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Research Article

Experimental Device of Cold HD-Fusion Energy Development and Testing (Verification Experiment)

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Abstract

The work is devoted to experimental check of the intensive cold fusion model (the *chemo*nuclear fusion scenario) developed. For experiments, the experimental device of cold fusion energy in HD–nickel system has been made. To create an "active pseudo-composite" layer (offered in V.F. Zelensky, The Int. Conf. on Cold Fusion-20. Japan, 2016) on the electrode surface, an operating procedure has been developed for processing nickel electrodes of the energy generator. All the phenomena expected in the *chemo*nuclear fusion scenario were observed in the "verification experiment" (except γ-radiation caused by the bineutron–nickel nucleus interaction). The conclusion is drawn that the *chemo*nuclear fusion scenario successfully explains the process of intensive cold fusion in three fusion systems (2D–, HD– and $(^7\mathrm{Li}–^1\mathrm{H})_{\mathrm{gas}}$-transitive metal), and thus, can form the basis for the development of cold fusion reactors.
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1. Introduction

The work in the new line of scientific research, now known as "cold fusion", was started at the Kharkov Institute of Physics and Technology (KIPT, Ukraine) in 1989, following the publication of information on the phenomenon [1]. In 2012, we published the paper [2], where the two-stage, cluster model of cold fusion was offered. The statements put forth in [2] about participation of virtual photons of anomalous internal γ-conversion in the fusion process, have provided explanation of cold fusion at a qualitative level. However, the proposed model needed further development.

The point was that the basic version of the scenario on the decisive role of conversion electrons in realization of intensive cold fusion called for experimental verification. That was caused by the fact that this version had been based on the works, the authors of which interpreted their results without considering the participation of the anomalous γ-conversion phenomenon in the cold fusion process

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Considering great importance for understanding the cold fusion phenomenon and its practical use, further studies on both the $\gamma-$radiation yield during cold fusion, and the radioactivity of materials used for the reaction were also needed, because the experimental results on the subject were contradictory in character.

The answers to the questions could be obtained only in the direct experiment, and that has been the task of the present work. The task was performed in two stages. The first stage included creation of the pilot source of cold HD-fusion energy. The second stage was devoted to conducting the "verification experiment". For four years that have passed since publication of our paper [2], the fusion model has received further development in our work [3] and also, the experimental evidence in work [4] and in our present work. Here we report the main results of model verification in the "verification experiment".

2. Creation of an Intensive HD-fusion Pilot Energy Source

As a method of cold fusion initiation the electric discharge in gas was used (material of electrodes is nickel) [5]. On the bases of thermo-physical stand of institute [6] gas-discharge installation–KD installation has been created and mounted.

The KD installation is a stainless-steel high-vacuum chamber, equipped with various devices and accessories, which are necessary for cold fusion initiation and conduction of experiments. Installation includes a means for maintaining of high vacuum ($p \leq 10^{-7}$ torr). For storage and metered flow of D_2 and H_2 chemical pumps based on Zr–Al–Fe-adsorbent are used (they are also necessary for ^{4}He and ^{3}He clearing).

The water-cooling of the chamber serves as a flowing calorimeter. The γ-spectrometer Inspector-2000 (Canberra Industries) with the HPGe-detector is used. Outside of the chamber dosimeters for neutron (ALNOR) and total (DTU) radiation level registration are located.

For analysis of chemical/isotopic compositions of gases, the installation is equipped with the MX7304A mass spectrometer, while the gas-discharge ampoule serves for the analysis of optical spectra on the SL40-2 spectrometer.

D_2 and H_2 are the hydrogen isotopes. Therefore, there have been reasons to expect that the method elaborated in deuterium experiments for initiating intense cold fusion (it consisted in creation of a transition metal-based "pseudo-composite" layer on the electrode surface [5,7]) will be efficient to solve the problem of intensive cold HD-fusion initiation in the $D_2+ H_2$ mixture. In our case, the "pseudo-composite" is the nickel-based matrix containing a lot of working gas-loaded cracks, pores and other voids.

The major link of the technological process of obtaining the surface "pseudo-composite" layer under discussion consists in operation of nickel electrodes in the mode of variable-polarity gas discharge.

