TRITIUM GENERATIONS IN METALS AT THERMAL ACTIVATION

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ABSTRACT

The researches of thermo-activated tritium generation is conducted, arising at high temperature in metals interacting with hydrogen isotops and the nature of this generation is discovered. The researches are conducted on samples of iron and its alloys as well as on samples of titanium and niobium at interaction, basically, with ordinary hydrogen. It is established, that the short-term bursts of tritium generation, arising at interaction of hydrogen isotops in which is immersed, previously heated up metal sample, are connected with output tritium, early accumulated, owing of effects isotops.

1. INTRODUCTION

In [1,2] was shown, that the output tritium from metals is possible not only at effect of accelerated ions, but also in media of deuterium and ordinary hydrogen (protium + 0,015 % deuterium) at thermal activation. These experiments have revealed the complex kinetic of tritium accumulation in the plasma-forming gas, even at use, as active media, ordinary hydrogen only. At comparable total accumulated of tritium, in conditions of thermal activation, registered the generation rate could be even greater (10^{10}-10^{11} at/s), for reason of short time (0,25-5 minutes) [2]. In similar experiments was received the exponential increasing of tritium generation rate versus temperature, dependence on reduction of the tritium generation rate versus pressure of gas and is shown, that optimum on tritium generation rate have 10 % deuterium, for mixes protium-deutrium is in region.

The present work is devoted to study of tritium generation, arising at thermal activation in metal samples at effect of hydrogen isotops and determination the nature for tritium generated on various stages of experiment.

2. EXPERIMENTAL DESIGN AND PROCEDURE

In quality of the first samples for new techniques used large, the hollow cylinder of alloy Fe-Cr-Ni-Ti (71-18-10-1), weight about 10 kg and area of surface about 2 m^2 (Fig. 1).

The sample 1 have placed is coaxial in the vacuuam chamber 3 with water cooling 4. The sample 1 heated up with help resistive heater 2 of molybdenum wire, with capacity of supply to 5 KW. The chamber 1 was cooled by water for protection of elastic hermetically seales from aver-heating. The temperature of sample, during preliminary heating, reached 670 K. The experiment conducted as follows. In the beginning the working chamber was pump out, the sample heated up to given temperature and have conducted it out-gasing at pressure P < 10^3 Pa, during 1-2 h. Then in chamber filled the hydrogen to pressure (5 - 60)·10^3 Pa and maintained the definite time (0,1-50 h). Further the hydrogen pump out in rubber volume for subsequent burning, preparation of tests water and analysis by liquid, scintillation method. For experiments used mixture of isotops with concentration from 0,015 % deuterium in protium (ordinary hydrogen) to 95 % deuterium and 5 % protium (technical deuterium). The measurement of contents tritium in plas-

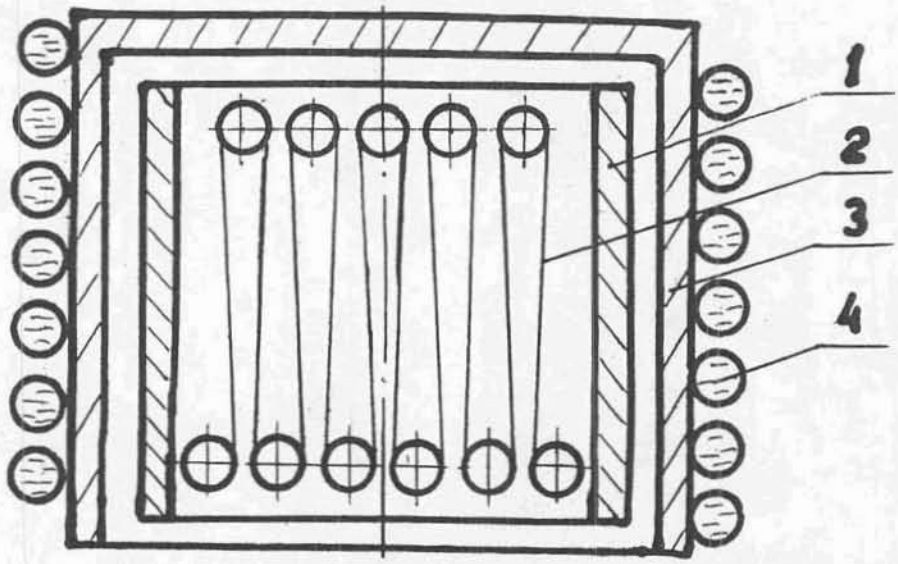

Fig. 1. The scheme of experimental installation for study tritium generation by thermal activation.
1-sample; 2-resistive heater; 3-chamber; 4-cools of chamber.

ma-forming gas wasmade on fulfilled program with error was not exceed $\pm$50 % [1-3].

