

# The Change of Tritium Concentration during the Electrolysis of D<sub>2</sub>O in Various Electrolytic Cells

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## ABSTRACT

The U-type and bell jar type electrolytic cells were designed using pyrex glass and modified for recombination of gases with platinum catalysts. The electrolysis of LiOD/D<sub>2</sub>O in U-type cell yielded more final activities in Pt/Pd system than Pt/Pt system. Some electrolysis of LiOD/D<sub>2</sub>O in Pt/Pd showed the increase of <sup>3</sup>T above 100%. The separation factor of D/T in electrolysis was not measured directly but assumed 2~3 from literature. The increase of <sup>3</sup>T can not be explained with the isotope separation effect.

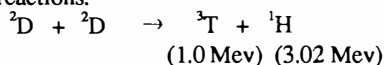
But in the modified cells with recombination, the electrolysis yielded no significant increase of final tritium activities in the total system. In this case, recombined D<sub>2</sub>O was collected separately and total <sup>3</sup>T activities were obtained by combining this with residue in D<sub>2</sub>O electrolytes.

Finally, bell jar type closed cells were designed with recombination catalysts. And palladium electrode was covered by different porous materials. After 10 days of electrolysis with a change of current density, one cell showed the increase of <sup>3</sup>T activities significantly.

## I. INTRODUCTION

The cold fusion reactions were usually confirmed by detection of neutron emission, and the production of tritium and heat.

This study is to observe the tritium which can be produced as a nuclear product in palladium metals that were used as cathode in various electrolytic cells of alkaline electrolytes by following reactions.



The production of tritium proves the existence of a nuclear reaction unquestionably and the change of tritium concentration can be measured easily by counting  $\beta$  activities in electrolytes with a liquid scintillation counter.

## II. EXPERIMENTAL

Galvanostatic electrolysis was conducted in the water bath with different cathodes and electrolytes at different current densities ranging from 50 to 1000 mA/cm<sup>2</sup>.

The different U-type and bell jar type electrolytic cells were designed using pyrex glass and modified for the recombination of evolved gases as shown in following figures.

500  $\mu$ l of liquid electrolytes were withdrawn for tritium analysis from the cell using a sterile syringe and  $\beta$  activities of electrolytes were counted by liquid scintillation counter.

X-ray, BET, ICP and SEM were used to analyze palladium electrodes before and after reactions.

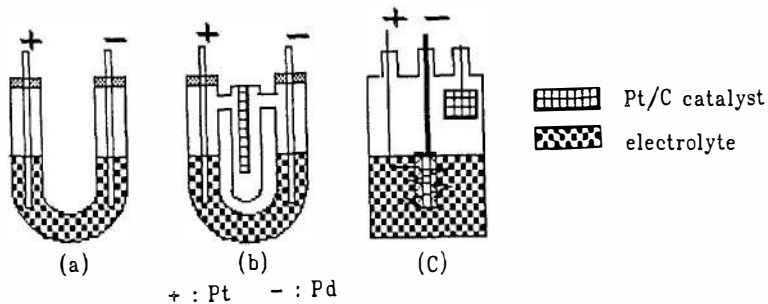


Fig. Electrolytic Cell of Cold Fusion Reactions

- (a) U-type cell (open cell)      (b) Modified U-type cell (closed cell)  
 (c) Bell jar type cell with porous materials

## III. RESULTS AND DISCUSSION

### 1. The variation of electrolytes

Electrolysis in LiOD/D<sub>2</sub>O (CF-3,4,5) yielded more final <sup>3</sup>T activities than KOH/D<sub>2</sub>O (CF-1) and LiOH/D<sub>2</sub>O (CF-2) at the Pd working electrode in U-type open cells (Table 1).

**TABLE 1. Increase of <sup>3</sup>T concentration in U-type open cell after electrolysis in different electrodes and electrolytes.**

Cell Code	Electrode		Electrolyte	Cell Type	Current Density (mA/cm <sup>2</sup> )	Before <sup>3</sup> T (dpm/ml)	After <sup>3</sup> T (dpm/ml)
	Cathode	Anode					
CF-1	Pd	Pt	0.1M KOH/D <sub>2</sub> O	A	60 - 600	120	140
CF-2	Pd	Pt	0.1M LiOH/D <sub>2</sub> O	A	60 - 600	105	130
CF-3	Pd	Pt	0.1M LiOD/D <sub>2</sub> O	A	50 - 500	106	196
CF-4	Pd	Pt	0.1M LiOD/D <sub>2</sub> O	A	50 - 500	87	165
CF-5	Pd	Pt	0.1M LiOD/D <sub>2</sub> O	A	50 - 500	187	289
CF-8	Pt	Pt	0.1M LiOD/D <sub>2</sub> O	A	50 - 600	166	212
CF-9	C	Pt	0.1M LiOD/D <sub>2</sub> O	A	50 - 600	186	238
CF-15	Pt	Pt	0.1M LiOD/D <sub>2</sub> O	A	50 - 500	129	132
CF-17	Pt	Pt	0.1M LiOD/D <sub>2</sub> O	A	50 - 500	124	146
CF-12	Pd	pt	0.1M LiOH/H <sub>2</sub> O	A	50 - 500	25	29
CF-18	Pd	Pt	0.1M LiOH/H <sub>2</sub> O	A	50 - 500	33	49