At operation in the cathode mode, owing to ion implantation, the electrode surface layer is saturated with a mixture of gases to a depth of about 100 Å. Simultaneously with it, the surface layer is exposed to a flow of conversion electrons. Under these conditions, the deeper cathode layers get saturated with the gas due to radiation-stimulated diffusion. With the polarity change, the working gas-filled layer is exposed to both the electrons from the anode discharge current and the flow of conversion electrons. The irradiation by electrons brings about the increase in the quasimolecular clusters concentration, growth of cold fusion intensity and increase of the matrix imperfection [5]. As a result, after repeated changes of polarity, the layer containing a great many cracks, ruptures and other voids filled with the working gas is formed on the electrode surfaces. As it follows from Refs. [5,7], under the action of the electron flow (in this case it is the anode current and the flow of conversion electrons), this sort of "pseudo-composite" becomes the optimum matrix for intensive cold fusion initiation.

In the "verification experiment", the above-described technology of the "pseudo-composite" layer formation on the nickel electrode surfaces and the choice of the appropriate mode of the electric discharge in gas have allowed us to achieve a steady intensive HD-fusion at the KD installation, in the mix of D_2 (85%) + H_2 (15%). On the basis of the KD installation, the pilot *chemo*nuclear HD-fusion energy source has been developed and tested. The experimentation

Table 1. Part of the data from June 6, 2015, experiment.

Time	ΔT (°C)	I (A)	U (V)	Water flow rate (100 ml /s)	P_{elect}(W)	P_{heat} (W)	Efficiency	Efficiency with the calibration account
9:36	1	0.083	614	79	50.96	5.29	0.10	0.11
10:20	6.9	0.083	589	79	48.89	36.51	0.75	0.80
11:24	7.6	0.109	475	79	51.78	40.21	0.78	0.84
11:40	9.3	0.1075	466.7	79	50.17	49.21	0.98	1.05
12:20	11	0.1095	414.2	80	45.35	57.48	1.27	1.36
14:19	10.5	0.1136	281.9	80	32.02	54.86	1.71	1.84
14:33	10.4	0.1147	274	80	31.43	54.34	1.73	1.86
14:46	10.8	0.1149	288.4	80	33.14	56.43	1.70	1.83
16:02	14.9	0.1414	324.5	80	45.88	77.85	1.70	1.82
16:16	14.4	0.143	311.9	80	44.60	75.24	1.69	1.81
16:31	14.2	0.145	298.7	80	43.31	74.20	1.71	1.84

with this energy source has confirmed the validity of the *chemo*nuclear 2D-fusion scenario for the HD-nickel system, too.

3. "Verification Experiment" Results

3.1. Measurements of excessive heat generation

In experiment with working mix of D_2 (85%) + H_2 (15%) the following results are received: the maximum efficiency of a system – 1.8–1.9; excess power – at level of 30–35 W. Table 1 shows a part of the data results, obtained in the June 6, 2015, experiment. Similar results have been obtained in June 3, 2015 and June 7, 2015, experiments.

3.2. Changes of electrical parameters of the discharge

In the transition to the mode of intensive cold fusion, as the excess heat yield increased, the resistance of the discharge gap changed from 8–7.5 down to ∼2 kΩ. At that, the discharge current at the given electric power of ∼50 W increased

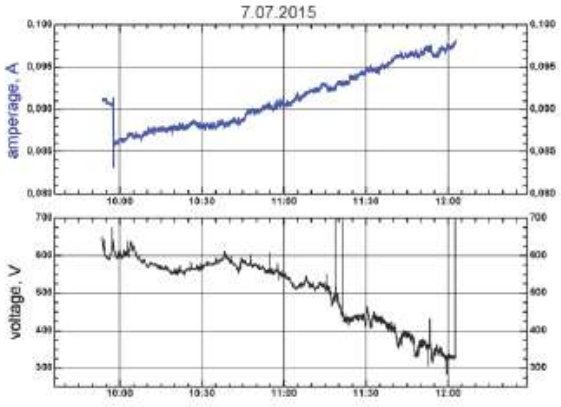

Figure 1. Electric characteristics of 7-07-2015 experiment.

Table 2. Some products of a bineutron absorption by a nickel isotopes reaction.

1	^{59}Co, stable
2	^{61}Co, β^- $T_{1/2}$ = 1.65 h, γ = 0.067 (0.89), β = 1.22 MeV
3	^{62}Co, β $^-$ $T_{1/2}$ = 1.5 min
4	^{63}Ni, β^- $T_{1/2}$ = 100 years, γ = 0

from 83 up to 143 mA, and the discharge gap voltage decreased to the values, at which the discharge could not be initially ignited. The changes in the electrical parameters of the experiment are shown in Fig. 1. Similar results have been obtained in June 3, 2015 and June 6, 2015, experiments.

