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Evaluation of Electrical Power Generation by BlackLight Power's Catalyst Induced Hydrino Transition (CIHT) Cells

Report Submitted
to

BlackLight Power, Inc
493 Old Trenton Road, Cranbury, NJ 08512

By

The ENSER Corporation
5430 70th Ave North, Pinellas Park, FL 33781

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Evaluators:

James K Pugh 4/4/2012
James K. Pugh, Ph.D.
Director of Technology

G. Dayalan 4/4/2012
Ethirajulu Dayalan, Ph.D.
Research Fellow

Background

Dr. Randell Mills of BlackLight Power, Inc. (BLP) has developed the "Grand Unified Theory of Classical Physics," by the application of physical laws and first principles rather than pure mathematics[1]. Based on this theory, Dr Mills has calculated, with great precision, bond energies and molecular structures that have been verified through experimental observation and reported in the literature. The theory predicts that there is a more stable lower energy state of hydrogen than previously believed. He has identified this more stable state of hydrogen as the "hydrino." The predicted hydrino state should have unique spectral signature and the catalytic/electrochemical reaction should also exhibit a continuum radiation and extraordinary fast H. Data has been published in leading physics journals confirming these[2,3,4,5,6]. A transition from hydrogen in the traditional molecular state, H_2, to the hydrino state will release energy up to two hundred times greater than combusting the same amount of hydrogen. BLP has invented an electrochemical cell, the catalyst induced hydrino transition cell (CIHT), to harness this energy as direct electrical output.

The CIHT cell contains an anode, unique electrolyte and a cathode as indicated in the schematic below. Atomic hydrogen is formed via initial electrolysis of water vapor flowing into the cell. That hydrogen is then converted via catalytic reaction of the unique electrolyte to form hydrinos. The energy released by the formation of hydrinos is captured as net electrical output of the CIHT.

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[1] R. Mills, *The Grand Unified Theory of Classical Physics*, July 2010 edition, http://www.blacklightpower.com/theory/bookdownload.shtml.

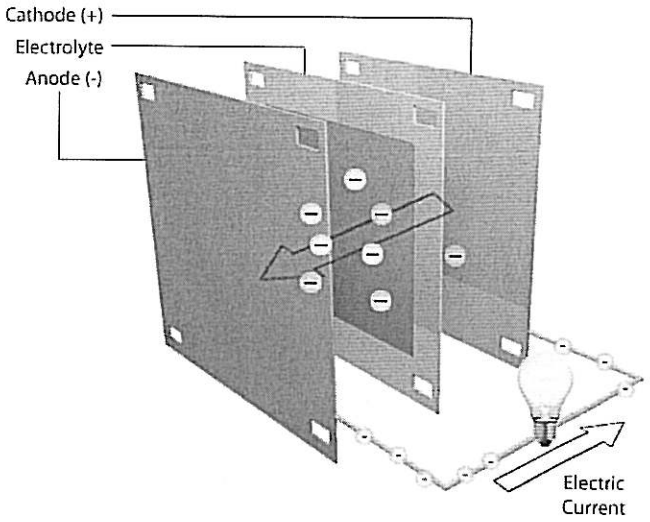
[2] R. L. Mills, R. Booker, Y. Lu, "Soft X-ray Continuum Radiation from Low-Energy Pinch Discharges of Hydrogen," IEEE Trans. Plasma Sci, submitted.

[3] R. L. Mills, Y. Lu, "Time-Resolved Hydrino Continuum Transitions with Cutoffs at 22.8 nm and 10.1 nm," Eur. Phys. J. D, 64, (2011), pp. 63, DOI: 10.1140/epjd/e2011-20246-5.

[4] R. L. Mills, Y. Lu, "Hydrino Continuum Transitions with Cutoffs at 22.8 nm and 10.1 nm," Int. J. Hydrogen Energy, 35 (2010), pp. 8446-8456, doi: 10.1016/j.ijhydene.2010.05.098.