For development of thermo-activation technique inside to sample of alloy Fe-Cr-Ni-Ti (71-18-10-1) had displacement the new sample of technical iron (C< 0,1 %) sizes 2 x 200 x 1200 mm. The Fe sample was displacement coaxial to sample of alloy Fe-Cr-Ni-Ti (71-18-10-1), was heated up by straight miss of electric current to temperature 750 K and, actually, it was as additional heater for sample of alloy Fe-Cr-Ni-Ti (71-18-10-1). For subsequent researches at temperatures to 900 K sample of Fe was made as zigzag, and after the sample of alloy Fe-Cr-Ni-Ti (71-18-10-1) was removed from chamber of the installation. Similarly the new sample was then made of alloy Fe-Cr-Ni-Ti (71-18-10-1), consisting from plates of thickness about 0,5 mm, which were set up in section from 3 to 6 pieces. The size of one piece was equal 0,5 x 200 x 1000 mm. The maximal temperature of such sample reached 900 K, at rolling up its in spiral could be within the limits of 1100-1200 K. On described samples the experiments were conducted, basically, at short-term processis. The hydrogen, deuterium or their mixes filled in chamber, with heated up to working temperature sample, and then, consistently, selected the tests of gas as at switched off, as at included heating of sample. The part of similar experiments conducted in thermo-cycles regime (about 10 cycles), with periods of heating and cooling to several tens of minutes.

3. RESULTS

The rate of samples cooling of Fe and alloy Fe-Cr-Ni-Ti (71-18-10-1) afterwards filled of hydrogen and switching-off of heating in coaxial geometry was great sufficiently and it had cooling in duration about 0,5 h to room temperature.

The schedules for dependence of gas test activity on tritium versus time, after heating of sample in hydrogen media as well as afterwards filled

of hydrogen in chamber with heated up sample and subsequent switching-off heating, are shown on Fig. 2. It is visible, that the activity reaches the maximum during 15-60 s and then slowly drops. Thus appreciably, that heating of samples together with hydrogen (Fig. 2; 4,5,6) gave much more lesser the level of activity on size, in comparison with preliminary heating of samples in vacuum (Fig. 2; 1,2,3). It is possible it happened because of more low temperature of samples, achievable during heating (determined

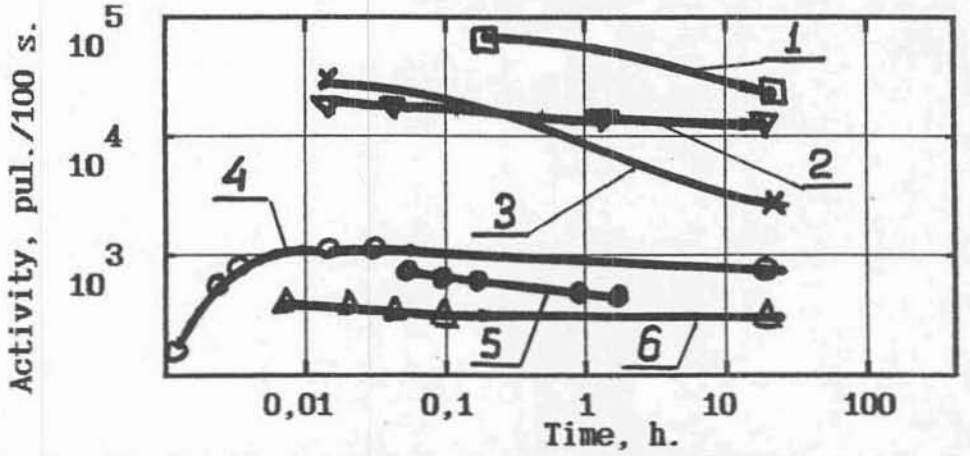

Fig. 2. The dependence of gas activity tests for hydrogen versus time, for various techniques of heating sample. 1,2,3- preliminary heating of sample in vacuum; 4,5,6- heats of sample together with hydrogen.

increased heat-transfer of hydrogen on system of cooling).

The typical dependence of hydrogen activity versus time of experiment is shown on Fig. 3. Appreciably, that heating of sample to temperature about 850 K in vacuum with constant detection of activity , does not result in significant tritium output from sample, and only afterwards filled of hydrogen in chamber the activity was increased nearly on three order. Follows to pay attention, that for subsequent 20 h the activity has decreased in 7 time.