3.3. Absence of induced γ-radiation

Some supposed products of bineutron absorption by nickel isotopes reaction are presented in Table 2. Neither in the process of experiment nor at the subsequent "flashing" ("flashing", the decay of γ-activity induced in experiment) is not found a γ-radiation differs from background level. In Fig. 2 the site of a spectrum in the field of a 0.067 MeV line for a spectrums registered during the discharge, after discharge termination and for a background spectrum (a, b, c accordingly) is shown. Appreciable differences between spectra are not revealed.

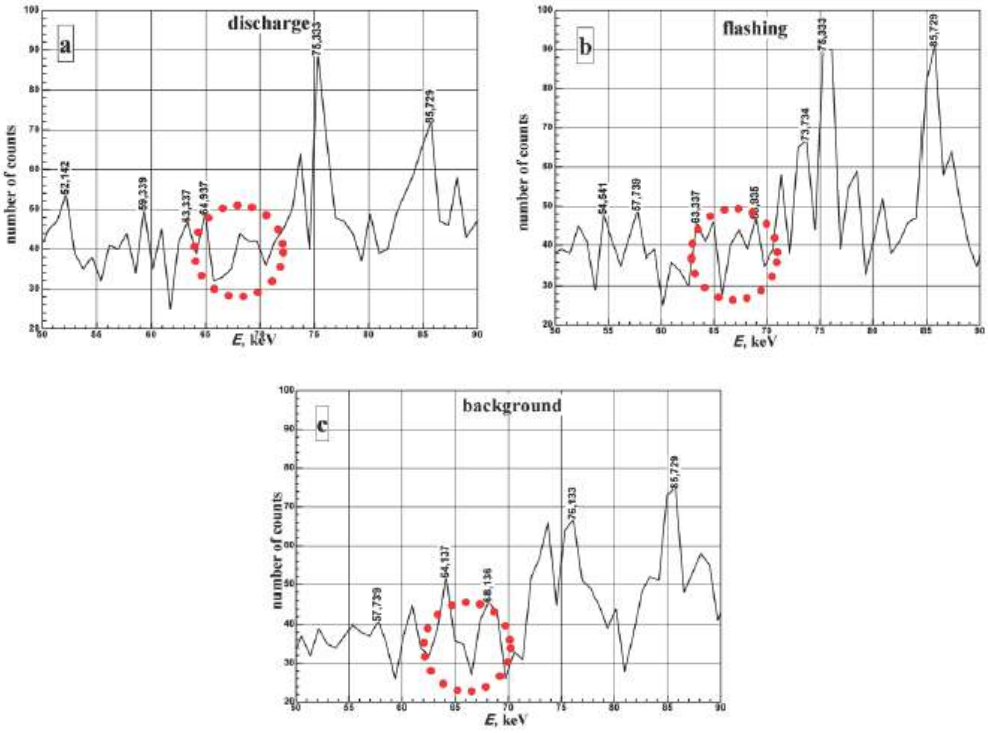

Figure 2. γ-spectral regions in the neighborhood of the 67 keV line for various registration conditions: (a) during the operating time of the discharge (6.07.15); (b) after discharge termination; (c) background.

During carrying out of experiment the sum of γ-spectrometer count-downs in a range of (50–2000) keV exceeded background activity on $\sim$0.8% that does not fall outside the limits admissible changes of a background level. The activity of radon peaks during the experiment did not exceed the background level. The line of ^{214}Bi (609.3 keV) decay was not detected. At first sight, it contradicts to our earlier work [8], where ^{214}Bi activation was reliably registered under similar conditions. In actual fact, we may not compare the results obtained in the present work and in [8], because the activity measurements in [8] were carried out with a low-background stationary γ-spectrometer at an order-higher measuring sensitivity and at a lower background level (by a factor of $\sim$4) [5].

The signal from ALNOR- (registration of neutron radiation) and DTU- (registration of the total level of radiation) dosimeters corresponds to the natural background level.

3.4. ^{3}He generation

The analysis of gaseous mixture was carried out in two stages. The first was the analysis of a "zero" spectrum (the analyzer spectrum). The second stage included the analysis of the working gas after its processing by the chemical pump (the chemical pump absorbs reactive gas components such as hydrogen/deuterium/HD, water vapor and carbon oxides; neutral gases are not absorbed, as they do not react with the metal absorber). The gas analysis was carried out with gradual increase of ionization voltage. This approach along with the application of the chemical pump allows distinguishing HD and ^{3}He components in the analysis. A similar technique was used in work [9].