[5] K. Akhtar, J. Scharer, R. L. Mills, "Substantial Doppler Broadening of Atomic Hydrogen Lines in DC and Capactively Coupled RF Plasmas," J. Physics D: Appl. Phys., Vol. 42, Issue 13 (2009), 135207 (12pp).

[6] R.L. Mills, K. Akhtar, "Tests of Features of Field-Acceleration Models for the Extraordinary Selective H Balmer α Broadening in Certain Hydrogen Mixed Plasmas," Int. J. Hydrogen Energy, Vol. 34, (2009), 6465–6477.



CIHT cell schematic

Evaluation of CIHT Cells by ENSER Technical Staff

Dr. James Pugh (electrolyte scientist and Director of Technology at The ENSER Corporation) and Dr. Ethirajulu Dayalan (electrochemist and Research Fellow at The ENSER Corporation) visited BLP's facilities in Cranbury NJ on February 12-13, 2012 – the purpose of which was to review the classical theory and analytical data regarding the identification of the newly identified form of hydrogen as the cell product, the lower state hydrogen called "hydrino." Included was a review of the results from numerous CIHT test cells BLP has built and operated over several months, improvements and optimizations during that period and reports of several outside experts.

Excess electrical energy, up to 100 times that used for water electrolysis, was produced in cells run as long as sixty days. Analytical tests have been performed on multiple cells including elemental analysis by Inductively Coupled Plasma Mass Spectrometry (ICP-MS), X-ray Fluorescence spectrometry (XRF), X-ray Diffraction (XRD), residual gas analysis (RGA-MS), gravimetric analysis and mass balance measurements by weight. No known conventional energy mechanism could be identified that would support the net energy generation seen. Rather, the

hydrino formation, as theorized by Dr. Mills, has been confirmed by proton Nuclear Magnetic Resonance (^{1}H-NMR) analysis of the cell following operation.

ENSER staff witnessed on February 12th careful assembly of four CIHT cells. Three of the test cells were comprised of pre-oxidized porous nickel cathode, LiOH-LiBr-MgO electrolyte and pressed porous nickel anode. A fourth test cell used a Molybdenum (Mo) anode. The startup of the cells and data collection setup was also witnessed. Initial data indicated that all four cells showed excess energy production during discharge compared to the energy input during short charge pulses. The Mo anode cell showed much higher energy discharge excess than the nickel anode cells.

The CIHT unit involved the single electrochemical cell placed in a sealed stainless steel, vacuum tight vessel with H_2O entrained in an inert (argon) carrier gas as the only mass input. Alternatively H_2O could be provided from a sealed H_2O vapor generator. No readily recognized reaction is expected to occur at the electrodes or the electrolyte that could produce the observed electrical energy. Furthermore, there is no possible reaction of H_2O with the cell constituents based on system thermodynamics. Dr. Mills' theory offers a plausible explanation: H formed during electrolysis undergoes a reaction to form hydrinos with the release of electrical energy. Results were consistant with the proposed CIHT cell half-cell reactions forming the hydrino catalyst in the presence of atomic hydrogen, and the cell performance matched predictions based on the hydrino mechanism including the upfield NMR results characteristic of the hydrino product.

Control cells were also built during the visit where the electrolyte was different than the optimized CIHT cell electrolyte or where the cell is run without the supply of water vapor wherein the chemically similar, but not hydrino catalytic cells showed an energy loss and the otherwise active chemistry lacking the required H_2O quickly decayed to zero power.

Periodic updates of the data from the cells built for ENSER validation were sent by BLP staff. The cells ran for nearly forty days before they were stopped with ENSER concurrence.

Typical data from the four CIHTcells built for ENSER validation are shown below. The cells with Nickel anodes showed an energy gain of 332%, 8625% and 793% and the cell with the Mo anode showed an energy gain of 144028% all in about 39 days.

