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PRELIMINARY RESULTS OF COLD FUSION STUDIES USING A FIVE MODULE HIGH CURRENT ELECTROLYTIC CELL

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Introduction

In their first cold fusion paper [1] Fleischmann *et al.* suggested that an electrolytic cell with large volume and surface area and high current density may cause fusion reactions resulting in the production of significant amounts of heat and nuclear particles. The experiments reported in this paper present the results of our early efforts to design and operate a high current modular Pd-Ni electrolytic cell and look for cold fusion reactions.

Electrolyser and Operation

A five module cell of bipolar filter press configuration having palladium (25%) silver alloy [procured from M/s Johnson-Matthey (U.K.)] as cathode (0.1 mm thickness) and porous Nickel as anode was fabricated. The electrodes are of circular plate geometry having a sectional area of $\approx 78\ cm^2$. The five modules of the cell are connected in series and can be operated even up to a high current density of $1\ A/cm^2$ and temperatures of 100°C. The mixed gaseous products are carried out of the cell and recombined in a burner-condenser unit and the resultant heavy water recycled back to the electrolyser. The electrolyte can be recirculated via a cooler to keep the operating temperature sufficiently low to reduce evaporation losses. Fig. 1 gives a schematic diagram of the modular cell. A flow diagram of the electrolyser and accessories is shown in Fig. 2.

The D_2 and O_2 gases produced in the electrolyser and evolving out in a mixed stream enters the recombination unit. This unit is essentially a burner complete with a self igniter and a cooling arrangement so that the product of recombination namely D_2O is condensed and collected. There is a provision to add incremental quantities of oxygen continuously to ensure the complete conversion of D_2 to D_2O.

The system was filled with freshly prepared NaOD in D_2O (20%) up to the preset mark in the level gauge and the electrolyser switched ON and operated continuously at a current of 60 to 65 amps (corresponding to applied voltage of $\approx$ 12.5 V) from 5th May 1989 onwards, with a few hours of interruption due to failure of the D.C. power supply. Occasionally the current was raised to 78 A. The summary of characteristics of the cell are shown in Table I.

The present operation was carried out to test the electrolyser, recombination unit and other subsystems. Sustained operation for extended periods of time, particularly in closed loop mode, has not been carried out in this preliminary study.

Neutron and Tritium Measurements

The placement of neutron detectors around the cell was similar to that described in paper A-1. [2] Two neutron detectors namely a bank of three BF_3 detectors embedded in paraffin wax and an 80 mm dia × 80 mm high plastic fast neutron detector were employed to monitor the neutron output. The counts data was printed out on scroll printer. The BF_3 channel was counted for 110 seconds each while the plastic detector counted for 100 sec each. But both counting intervals were commenced at the same time. The cell was operated continuously for 4 hours, when a big burst of neutrons overlapping two counting intervals was recorded in both the detectors. Table II summarises the neutron counts data.

The tritium content of the electrolyte before and after electrolysis as analysed by liquid scintillation counting techniques (see paper A-9 [3]) were 0.055 nCi/ml and 190.3 nCi/ml respectively. The significant quantities of tritium carried away by the combined D_2 and O_2 gas stream has not been accounted for in this. Considering that the total volume of the electrolyte in the system including hold up was ~1 litre, this corresponds to a total tritium build up of 190 μCi or 4×10^{15} atoms.

Conclusion

The electrolysis though carried out for limited periods only has shown conclusively that cold fusion occurs in this system also. This is obvious from the neutron bursts obtained (Table II) and the results of tritium analysis in the electrolyte. The latter results have shown an increase of over 3500 times in the electrolyte after 50 hours of operation.

From the efficiency of the neutron detectors and the neutron counts data given in Table II, it is inferred that about 5×10^6 neutrons were produced over a 100 second interval. The corresponding tritium yield was $\sim4\times10^{15}$, suggesting a gross neutron to tritium yield ratio of $\sim10^{-9}$. But it must be emphasized that a considerable quantity of tritium may have been carried away by the gas stream. Although efforts were made to recombine and recover this D_2O for tritium it was not successful. The estimate of 10^{-9} for the neutron to tritium yield ratio may therefore be considered as a lower limit only.

The limited experimental studies conducted with this system has given enough experience for initiating a prolonged closed cycle operation, where simultaneous counting of neutrons and monitoring of progressive build up of tritium during electrolysis is proposed to be carried out.