In the course of the experiment the isotopic composition of the working gas has changed drastically (Table 3). In the experiment with gas composition of 85% D_2 and 15% H_2 the ratio of the peak height of mass-3 to the peak height of mass-4 ranged up to 17. In the experiment with low hydrogen content ($\sim$1%) this ratio was equal to 10. This gives grounds to conclude that ^{3}He is generated in the experiment. The content of D_2 and H_2 molecules in the analyzed gas was minimum due to their absorption by the chemical pump adsorbent, and could not affect considerably the ^{3}He/^{4}He ratio.

Figures 3 and 4 show the mass-spectrum peaks and their intensities in the range $m/z = 1$ to 4 versus the ionization voltage: in the analyzer chamber (Fig. 3); for the spent gas mixture after processing in the chemical pump (Fig. 4). It can be seen that the curves for $m/z = 3$ in Figs. 3 and 4 have various behavior: in Fig. 3 the curve "intensity" remains practically unchanged with increase in $U_{\mathrm{ionization}}$, whereas in Fig. 4 the "intensity" increases by approximately an order of magnitude. The behavior and the "intensity" level of the curves for $m/z = 4$ are very close (cf., Figs. 3 and 4).

The obtained results allow us to conclude that in our "verification experiment", it is ^{3}He that is generated, while the ^{4}He concentration remains invariable.

3.5. Modifications of electrodes surface

During the operation of electrodes in a mode of intensive cold fusion, the occurrence of specific superficial structures has been revealed. Figure 5 shows two pictures, whose images may be interpreted as the opened blisters. It should

Table 3. Results of the gas analysis.

Dates of experiments	Pressure during the analysis (Pa)	Analyzed gas	Parity of peak intensities of masses 3 and 4 – I_3/I_4
19-03-2015	$2.5–4.7\times10^{-4}$	Vacuum	2.7–5.5
09-04-2015	$7.9–9.6\times10^{-5}$	D_2/H_2 (99%/1%) + chem. pump	8–9.5
30-06-2015	$0.5–1\times10^{-4}$	Vacuum	0.7–3.5
07-07-2015	0.5×10^{-4}	D_2/H_2 (85%/15%) + chem. pump	6.4–17

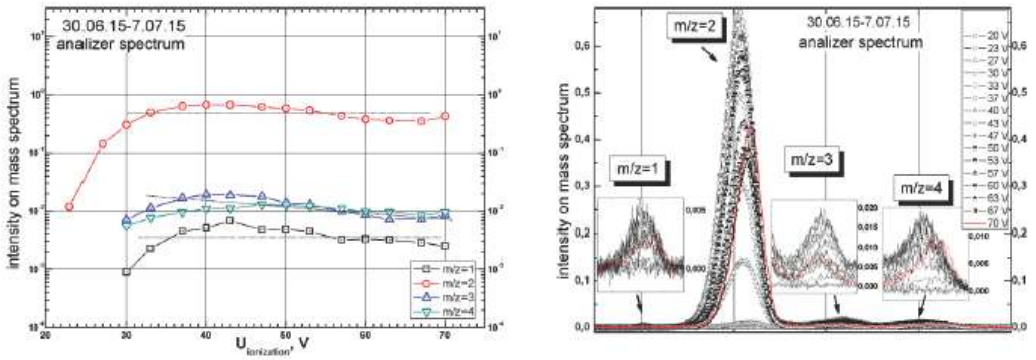

Figure 3. Peaks intensity on a mass spectrum in a range $m/z = 1$ to 4 depending on voltage of ionizations (20–70 V) in the gas analyzer chamber (the data from experiments made during 30-06-2015 to 7-07-2015).

be borne in mind that as these images are obtained in the secondary electrons (SEI), the contrast is largely determined by the composition and not of the sample topography. Studies held in the topology of the surface of the backscattered electron detection mode. However, the small size objects (less than 1 μm) does not allow to apply this method due to its low spatial resolution. Inside the blisters probably disclosed internal relief is observed rather than a smooth surface characteristic of the gas-filled voids, after processing the image.

Based on the foregoing, it is doubtful interpretation of these images as images of gas-filled blisters.

Formation on the surface of shown above structures – structures with an internal relief, well agrees with the mechanism of intense cold fusion considered here (see description responsible for the intense cold fusion matrix, viz "the pseudocomposite", [3]). Studying these structures will provide additional information about the nature of the *chemo*nuclear fusion. Investigations are continuing.