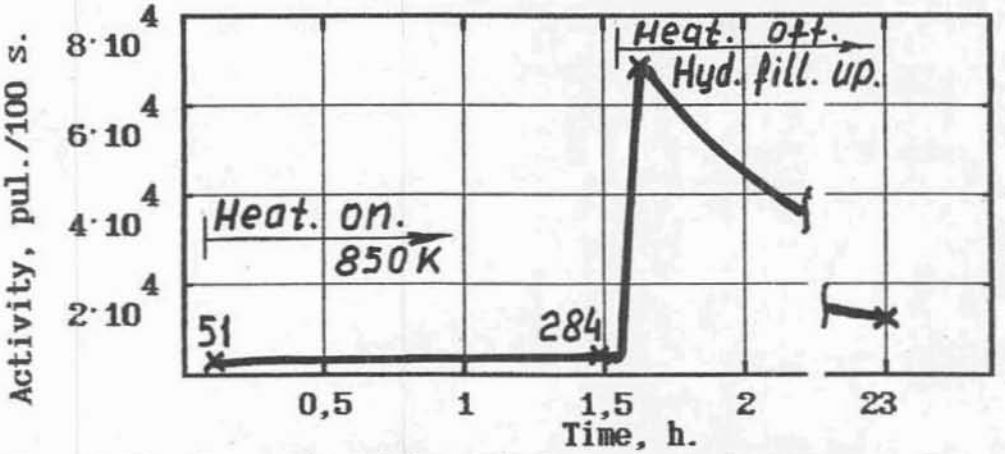

Fig. 3. The change of activity of hydrogen on various stages of experiment.

Thermo-cycles of samples has allowed to establish, that the increase of gas activity happened not at the time of heating, but in during cooling of

samples (Fig. 4). It is naturaly for samples of alloys Fe-Cr-Ni-Ti (71-18-10-1), as in its the solubility of hydrogen at reduction of temperature was decreases.

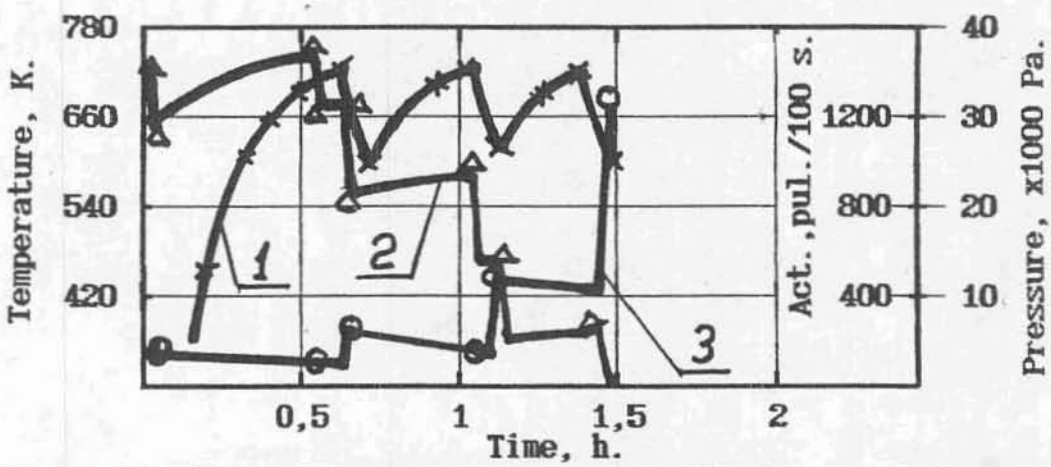

Fig. 4. The change of temperature for sample and hydrogen activity at thermo-cycles (sample: Fe-alloy Fe-Cr-Ni-Ti (71-18-10-1)).
1-temperature; 2-pressure; 3-activity.

The samples which was made as zigzag and rolling up in spiral have revealed, that after burst of activity the recession happens faster with heated up sample. Already on Fig. 5 appreciably, that the recession of activity happened is more sharp at increase of heating duration for sample with hydrogen.

It is repeating of thermo-cycles has shown, that the tritium generation more depends from the hydrogen pressure in chamber, than from quantity and parameters thermo-cycles. The majority of experiments demonstrated the increase of tritium generation rate, at short-term processis, with reduction of hydrogen pressure in chamber (Fig. 6).