2. The variation of Electrolytes  
Under the same electrolysis condition the increase ratio of  $^3\text{T}$  at Pd (CF-3,4,5) was larger than that of Pt (CF-8,15,17) and carbon electrodes (CF-9) (Table 2).
3. Blank Test  
The electrolysis with  $\text{LiOH}/\text{H}_2\text{O}$  was run for the blank test to compare with  $\text{LiOD}/\text{D}_2\text{O}$ . Almost no increase of  $^3\text{T}$  activities was observed even after long periods of electrolysis (CF-12 and CF-18 in Table 1).
4. The pretreatments of palladium  
Torching, quenching, etching and mechanical hammering of Pd metals were carried out. But this pretreatments gave no significant effect on the increase of  $^3\text{T}$  activities in this study.
5. Modified closed U-type cell  
U-type cells were modified as closed system to recombine the evolved gases by Pt catalysts. (> 98% recovery). As shown in Table 2, small increase of  $^3\text{T}$  was observed but was considered within the error bound (CF-25,26) in the total system. The small increase in remained electrolytes and the decrease in recombined  $\text{D}_2\text{O}$  were observed

**Table 2. The total  $^3\text{T}$  activity in modified U-type closed cell before and after electrolysis.**

Cell Code	Electrode		Electrolyte	Cell Type	Current Density (mA/cm <sup>2</sup> )	Before <sup>3</sup> T	After <sup>3</sup> T	Uf	Rf
	Cathode	Anode				*1 (dpm)	*2 (dpm)	*3 (dpm/ml)	*4 (dpm/ml)
CF-24	Pd	Pt	0.1M LiOH/D <sub>2</sub> O	B	50-500	1523 (152)	1545	171	82
CF-25	Pd	Pt	0.1M LiOD/D <sub>2</sub> O	B	50-500	1604 (160)	1626 -1900	191-241	83-96
CF-26	Pt	Pt	0.1M LiOD/D <sub>2</sub> O	B	50-500	1391 (139)	1408 -1872	166-237	74-83
CF-27	Pd	pt	0.1M LiOH/D <sub>2</sub> O	B	50-500	1391 (139)	1459	167	78

- \* 1 : dpm/ml x initial volum (ml)  
 2 : Uf x Volum of remained electrolyte + Rf x Volum of recombined D<sub>2</sub>O  
 3 : Uf :  $^3\text{T}$  activity in remained electrolyte  
 4 : Rf :  $^3\text{T}$  activity in recombined D<sub>2</sub>O

6. Bell jar type closed cell  
Ordinary bell jar type cells with catalyst (F.P cell type) were tested with variation of Pd electrodes. Some Pd electrodes were covered with microporous materials, porous vycor glass and porous Al<sub>2</sub>O<sub>3</sub>/PS. In most cells no increase of  $^3\text{T}$  activities was observed except one cell in which Pd was covered with porous vycor glass. (CF-30). This phenomenon was not reproduced. In this cell silica was dissolved from Vycor and deposited on the surface of Pt electrode.

**Table 3. Increase of  $^3\text{T}$  concentration at different Pd electrodes in bell jar type closed cell**

Cell Code	Electrode		Electrolyte	Cell Type	Current Density (mA/cm <sup>2</sup> )	Before $^3\text{T}$ (dpm/ml)	After $^3\text{T}$ (dpm/ml)
	Cathode	Anode					
CF-28	Pd	Pt	0.1M LiOD/D <sub>2</sub> O	C	50 - 500	124	115
CF-30	Pd/Vycor	Pt	0.1M LiOD/D <sub>2</sub> O	C	100 - 450	112	208
CF-31	Pd/Vycor	Pt	0.1M LiOD/D <sub>2</sub> O	C	100 - 800	112	115
CF-32	Pd/Vycor	Pt	0.1M LiOD/D <sub>2</sub> O	C	100 - 900	124	120
CF-33	Pd/PS	Pt	0.1M LiOD/D <sub>2</sub> O	C	100 - 600	112	127

#### IV. CONCLUSION

Even though the fusion reaction was not confirmed by the exponential increase of  $^3\text{T}$ , the increase of  $^3\text{T}$  activity was a real phenomenon during the electrolysis of LiOD/D<sub>2</sub>O at Pd electrode in this study. And this increase could not explained only by the concentration effect of D/T separation factor in electrolysis.

#### V. REFERENCES

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