021212XY1-1387 (Validation cell for ENSER)
Anode: Ni

Time	Charge energy, Wh	Discharge energy, Wh	Energy gain, %
17h	0.0058	0.0592	1020.7
1d17h	0.0241	0.1332	552.7
2d17h	0.0424	0.2071	488.4
3d17h	0.0607	0.2803	461.8
4d17h	0.0764	0.3558	465.7
7d17h	0.1484	0.5603	377.6
8d17h	0.1747	0.6257	358.2
9d17h	0.1969	0.6963	353.6
10d17h	0.2170	0.7674	353.6
11d17h	0.2394	0.8377	349.9
14d17h	0.3147	1.0388	330.1
15d17h	0.3388	1.1067	326.7
16d17h	0.3635	1.1739	322.9
17d17h	0.3829	1.2471	325.7
18d17h	0.4034	1.3182	326.8
21d17h	0.4769	1.5219	319.1
22d17h	0.5058	1.5853	313.4
23d17h	0.5325	1.6504	309.9
24d17h	0.5545	1.7204	310.3
25d17h	0.5744	1.7926	312.1
28d17h	0.6552	1.9846	302.9
29d17h	0.6749	2.0570	304.8
30d17h	0.6909	2.1329	308.7
31d17h	0.7127	2.2030	309.1
32d17h	0.7336	2.2740	310.0
35d17h	0.7918	2.4905	314.5
36d17h	0.8071	2.5666	318.0
37d17h	0.8197	2.6462	322.8
38d17h	0.8325	2.7247	327.3
39d15h	0.8426	2.7986	332.1

021212XY2-1388 (Validation cell for ENSER)
Anode: Ni

Time	Charge energy, Wh	Discharge energy, Wh	Energy gain, %
17h	0.0001850	0.0681	36810.8
1d17h	0.0004419	0.1623	36727.8
2d17h	0.0007194	0.2555	35515.7
3d17h	0.0009953	0.3476	34924.1
4d17h	0.0013	0.4393	33792.3
7d17h	0.0021	0.7146	34028.6
8d17h	0.0022	0.8058	36627.3
9d17h	0.0023	0.8980	39043.5
10d17h	0.0025	0.9884	39536.0
11d17h	0.0026	1.0800	41538.5
14d17h	0.0042	1.3489	32116.7
15d17h	0.0084	1.4328	17057.1
16d17h	0.0086	1.5262	17746.5
17d17h	0.0087	1.6176	18593.1
18d17h	0.0088	1.7077	19405.7
21d17h	0.0091	1.9788	21745.1
22d17h	0.0092	2.0686	22484.8
23d17h	0.0093	2.1581	23205.4
24d17h	0.0094	2.2481	23916.0
25d17h	0.0095	2.3385	24615.8
28d17h	0.0099	2.6038	26301.0
29d17h	0.0115	2.6917	23406.1
30d17h	0.0153	2.7761	18144.4
31d17h	0.0191	2.8603	14975.4
32d17h	0.0231	2.9444	12746.3
35d17h	0.0364	3.1948	8776.9
36d17h	0.0408	3.2786	8035.8
37d17h	0.0409	3.3704	8240.6
38d17h	0.0410	3.4611	8441.7
39d15h	0.0411	3.5449	8625.1