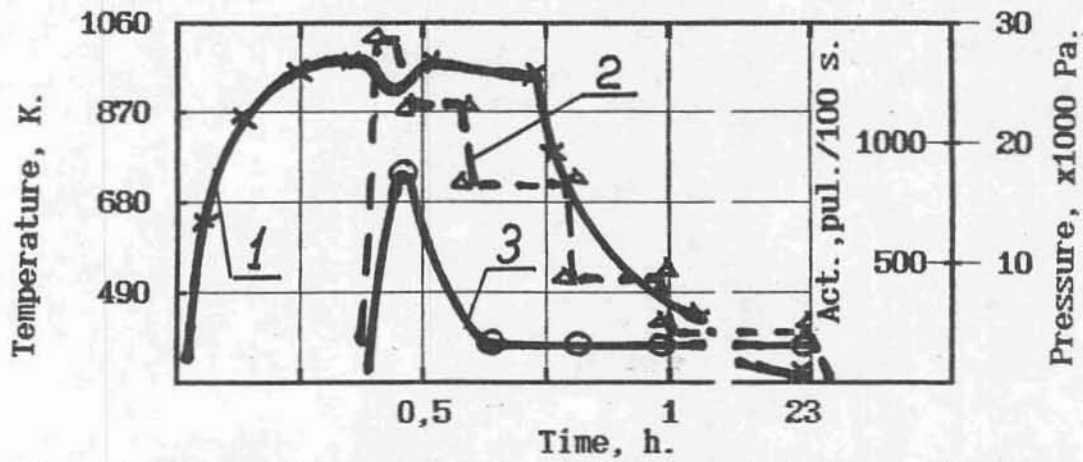

Fig. 5. The dependence of activity for hydrogen tests versus time, on various stages of experiment (sample: Fe-zigzag).
1-temperature; 2-pressure; 3-activity.

The results the most of characteristic experiments on tritium generation are adduced in Tab. 1.

4. DISCUSSION

Found out by us, the effect of short-term output tritium from heated up sample at interaction with hydrogen and deuterium interesting by theme, that the time of output for main quantity is very small (15-30 s). The sub-

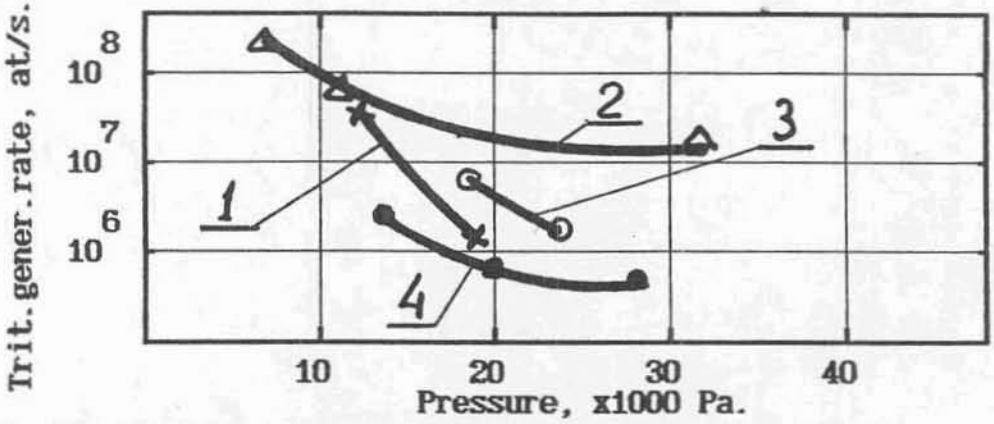

Fig. 6. The dependence of tritium generation rate versus pressure of hydrogen, at thermo-cycles (sample:Fe-all.Fe-Cr-Ni-Ti(71-18-10-1)). 1-03.02.97; 2-11.02.97; 3-11.03.97; 4-17.03.97.

Table 1.

The characteristic results of experiments on tritium generations, with ordinary mix of hydrogen isotops as active media, for new samples