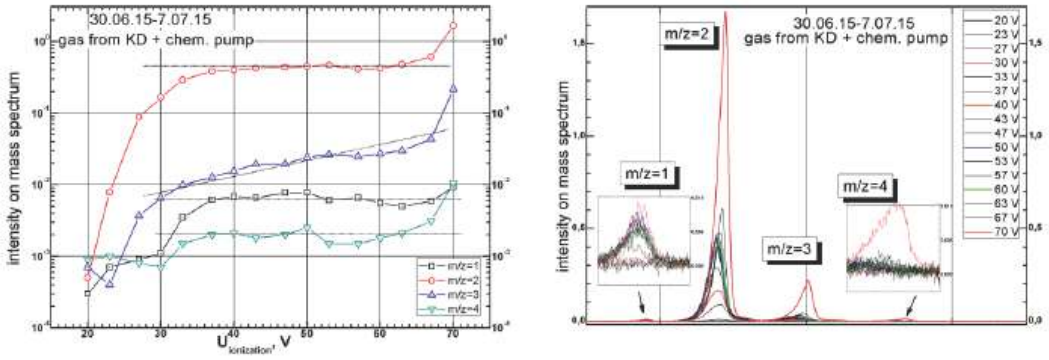

Figure 4. Peak intensity of the mass spectrum in the range $m/z = 1$ to 4 versus ionization voltage (20–70 V) for the exit gas from the KD setup after processing in the chemical pump (the data from experiments made during 30-06-2015 to 7-07-2015).

Table 4. Nickel isotopic structure in nature, in "ashes:" of HTE-Cat reactor [6] and in present work.

No.	Isotope	Natural composition (%)	Isotope composition in "ashes" (% [6])	Composition on a cathode surface (the present work) (%)	Proton energy in reaction ^{x}Ni $+^{2}$n $\rightarrow$ $\rightarrow^{x+1}$Co $+$p (E)) (MeV)	Columbs barrier E_c (MeV)	$(E_p - E_c)$ (MeV)
1	^{58}Ni	67.76	0.8	66.52	10.7	$\sim 7 \pm 1$	$+3.7$
2	^{60}Ni	26.16	0.5	26.72	10.24	$\sim 7 \pm 1$	$+3.2$
3	^{61}Ni	1.25	0	1.24	6.06	$\sim 7 \pm 1$	–1
4	^{62}Ni	3.66	98.7	4.42	3.9	$\sim 7 \pm 1$	–3.1
5	^{64}Ni	1.16	0	1.1	–	–	–

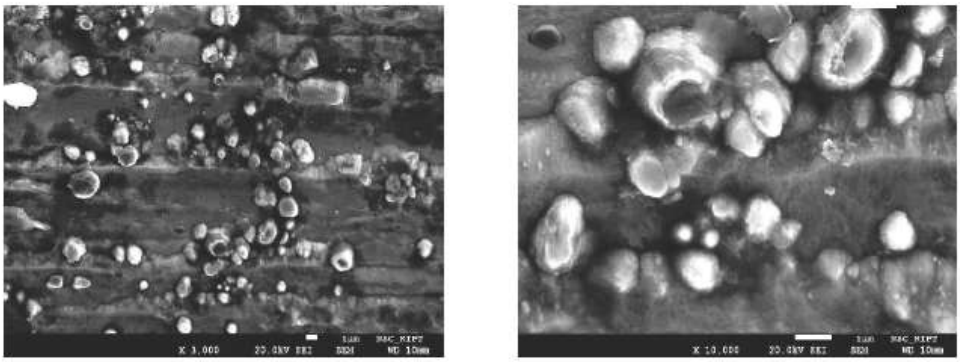

Figure 5. Microphotos of a surface of electrodes.

3.6. Changes of nickel isotopic composition

The research results for the Ni isotopic composition on the electrode surfaces are presented in Fig. 6 and Table 4. The 20% increase in the ^{62}Ni isotope concentration has been found.

In Fig. 7 and Table 4 the data of fuel analysis taken from Ref. [4] is shown. From Fig. 7 and Table 4 it can be