021212XY3-1389 (Validation cell for ENSER)
Anode: Ni

Time	Charge energy, Wh	Discharge energy, Wh	Energy gain, %
17h	0.0000409	0.0646	157946.2
1d17h	0.0001031	0.1566	151891.4
2d17h	0.0001555	0.2471	158906.8
3d17h	0.0002106	0.3360	159544.2
4d17h	0.0002718	0.4238	155923.5
*(Restart-Recovery)			
6d14h	0.0003894	0.5871	150770.4
7d14h	0.0004567	0.6736	147492.9
8d14h	0.0005287	0.7606	143862.3
9d14h	0.0005968	0.8463	141806.3
10d14h	0.0006726	0.9325	138641.1
13d14h	0.0010	1.1864	118640.0
14d14h	0.0013	1.2701	97700.0
15d14h	0.0017	1.3522	79541.2
16d14h	0.0053	1.4319	27017.0
17d14h	0.0106	1.5090	14235.8
20d14h	0.0360	1.7324	4812.2
21d14h	0.0471	1.8043	3830.8
22d14h	0.0592	1.8747	3166.7
23d14h	0.0725	1.9447	2682.3
24d14h	0.0870	2.0141	2315.1
27d14h	0.1345	2.2144	1646.4
28d14h	0.1523	2.2811	1497.8
29d14h	0.1706	2.3471	1375.8
30d14h	0.1892	2.4126	1275.2
31d14h	0.2085	2.4773	1188.2
34d14h	0.2744	2.6692	972.7
35d14h	0.2973	2.7324	919.1
36d14h	0.3207	2.7960	871.8
37d14h	0.3443	2.8584	830.2
38d14h	0.3683	2.9208	793.0

021212XY4-1390 (Validation cell for ENSER)
Anode: Mo

Time	Charge energy, Wh	Discharge energy, Wh	Energy gain, %
17h	0.0000427	0.0784	183606.6
1d17h	0.0000961	0.1853	192820.0
2d17h	0.0001440	0.2910	202083.3
3d17h	0.0001961	0.3952	201529.8
4d17h	0.0002493	0.4975	199558.8
*(Restart-Recovery)			
6d14h	0.0003561	0.6881	193232.2
7d14h	0.0004130	0.7893	191113.8
8d14h	0.0004710	0.8906	189087.0
9d14h	0.0005235	0.9880	188729.7
10d14h	0.0005797	1.0831	186838.0
13d14h	0.0007575	1.3671	180475.2
14d14h	0.0008135	1.4616	179668.1
15d14h	0.0008661	1.5558	179632.8
16d14h	0.0009187	1.6499	179590.7
17d14h	0.0009743	1.7432	178918.2
20d14h	0.0011	2.0228	183890.9
21d14h	0.0012	2.1155	176291.7
22d14h	0.0013	2.2066	169738.5
23d14h	0.0013	2.2976	176738.5
24d14h	0.0014	2.3883	170592.9
27d14h	0.0015	2.6516	176773.3
28d14h	0.0015	2.7398	182653.3
29d14h	0.0016	2.8279	176743.8
30d14h	0.0017	2.9151	171476.5
31d14h	0.0018	3.0019	166772.2
34d14h	0.0020	3.2602	163010.0
35d14h	0.0021	3.3456	159314.3
36d14h	0.0022	3.4319	155995.5
37d14h	0.0023	3.5164	152887.0
38d14h	0.0025	3.6007	144028.0

