isotope from 30 years to several (2 - 3) weeks. These experiments with a real radioactive

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Cs^{137} isotope were first carefully studied based on the $Cs^{133} + p = Ba^{134}$ reaction with a stable analogue Cs^{133} of this radioactive Cs^{137} isotope.

We are currently implementing a similar research technique to create a technology for the deactivation of another dangerous isotope, Sr^{90}, in the reaction $Sr^{88} + p = Y^{89}$ of transmutation of a stable Sr^{88} analogue of this isotope. In the course of the experiment, new methods of optimization of such reactions were investigated – the impact of shock-cavitation waves on the syntrophic association in order to increase the viability in life-threatening conditions of this association.

2. MATERIALS AND METHODS

As the object of our research, we chose an anaerobic syntrophic association grown on waste from the food and light industries. The optimum temperature for the life of the microbial community used for the experiments was 34 - 36°C.

One of the main goals of the experiments was the search for methods to optimize the transmutation reaction with the participation of heavy chemical elements and isotopes. In this series of experiments, we investigated the distant effect of weak undamped temperature waves acting for a relatively short time on a given microbiological association. The possibility of the existence and features of the propagation of such undamped temperature waves directly follows from the refined equations of thermodynamics, if we take into account the time τ of local thermal relaxation (time of thermalization) at any point of the field of the thermal (temperature) wave. Such waves can propagate over a long distance without dissipation, and their frequency is determined by the formula $\omega = (n + 1/2)\pi/\tau, n = 0, 1, 2 \ldots$. These waves were predicted, observed, and studied in detail (both theoretically and experimentally) in our works [6]–[9].

The action of such waves leads to the formation of weak shock-acoustic waves in the volume, which contains the used microbiological association.

Earlier, we carried out similar detailed studies on the stimulation of nuclear (dd)-fusion in remote Ti + D targets due to the action of the same waves [9]. In these older experiments, we very effectively stimulated this fusion reaction through the formation of coherent correlated states in the target [10]–[16].

Such quantum states correspond to a coherent quantum superposition of the eigenfunctions of a particle in a potential well (in particular, to a coherent superposition of proton vibrations modes in an interatomic potential well).

These states are formed by, for example, a fast pulse deformation of a potential well, or when it is periodically modulated at certain frequencies [10]–[16]. The main feature of such states is the possibility of the formation of very large fluctuations in the momentum and energy of the particle, which leads to a very sharp increase in the probability of the tunneling effect and, accordingly, in the probability of a nuclear reaction at low (e.g., room) temperature. These states and the associated process of stimulation of nuclear processes have been studied in detail in works [10]–[16].

In the current experiment with Sr^{88} isotope (natural abundance 82.6%) we also wanted to test the effectiveness of such undamped temperature waves on a distant microbiological association before the start of a long process of $Sr^{88} + p = Y^{89}$ nuclear transmutation. The synthrophic association biomass concentrate with a volume of 30 ml was left under the action of these waves at a distance of 20 cm from the wave's source for 30 minutes. These waves were generated at the exit surface of the cavitation unit with an internal water jet. Experiments carried out by us many times have shown that the fundamental frequency of such continuous waves depends on the state of the air (temperature, pressure, and humidity) and lies in the range of 75-85 MHz. There were several possible reasons for such an additional action (both nuclear-physical and purely microbiological) and the final results confirmed our expectations.

A photo of the irradiation process is shown in Fig. 1.

In control experiments, there was no such preliminary irradiation of microbiological association.

Both experiments (the main one with preliminary irradiation of the microbiological association and the control one without such irradiation) were carried out simultaneously on spatially separated installations.

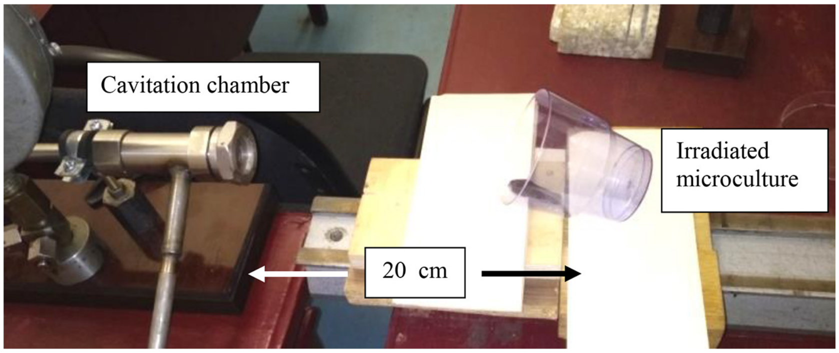

Figure 1. Photo of the system for remote irradiation of microculture before the start of the nuclear transmutation process.

A wet biomass centrifugate of the syntrophic association weighing $\sim$1.41 g was placed in a culture medium with a volume of 0.075 L, with a strontium content of about 50 mg/L ($Sr(NO_3)_2$ salt). In addition to the high content of heavy metal, the absence of biogenic elements, including sources of potassium, phosphorus, and calcium, was a vital factor.

As a control experiment, a concentrate of syntrophic association biomass without wave action ($\sim$1.48 g) was used.

Glucose was used to ensure the physiological growth of microcultures.

Glucose was introduced at the rate of 0.1 - 0.8 g/L per day, taking into account the assessment by the photometric method of its consumption for the growth of microcultures. To carry out this periodic current concentration of glucose analysis from the composition of the working nutrient medium, microsamples of the medium with a volume of 25 microliters were taken. Such tests were carried out 5 times per day. The liquid taken for such analyzes was taken into account when calculating the content of elements before and after incubation.

After the end of the incubation, the biomass of the syntrophic association was separated by centrifugation under the same conditions.