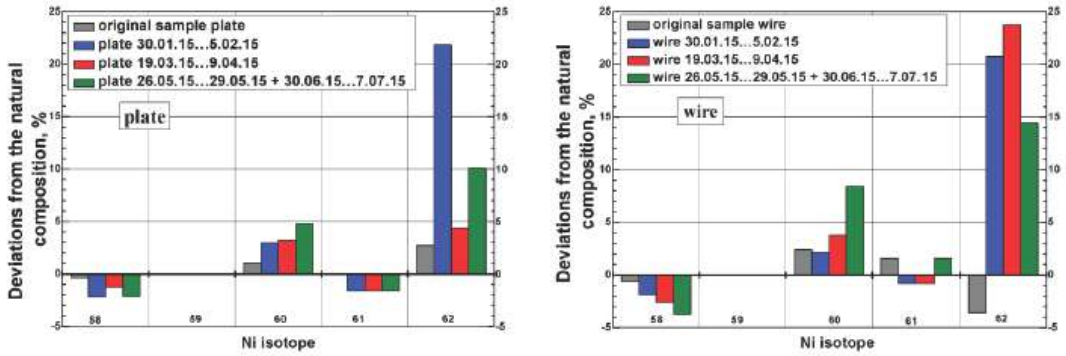

Figure 6. Ni isotopic composition deviations in initial samples and on a surface of electrodes (wire is a central electrode, plate is a lateral electrode) relative to a natural composition.

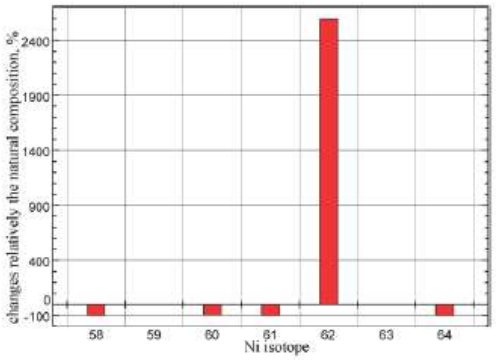

Figure 7. Deviations of nickel isotopic composition in "ash" from HTE-Cat reactor [7] relative to a natural composition.

seen that the isotopic composition of nickel observed in [4] has significant changes. On completion of the experiment, the HTE-Cat "ash" contained almost 99% of ^{62}Ni isotope (cf. its initial content of 3.66%). As to our experiment, the changes in the nickel isotopic composition are not so striking. However, this does not cast any doubt on the reliability of data, since the excess of the ^{62}Ni isotope content (near 20%) goes far beyond the limits of instrument errors. Such different results are attributed to differences in the operating modes, viz., a considerably shorter duration of our experiment and a lower intensity of process in this case).

4. The Discussions of Results

According to the *chemo*nuclear 2D-fusion scenario, one should expect that in the "verification experiment" with the use of the mixture D_2 (85%)+ H_2 (15%), it is the HD-reaction that will be responsible for the occurrence of intense cold fusion [2,3]. The fusion process in this case should be accompanied by the following nuclear processes.

(a) Considerably strengthened by medium "*chemo*factors" an intercluster (proceeding inside "Gryzinski quasi-molecules" ($D^+ + e^- + H^+$)) HD-reaction:

$$D^+ + e^- + H^+ \rightarrow {}^3_2\mathrm{He} + e^-_{\mathrm{conv}}(\Sigma E = 5.5\ \mathrm{MeV}). \tag{1}$$

(b) Reactions of weak interaction, first of all, generating of a bineutron ^{2}n reaction:

$$D + e^-_{\mathrm{conv}} \rightarrow {}^2n + \nu_e \tag{2}$$

drastically strengthened in the conditions of intensive cold fusion.

(c) Interaction of bineutron with nickel and working gas nuclei reactions [5].

The major path for a "verification experiment" is the absorption of a bineutron by nickel nuclei reaction:

$$ {}^x_{28}\mathrm{Ni} + {}^2n \rightarrow {}^{x+2}_{28}\mathrm{Ni}^* \rightarrow {}^{x+1}_{27}\mathrm{Co} + p(E). \tag{3}$$

(1) Secondary reactions.

Interactions reactions fast protons from (3) reaction with nickel nuclei (4) and other element of active zone of reactor nuclei.

$$ {}^x_{28}\mathrm{Ni} + {}^1p \rightarrow {}^{x+1}_{29}\mathrm{Cu}. \tag{4}$$

Generating copper nuclei with the exception of stable ^{63}Cu and ^{65}Cu isotopes decays by one of channels:

$$^{x+1}_{29}\mathrm{Cu} \rightarrow {}^{x+1}_{28}\mathrm{Ni} + \mathrm{e}^{+} + \nu_{\mathrm{e}} \quad (\text{positron decay}), \tag{5}$$

$$^{x+1}_{29}\mathrm{Cu} + \mathrm{e}^{-} \rightarrow {}^{x+1}_{28}\mathrm{Ni} + \nu_{\mathrm{e}} \quad (\text{electron capture}). \tag{6}$$

"Products" of nuclear reactions under (a) in a "verification experiment" will be: excess heat without high energy γ-radiations emission; conversion electrons emission; generating of ^{3}He atoms; on a surface of electrodes specific formations will appear (swellings, blisters, craters) etc.