Acknowledgments

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References

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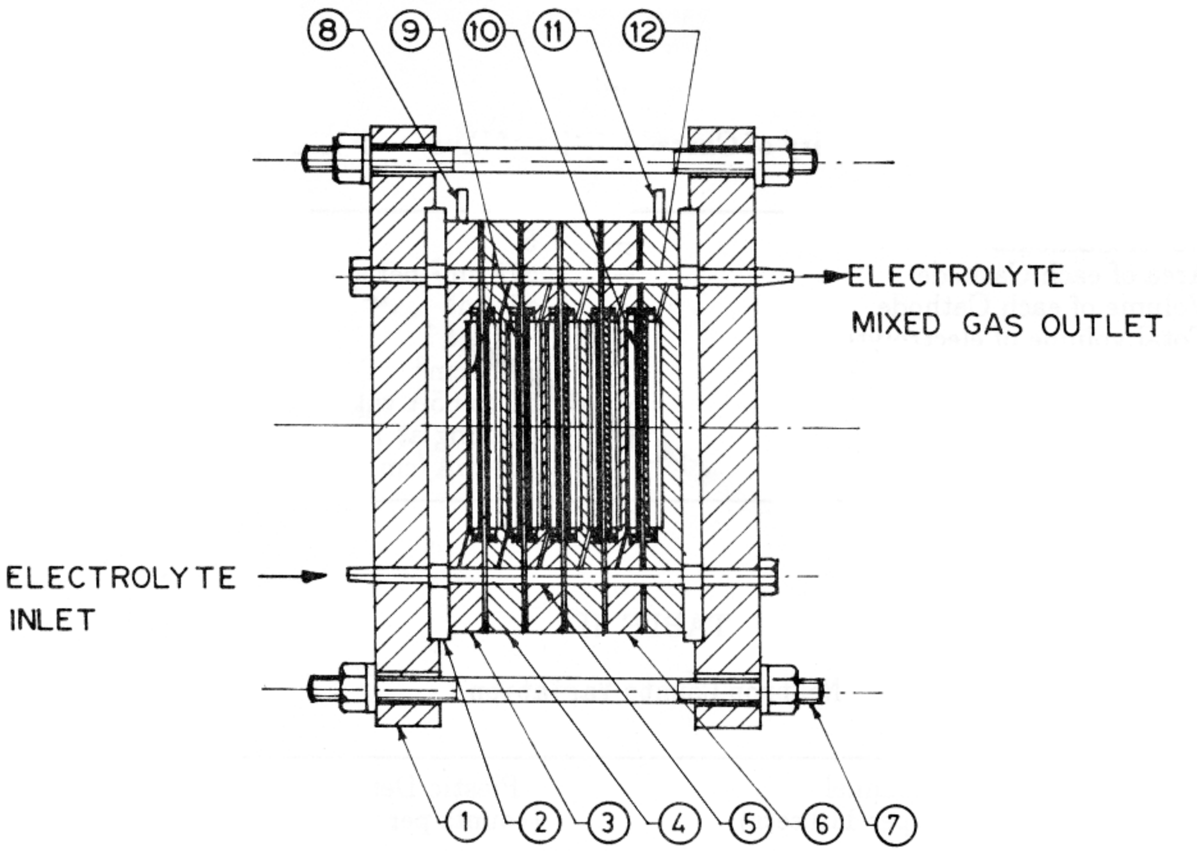
TABLE I Summary of Characteristics of Five Module Cell

No. of Cathodes	5
Area of each Cathode	≈78 cm^2 per surface
Volume of each Cathode	≈1 cm^3
Total volume of electrolyte in system	1000 cm^3
Current	60 to 65A with occasional peaking at 78 A
Current density	750 mA/cm^2

TABLE II Neutron Counts Variation

BF_3 channel (counts per 110 sec)	Plastic Detector (counts per 100 sec)
131	168
125	164
143	184
136	173
121	150
148	172
17198*	1563*
19751*	21113*
125	165
138	182
134	171

* The ratio of counts in the two channels were different in the two consecutive time intervals presumably because the single neutron burst, is partitioned unequally in the two consecutive intervals. This was because the counting intervals was longer by 10 seconds in the BF_3 channel.