3. RESULTS AND DISCUSSION

The weight of the wet sediment of the biomass was 2.4455 g. The content of Sr, Ca, Y and K was analyzed by the ICP-MS method under initial conditions and after incubation in all components of the working volume including supernatant (liquid phase that remains after insoluble substances are precipitated during centrifugation).

Table 1 shows the results of the analysis of the content of these elements in the initial biomass, the original nutrient medium, supernatant and biomass sediment after incubation.

The measurement error was $\pm$ 4% (or less) for each of the presented results.

A typical series of experiments lasted 21 days under anaerobic conditions.

The results of the analysis of the elemental composition of a closed cell with a microbiological association and all components of the culture medium at the beginning and after the end of the optimal experiment with preliminary irradiation are presented in Table 2.

The main result of the experiment is a significant decrease in the concentration of strontium, as well as an increase in the concentration of yttrium isotope in the optimal experimental closed volume.

In addition, a significant increase in the concentration of calcium was found as a result of the process $K^{39} + p = Ca^{40}$, as well as a decrease in the concentration of potassium.

The lack of a complete balance in the change in the concentrations of pairs of elements (strontium-yttrium) and (potassium-calcium) in Table 1 is most likely caused by other additional transmutation reactions that we have not yet discovered.

Table 1. The results of the analysis of the total content of Sr, Y, K and Ca in all components of the experimental system.

Sample name	Content mg/L solution or mg/g wet biomass			
	Sr	Y	Ca	K
Initial solution	56.32	< 0.005	0.3	264.25
Initial biomass	0.013	0.000266	0.748	0.433
Supernatant	19.4	<0.005	1.133	205.00
Biomass sediment	1.043	0.000206	0.462	1.25

Table 2. Content of elements at the beginning and at the end of the optimized microbiological LENR experiment.

Element name	**Total mass at the beginning of the experiment, mg**	**Total mass at the end of the experiment, mg**	**Increase or decrease, %**
Sr	4.24	4.01	↓5.4
Y	0.00037	0.00050	↑35.1
K	20.4	18.4	↓9.8
Ca	1.08	1.21	↑12.0

In the control experiment, practically no glucose was consumed. This result confirms the very low metabolic rate in such a microculture. It was found that the control biomass lost weight from 1.4801 to 1.3991 grams, which indicates that there was no growth of the untreated biomass wave due to the lack of necessary microelements (e.g., P and Ca). It should be noted that in the control experiment the balance for the same elements at the beginning and at the end of incubation converged and did not exceed the statistical error.

It should be noted that in nuclear reactions stimulated by the process of formation of coherent correlated states, the channels of nuclear reaction, the daughter products of which are radioactive nuclei, are completely impossible and forbidden by the strict laws of quantum mechanics [11], [14]. For this reason, the additional reaction $\mathrm{Sr}^{86} + \mathrm{p} = \mathrm{Y}^{87}$ with participation of another Sr^{86} isotope (natural abundance 9.86%) which leads to the formation of radioactive Y^{87} isotope, is fundamentally impossible.

4. CONCLUSIONS

The fact of the vitality of the syntrophic association and its effect on the Sr content as a result of treatment with shock-cavitation waves in such life-threatening conditions as a lack of macro- and microelements was revealed. It was shown that in the optimized experiment, effective processes of synchronized changes in strontium and yttrium, as well as potassium and calcium take place.

The biophysical reason for this transmutation is most likely due to the fact that the synthesized isotope of yttrium is a direct biochemical analogue of calcium (for yttrium, this radius is $R_Y^{(2+)} \approx 0.99A$ and for calcium $R_{Ca}^{(2+)} \approx 0.99 \ldots 1.011A$). The same reason justifies the process of another observed transmutation (potassium to calcium).

Using the same considerations and estimates, it is easy to make sure that with an optimal experimental setup, the direct use of radioactive strontium by a growing microculture (its ionic radius $R_{Sr}^{(2+)} \approx 1.12A$ is not as close to calcium $R_{Ca}^{(2+)}$ as yttrium $R_Y^{(2+)}$) can be much less effective than its "processing" into yttrium with subsequent absorption.

Based on our preliminary estimates, we tried to reduce the initial (impurity) calcium content in all components of the system. It is very difficult to completely eliminate calcium, since initially calcium was contained in the medium in a bound form during the introduction of biomass.

As is well known, calcium is one of the essential trace elements and such transmutation processes are very efficiently supported by growing microcultures.

We discussed this process in detail in our early works [1]–[4]. It consists in the fact that the fluctuationally formed nucleus (that is, formed during the transmutation reaction) of the required isotope, together with its electron shell, very quickly (practically instantaneously) integrates into the structure of the growing microculture, which fixes the process of transmutation.

Obviously, with a more complete “purification” of the system from impurity calcium, as well as eliminating the prerequisites for an alternative pathway of calcium formation in the reaction $K^{39} + p = Ca^{40}$ (which will require minimizing the initial potassium concentration), the conversion efficiency of strontium (including the radioactive Sr^{90} isotope) will be significantly higher. We are planning such experiments in the near future.

The nuclear-physical aspects of this transmutation, in our opinion, are associated with the formation of coherent correlated states [6]–[12].

In our opinion, these reactions were stimulated by the same processes of optimization of nuclear reactions at low energies due to the formation of coherent correlated states in growing microbiological associations [2], [3], [4], as in the case of Cs^{137} isotope transmutation.

Pre-irradiation of the syntrophic association with shock-cavitation waves optimized the structure of the multicomponent syntrophic association and launched the process of an initial nuclear transformation, which then proceeded for a long time in the absence of such stimulation.

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