

Time-Evolution of Tritium Concentration in the Electrolyte of Prolonged Cold Fusion Experiments and its Relation to the Ti Cathode Surface Treatment

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ABSTRACT

Tritium concentration in the electrolyte has been carefully monitored in more than twenty electrolytic cold fusion experiments accomplished in open cells. In order to distinguish between T-natural enrichment (isotopic enrichment) and any other T source inside the cell a macroscopic theoretical model is proposed to analyze the experimental data. It is concluded that T-concentration variations in the electrolyte above the level due to natural enrichment can be detected with confidence and therefore that open-cell experiments are convenient to investigate T-production. In addition, some empirical correlations between model parameters (measured separation factors) and cathode surface treatments prior to experiment have been found.

1. Introduction

Most of our present knowledge on the processes at the cathode surface and hydrogen generation in an electrolytic cell has been gained by conventional electrochemical experiments accomplished in short time (from minutes to a few hours). Longer electrolysis like those in cold fusion experiments will yield new problems in relation to the cathode behaviour and the electrolysis itself. On the other hand, more discussion is needed to elucidate whether cold fusion experiments with open or closed cells must be accomplished. Closed cells may represent a potential danger whereas results obtained with open cells are, in general, difficult to be analyzed. In relation to T production in cold fusion experiments with open cells some T goes out from the cells with the produced gases and some difficulties may appear on determining possible increases of its concentration due to the nuclear processes. We have faced both problems in our current research. Some of the conclusions obtained about T-production in electrolytic cold fusion experiments and its relation to previous cathode surface treatments are now presented.

2. Experimental

Main characteristics (materials and procedures) of our experiments have been already published (Fernández et al. 1990). In all cases electrolysis was carried out in open cells. Measurements of the electrolyte T-content with a scintillation counter have been described in the same paper and only a few details will be given now. Background signal of our measurements is ~ 6 cpm per ml of electrolyte and stability better than 2%. Electrolyte volume in the cells was in all cases 75 or 150 ml. Daily sampling (2 ml) to measure T-concentration was done. Before taking the electrolyte sample, the cell was -refilled up to reach the original level in order to compensate losses due to electrolysis and other processes. Sample taken was stored in a vial at low temperature. Chemiluminescence and other misleading phenomena were eliminated. All Ti and Pd cathodes used in our experiments were treated prior to the experiment. Details of the treatments will be given in the text.

3. Results and discussion

According to our experimental characteristics the following conditions can be accepted to figure out an equation to describe the evolution of T-concentration in the electrolyte:

- We only consider kinetics of T and D concentrations
- Different processes contribute to remove electrolyte from the cell. We accept that in all cases the amount removed is proportional to the remaining electrolyte volume.
- Permanent and continuous refilling of the cell was done to keep

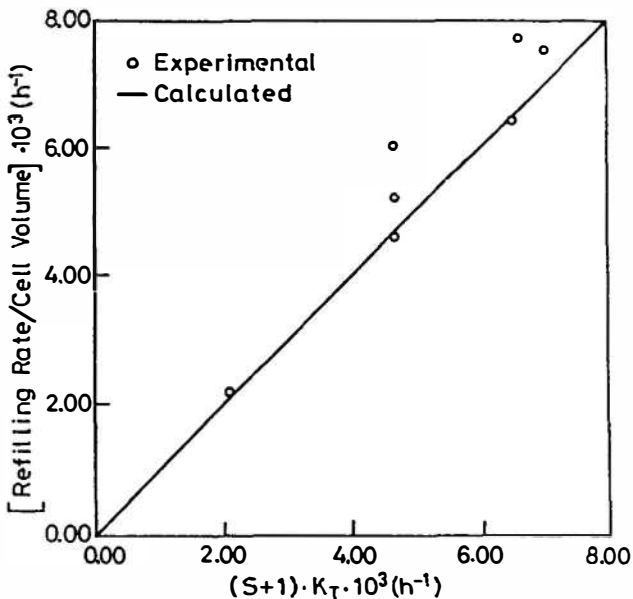


Figure 1. Model parameters (S and K_T) versus refilling rate.

constant the electrolyte volume.

d) T concentration is in all cases much smaller than D concentration.