1 END FLANGE
2 INSULATOR
3 END PLATE
4 BIPOLAR PLATE
5 ELECTROLYTE INLET DUCTS
6 DIAPHRAGM GASKET
7 TIE ROD
8 ANODE TERMINAL
9 POROUS NICKEL ANODES
10 AG PALLADIUM CATHODE
11 CATHODE TERMINAL
12 ELECTROLYTE AND GAS OUTLET-DUCTS

Fig. 1. 5-module Pd-Ni electrolyser.

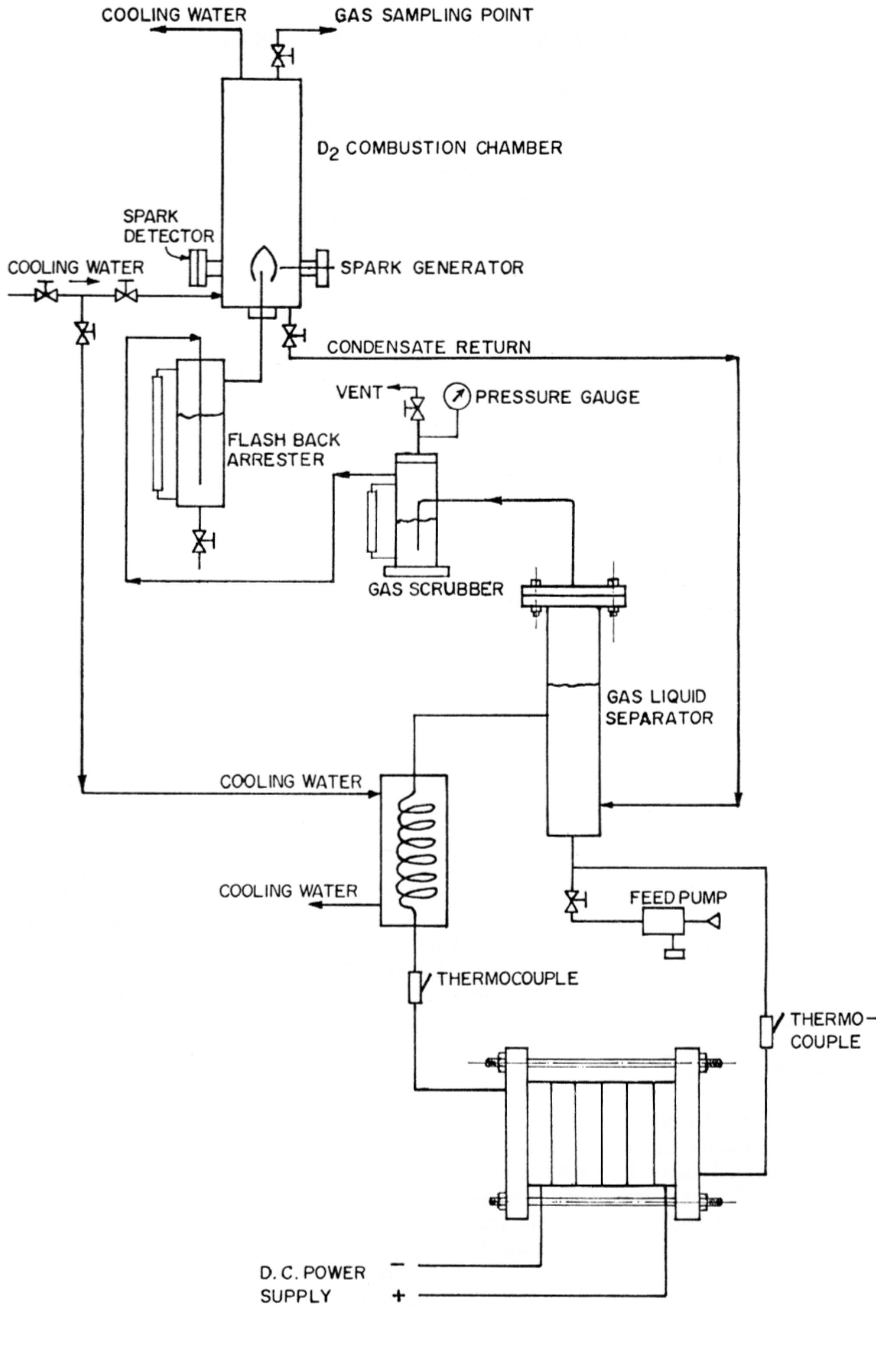


Fig. 2. Electrolyser system for cold fusion studies.