The reactions under (b), (c) should be accompanied by "products" of a bineutron interaction with a matrix and working gas: fast p-, n-nucleons and their clusters d, T, ^{4}He, ^{3}He yield; generation of anomalous isotopic composition impurities; γ-radiation of radioactive impurity nuclides and others.

Registered in the conditions of a "verification experiment" under (a), (c) should be: anomalous changes of nickel isotopic composition (^{62}Ni concentration growth against burning out of other isotopes); γ-radiation 0.067 MeV line, $T_{1/2} = 1.65$ h (Table 2).

The intensity of secondary reactions (d) significantly less than intensity of reaction from (a)–(c) and therefore secondary reaction products in "verification experiment", likely, will not register.

One of the main results of the present work has been the creation of the experimental device of intensive cold HD-fusion energy, i.e., the source of thermal energy, which is not accompanied by emission of high-energy radiation. The generator creation is the practical realization of *chemo*nuclear fusion scenario statements, and thus, the very fact of generator creation is the evidence of the scenario validity.

As indicated in [5,7], the main secret of intensive cold fusion lies in the fact that the transition state formed in the process of fusion in the system of co-operating particles, – the "Gryzinski quasimolecule", provides a timely discharge of the fusioned nucleus due to participation of virtual photons and electrons of anomalous γ-conversion. The last removes the restrictions caused by the problems related to γ-quantum radiation. In that event, each "Gryzinski quasimolecule" system has its own elemental composition. The fusion process in this case proceeds without rupture of nuclear bonds and demands overcoming the low Coulomb barrier inherent in light nuclei. This accounts for high intensity of cold fusion in all three systems of fusion.

All expected results listed above in a "verification experiment" exception of γ-activity were observed sufficiently well.

As expected, the experiment has proved the generation of ^{3}He atoms (see Table 3). The ratio of the mass-3 peak height to the mass-4 peak height in the experiment with a low hydrogen content (D_2 $\sim$99%; H_2 $\sim$1%) was approximately equal to 10, while in the experiment with the D_2+H_2 (85%+15%) mixture this ratio was as high as 17, whereas in nature the ratio is negligibly small. The ^{3}He atom generation in the "verification experiment" testifies that the fusion reactions proceed under the given conditions by the intercluster mechanism unrelated to the rupture of the nucleus. In this case, it is the "Gryzinski quasimolecule" (D^{+}+e^{-} +H^{+}) that serves as an initial ion cluster, and the intracluster reaction (1) is responsible for the HD-fusion process.

The "verification experiment" has also provided evidences in favor of the version that the conversion electrons take part in the cold fusion process. Radical changes in the gas discharge parameters, as the system turns to the mode of intense heat generation (see Fig. 1), testify that the excess heat in the "verification experiment" is taken off by the conversion electrons. The radiation outside the discharge chamber, observed in early experiments by Karabut [10], can be explained in the *chemo*nuclear fusion scenario as the HD-fusion reaction yield of conversion electrons of energy up to 5.5 MeV (see [2]).

The nickel isotopic composition change on the electrode surfaces in the "verification experiment" is one of the most compelling evidences of the validity of the *chemo*nuclear fusion scenario. According to this scenario, the experimentally observed cardinal changes in the Ni isotopic composition are the result of bineutron absorption by the Ni nucleus. This absorption reaction cannot be accompanied by the proton yield from ^{62}Ni nucleus (Coulomb barrier forbiddenness, see Table 4), and consequently, the ^{62}Ni isotope accumulation takes place. This was found out in experiment [4] and in our present work.

The "verification experiment" has registered the occurrence of specific formations (swellings, blisters) on the electrode surfaces (see Fig. 5), and this is also in good agreement with the intensive cold fusion mechanism considered in [5,7].