Under these conditions the following equation can be obtained:

$$C(t) = S \cdot C_r - (S \cdot C_r - C_0) \cdot \exp(-k_T \cdot t)$$

where $S = k_D / k_T$ and $C(t)$ is the T concentration expressed through the number of counts per minute and ml., C_r are the counts of the refilling electrolyte and C_0 those of the initial electrolyte (in most cases $C_r = C_0$). The parameter S will be called "macroscopic separation factor" and it is an average of separation factors from different microscopic processes. Therefore S is not directly comparable to microscopic separation factors from other works. k_D and k_T are proportionality constants between the loss-rate of D and T and their concentrations in the remaining electrolyte. Both S and k_T are obtained by fitting $C(t)$ to those experimental results where no nuclear process took place.

S values from experiments with Ti cathodes show consistent results. In particular a proportionality relationship between $(S+1) \cdot k_T$ and the electrolyte cell refilling rate is deduced from the model and is also well verified by the experimental data as shown in Fig.1. Different S values are obtained for the Ti cathodes according to their nature and surface treatment prior to experiments (Fig. 2). The first group (experiments 6,8 and 9) is formed by experiments accomplished with electrolytic Ti-cathodes which were mechanically polished. The second one (exp. 11,12 and 13) with the same Ti but chemically etched. Finally in the third group (exp. ETi17 and 19) Ti cathodes from commercial grade, cold rolled and chemically etched plates were used.

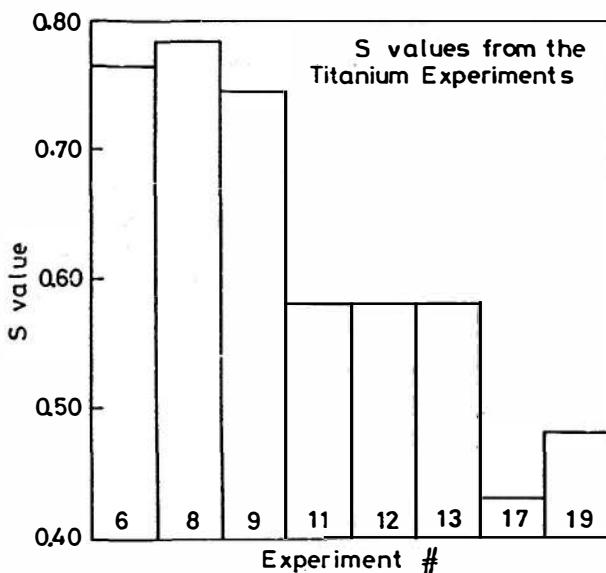


Figure 2. Influence of cathode surface treatment on the S values (see text).

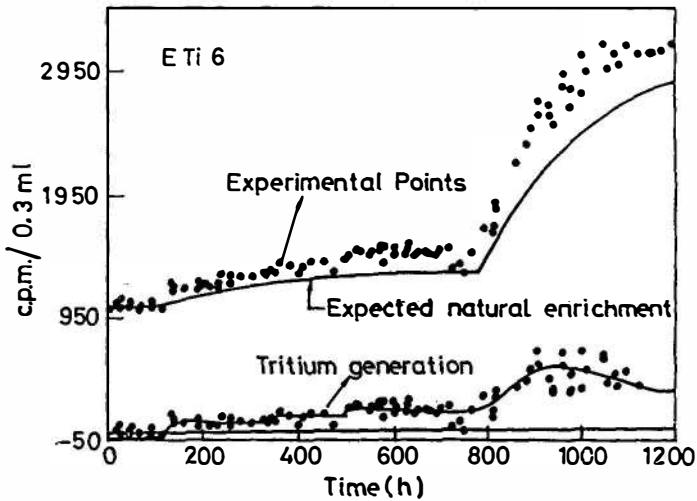


Figure 3. T-excess as measured in experiment ETi6

Finally, the result from experiment ETi6 has been analyzed according to the proposed model and T production due to nuclear processes has been detected and is shown in Fig.3. The total amount of T-atoms produced in the full experiment was $\approx 2.5 \cdot 10^{10}$.

4. References

1. Fernandez, J.F. et al, 1990, AIP Conference proceedings no.228."Anomalous nuclear effects in Deuterium/solid systems", pp.130 - 145. Provo, USA.

5. Acknowledgements

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