Practical Consideration

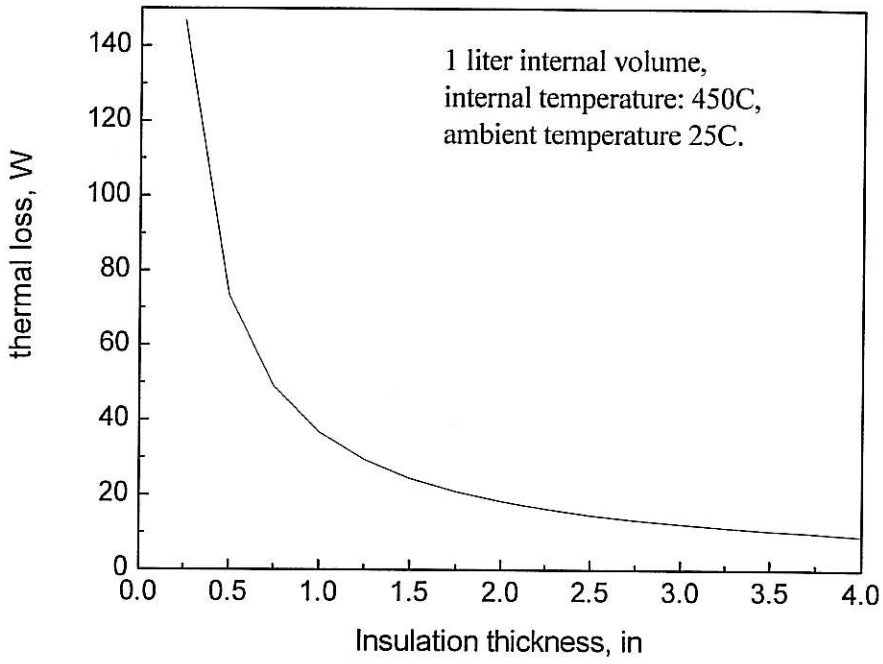
The test cells that were assembled lend themselves to fabrication utilizing more traditional molten salt batteries techniques (i.e. thermal batteries). The electrolyte salt composition is comprised of powdered materials and may be able to be pressed into pellet form utilizing the same high-tonnage pressing techniques that are employed in the thermal battery industry. The anodes and cathodes may take a little modification for large-scale production, but there is no apparent difficulty in assembling single cell and multi-cell batteries, based on the electrochemistry discussed herein, in a production scale environment. BLP has achieved >10 mW/cm^2 in their newest results with better electrode materials. It is not difficult to make electrodes in the range of 10 μm thickness. If each electrode and the electrolyte had these dimensions, then the projected volumetric power density could reach 3.3 W/cm^3 (3.3 kW/liter).

Heat Balance

As assembled and run, the single cell test systems had to be maintained at a high temperature. Although the system was fairly isothermal with regards to heat loss, there is an energy cost to initially heat and maintain the heat of the system. However, thermal modeling results demonstrate that this cost would not outweigh the energy gain realized by the functioning system. For example, BLP calculated the thermal loss through commercial thermal insulation materials such as Durablanket. The thermal conductivity data is shown in the following Table (from Thermal Products Company, Inc.).

Tem, C	Durablanket S 12PCF:192kg/m3 thermal conductivity in air, BTU·in/hr·ft^2·F	**Durablanket S 12PCF thermal conductivity in air, W/m·K**	thermal conductivity of air, W/m·K	**thermal conductivity insulation material under vacuum, W/m·K**
150	0.2964	**0.0427**	0.0352	**0.0075**
200	0.3401	**0.0490**	0.0385	**0.0104**
250	0.3882	**0.0559**	0.0418	**0.0141**
300	0.4409	**0.0635**	0.0449	**0.0186**
350	0.4981	**0.0717**	0.0479	**0.0238**
400	0.5599	**0.0806**	0.0508	**0.0298**
450	0.6261	**0.0902**	0.0536	**0.0366**
500	0.6969	**0.1004**	0.0563	**0.0440**

The following Figure shows the thermal loss as a function of insulation thickness from a 1 liter internal cell volume of under a 450°C operating temperature according to a complete energy balance that includes the cost of heating and maintaining the heat of the functioning cell system. The thermal loss is about 37 W with 1" thick insulation under vacuum. By carefully designing and optimizing the CIHT cell, a 1 liter volume could generate 3.3 kW . The relative thermal loss per liter is trivial-about 1% for 1" thick insulation, and could be lower if thicker insulation is used.



Thermal loss of a 1 liter internal volume as a function of the insulation thickness

Conclusion

In summary, BLP has successfully fabricated and tested CIHT cells capable of producing net electrical output several times that of the input to maintain the process. Some cells have produced steady power for over sixty days. The power generation is consistant with Dr. Mills theory of energy release resulting from hydrino formation. No other source of energy could be identified.

The current CIHT cells are about 3mW. The next development target should be a 10 W, reproducible, demonstration system with output gain sufficient to overcome the thermal losses

and balance of plant loads and net produce adaquate electric power for external loads. The Company should follow with 100 W and 1000 W output CIHT systems, while simultaneously developing standard assembly techniques with power density optimization and miniaturization of the cell unit as a precedent to commercialization of the technology.