γ-Radioactivity is the only phenomenon which was expected in the scenario (see Table 2), but was not observed in the "verification experiment". As it follows from Table 2, in accordance with the nickel isotopic composition change, the following reaction should take place in the "verification experiment":

$$^{60}_{28}\mathrm{Ni} + {}^{2}\mathrm{n} \rightarrow {}^{62}_{28}\mathrm{Ni}^{*} \rightarrow {}^{61}_{27}\mathrm{Co}(\beta;\ T_{1/2} = 1.65\ \mathrm{h};\ E_{\gamma} = 0.067\ \mathrm{MeV}) + \mathrm{p} \rightarrow {}^{61}_{27}\mathrm{Ni}_{\mathrm{stable}} + \mathrm{p}. \quad (7)$$

When creating the chamber, efforts were made to receive the maximum "signal" from the reaction. The americium-source calibration of the chamber has shown that the 0.067 MeV line intensity in experiment will be suppressed by no more than a factor of 5. In view of this, and also considering the rates of changes in nickel isotopes concentration observed in work [4] and here, one could expect that during the "verification experiment" the 0.067 MeV line would be registered reliably. However, neither in the course of the experiment, nor at subsequent "flashing" any γ-radiation other than the background radiation was observed. The radioactivity was not found either in the work by the panel of experts in Lugano [4].

At the same time, there is a large number of works, where during cold fusion experimentation the generation of β-active products was observed and the γ-radiation was registered [11]. As an example, we will consider our work performed in 2001 [12]. It was indicated there that in the process of pulsed electrolysis of LiO–D_2O solution in the cell having the palladium cathode and the tungsten anode, the generation of β-active products takes place. After the discharge termination, the electrolysis cell activity in the 250–350 keV energy range was 30% higher than the γ-background in the spectrometer chamber. In the range between 200 and 2000 keV, the spectral analysis has revealed a number of peaks, the height of which exceeded the background by more than 3σ. The chain of peaks revealed was as follows: 247 keV ($\sim 4.5\sigma$); 243 keV ($\sim 4\sigma$); 353 keV ($<3\sigma$); 161 keV ($<3\sigma$). The half-life of the strongest line of the chain ($E = 243$ keV) was determined to be 5 $\pm$ 0.2) days, this being in good agreement with $T_{1/2} = 5.1$ days for the ^{183}Ta isotope. The above-given γ-lines peaks were close, in both the energy and the relative intensity, to the lines of the ^{183}Ta isotope spectrum. This gave us grounds then to conclude [12] that in the conditions of the experiment in the electrolytic cell, along with other radioactive products not identified by us, the generation of ^{183}Ta isotope occurred.

Out of other similar works, we may mention a detailed research by Savvatimova et al. [8], who investigated the $\gamma-$activity arising during the process of gas discharge experiment in the D_2–W and D_2–Ta systems. It has been demonstrated by experiments that during the discharge an intensive γ-radiation arose. The radiation with the same set of lines continued for some time after discharge termination.

Comparison of the radiation spectrum and the target-surface isotopic composition changes during the experiment has provided a reliable identification of the composition of nuclides responsible for the chemical composition change of the electrode surfaces and the γ-radiation character. As in our experiment, the main result of experiments by Savvatimova et al. [13] is the generation of nuclides lighter than the nuclides of matrices (W and Ta). As an explanation, the authors of [13] have proposed that the obtained results should be attributed to the reactions of W and Ta with deuterium, that being very improbable in those experimental conditions.

At the same time, the results of the both works [12,13] can be adequately explained in terms of the *chemo*nuclear fusion scenario as a result of bineutron absorption by tungsten nuclei:

$$^{182}_{74}\mathrm{W} + {}^{2}\mathrm{n} \rightarrow {}^{184}_{74}\mathrm{W}^{*} \rightarrow {}^{183}_{73}\mathrm{Ta}_{\beta^-} + \mathrm{p}. \tag{8}$$

The seemingly contradictory results of cold fusion experiments may be explained in the *chemo*nuclear fusion scenario reasoning from the following.

The bineutron absorption in both groups of experiments causes the re-build of the nucleus and emission of nucleons or their clusters (see [2,3]). The specific nuclear excitation energy (the ratio of excitation energy to the number of nucleons in the nucleus) at bineutron absorption by the nickel nucleus essentially exceeds the specific excitation energy for tungsten, and the intensity of fusion process in the experiments with Ni is essentially higher than that in experiments with W. On this basis, the absence of γ-radiation in the Ni experiments can be caused by a deeper reorganization of the nucleus in this case. As it was noted in [5,7], in the matrix microvolume, where the fusion event takes place, the intensity of other phenomena may be drastically changed, too. These questions call for further investigations.

In summary, we note that the present results and the results obtained by the group of independent experts in Lugano (Italy) for the HTE-Cat reactor operation [4] suggest the conclusion that the *chemo*nuclear fusion scenario successfully explains the process of intensive cold fusion in all three (2D–, HD– and $(^{7}\mathrm{Li}\text{-}^{1}\mathrm{H})_{\mathrm{gas}}$–transitional metal) fusion systems, and thus, can serve as a basis for cold fusion reactor development.

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