Material	Current of heat	Temperature	Time of heat	Time of processis	Gas	Pressure	Specific active	Tritium generation rate	Specific tritium generation rate	
	A	K	h	h		$Pa_3 \times 10^3$	Pul/100s	Atom/s	At/s·g	At/s·cm^2
Fe	1200	1020	0.4	0.035	H	30	1398	$2.6 \cdot 10^8$	$8.1 \cdot 10^4$	$6.5 \cdot 10^4$
Fe	1200	1020	0.3	0.02	H	30	1758	$6.7 \cdot 10^8$	$2.1 \cdot 10^5$	$1.6 \cdot 10^5$
Fe	1300	990	0.3	0.1	H	10	884	$6 \cdot 10^7$	$1.9 \cdot 10^4$	$1.4 \cdot 10^4$
All.	1200	850	14	-	H	68	3502	$6.5 \cdot 10^8$	$3.3 \cdot 10^4$	$3.2 \cdot 10^4$
All.	1350	870	3	0.1	H	30	3913	$3.4 \cdot 10^8$	$2.1 \cdot 10^4$	$2.1 \cdot 10^4$
Ti	1190	1370	0.2	2.5	H	90	1092	$3.8 \cdot 10^7$	$2.3 \cdot 10^5$	$2.6 \cdot 10^4$
Nb	1300	1370	0.2	13.5	H	79	332	$2.2 \cdot 10^5$	$1.4 \cdot 10^3$	$4.7 \cdot 10^2$

sequent decrease of activity happens more slowly, but can be significant on size and enough fast (minute, hours) at sample heated up. These features for interaction of hydrogen isotops with heated up metal sample can render the influence on final results of experiments, especially short-term ones. Such effect can be useful to use for downturn of initial tritium concentration in the sample at long-term experiments. Then carry out it is previously one or some filled of hydrogen on hot samples with subsequent outpumping.

The tritium output for samples of iron and alloys as stainless steel was observed at downturn of temperature, that, obviously, is connected with decrease of hydrogen solubility (Fig. 4). For hydrideforming of metals and alloys the return dependence should be observed and tritium from samples should leave when heating.

The researches have shown, that the new samples, early not take part in experiments on tritium generation, had enough the low short-term activity (Tab.1), which, thereto in due course decreased. This fact, as well as that the tritium generation rate was increased at reduction of hydrogen pressure (Fig. 6) and, practically, did not depend from the thermo-cycles parameters, yes and tendency of short-term activity (Fig. 2, 5) in due course to decrease nearly to initial condition (at heated up sample), unequivocally prove the unnuclear nature of opened phenomenon. It is thus possible to conclude, that the effect short-term of activity change for hydrogen isotops, at their interactions with heated up metals, hence, and increase activity (tritium generation), is connected with output early accumulated of tritium from sample and subsequent its absorption in the same sample and environmental surfaces of installation. Obviously, such behaviour of tritium is connected with dynamic displaing of isotops effect, fixed in [4].

On all visibility, change of activity in results by O.Reifenschweiler is connected just with transfusion of tritium from sample in environmental atmosphere and back, at changes of temperature [5].

The possible useful use, opened by us, displaing of hydrogen isotops effects, can consist that at duly outpumping of gas on bursts of activity is possible to be reduced the initial concentration tritium in sample, for increase of accuracy and reliability of further researches.

5. CONCLUSION

5.1. It is established, that the short-term bursts of tritium generation, arising at interaction of hydrogen isotops in which is immersed, previously heated up, metal sample, are connected with output, early accumulated of tritium, owing to isotops effects.

5.2. It is necessary to take into account the large opportunities of these effects, in case of use for samples with admixture of tritium, since they can affect the final results of experiments.

5.3. The possible useful use displaing of hydrogen isotops effects, can consist that at duly outpumping of gas on bursts of activity is possible to be reduced the initial concentration tritium in sample, for increase of accuracy and reliability of further researches.

REFERENCES

1. V.A.Romodanov, V.I.Savin, Ya.B.Skuratnik. Progress In New Hydrogen Energy. Proceedings. ICCF-6, October 13-18, 1996, Japan. Ed. by M.Okamoto. NEDO, IAE. Tokyo, Japan, 1996, V.2, p. 585- 589.

2. V.A.Romodanov, V.I.Savin, Ya.B.Skuratnik. Cold Nuclear Fusion (Materials of the 4-d Russian conference on cold fusion and nuclei transmutation. Dagomys, Sochi, M.: SRC PTP "ERZION", 1997, p. 63-69. (In Russian).

3. V.A.Romodanov, V.I.Savin, Ya.B.Skuratnik and Yu.M. Timofeev. Voprosy Atomnoj Nauki i Tekhniki. Ser: Radiation Damage Physics and Radiation Technology, 1992, n. 1(58), 2(59), p. 73-82. (In Russian).

4. V.A.Romodanov. Patent of USSR N 4330994, from 1987.10.08, ICI G21 B 1/00.

5. O.Reifenschweiler. Reduced Radioactivity of Tritium in Small Titanium Particle.- Phys. Lett. A184, 149 (1994).