SMD/SABATIER METHANE ENERGY STORE PROJECT

by
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Prior art since 2001, SMD hydrogen generator. New style Sabatier reactor to be covered by a separate paper.

ELECTROLYSERS

An electrolyser is a device that splits water into hydrogen and oxygen by using electricity. The basic design of an electrolyser consists of two electrodes (cathode and anode) and an electrolyte (Larminie and Dicks 2003).

Ideally 39 kWh of electricity and 8.9 kg of water are required to produce 1 kg of hydrogen at 25°C and 1 atm pressure (Harrison and Levene 2008). The enthalpy change when water is formed is 286 kJ/molH_2 at 25°C and 1 atm pressure (Nave 2012). In a real unit, there are losses and the efficiency of an electrolyser system ranges between 50 and 80% (Harrison and Levene 2008).
Electrolysers are categorized by the type of electrolyte they use. There are two types of electrolysers that are commercially available today Alkaline and Proton Exchange Membrane (PEM). The main difference between the two types is that the alkaline electrolysers' electrolyte is a liquid and that the PEMs' electrolyte is a solid.

Alkaline electrolysers are the most common type in large applications where a large amount of hydrogen is produced. They generally have lower investment cost than PEM electrolysers (Harrison and Levene 2008). The PEM type is faster at adjusting its power consumption than the alkaline type and it also has benefits if the electrolyser is pressurized.

SABATIER REACTOR

The Sabatier reaction is an exothermic reaction where H_2 and CO_2 reacts to form CH_4 and H_2O. The exact reaction mechanism is under discussion but the most widely accepted mechanism is the combination of a reversed endothermic water-gas-shift-reaction and an exothermic CO methanation, the overall reaction is exothermic.

The overall reaction is favoured at lower temperatures, but due to kinetic limitations, a catalyst needs to be utilized (Brooks, et al. 2007).The implementation of this reaction therefore requires a careful heat management to maintain the reaction at relatively low temperature for a favourable equilibrium composition but at a sufficiently high temperature to overcome activation energies.

NICKEL/ZINC RECHARGABLE BATTERY

Nickel (II) hydroxide is frequently used in electrical car batteries. Specifically, $Ni(OH)_2$ readily oxidizes to nickel oxyhydroxide, NiOOH, in combination with a reduction reaction, often of a metal hydride (reaction 1 and 2).

Reaction 1 $Ni(OH)_2 + OH^- \rightarrow NiO(OH) + H_2O + e^-$

Reaction 2 $M + H_2O + e^- \rightarrow MH + OH^-$

Net Reaction (in H_2O) $Ni(OH)_2 + M \rightarrow NiOOH + MH$

Zinc is cheap and abundant metal (the 24th most abundant element in the Earth's crust) and it is not dangerous to health. Common oxidation is +2 so charge and discharge move two electrons instead of one as in NiMH batteries.

Nickel–zinc battery

Specific energy	100 W·h/kg
Energy density	280 W·h/L
Specific power	> 3000 W/kg
Energy/consumer-price	2–3Wh/US$
Nominal cell voltage	1.65 V

SMD ELECTROLYSERS

After many years of research and developement in finding an alternative system of fuel or energy storage, SMD (a research name), has come a long way to meeting those needs.

This system is based on the electrolysis of water to extract hydrogen in a form that is very energy conservative, it uses the complex electro chemical reaction to use the oxygen to create oxides, release and move electrons which maintain the driving power of the system.

Hydrogen cells use hydrogen and oxygen along with a catylist, platinum, to generate power from the electron movement when they combine to create water. In SMD cheap metals are used along with water containing an ionic catalist, these metals are used as two of the electrodes in a three electrode system. Nickel and Zinc can be used, where a nickel oxide is formed on one electrode and zinc oxide on the other. Hydrogen is generated on a separated electrode of stainless steel, making pure hydrogen collection far more simple. This hydrogen production is generated by a secondary circuit, the power supply coming from a store (low ESR supper capacitor bank) charged from the complex electron movement within the system (Ni-Zn battery formed 1,65v) in series with an external power supply such as solar, wind or even (night rate 50%) grid supply.

Fig: 1 shows the basicschematic of SMD

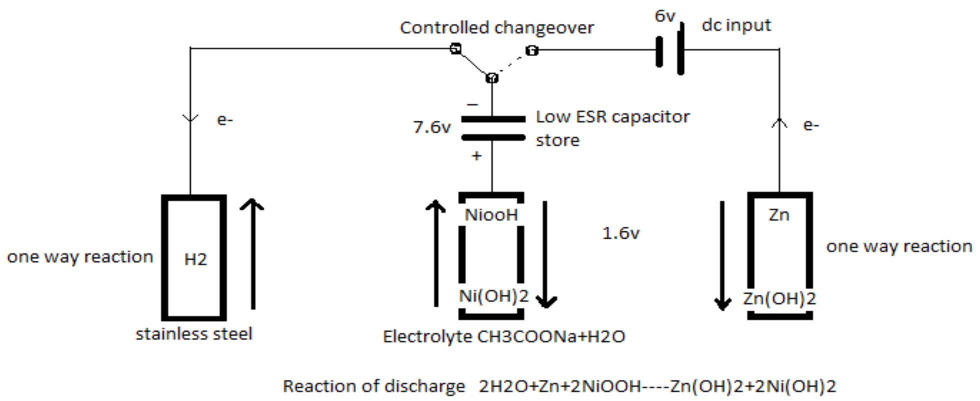

Fig: 1

Fig: 2 shows two cells SMD in series.

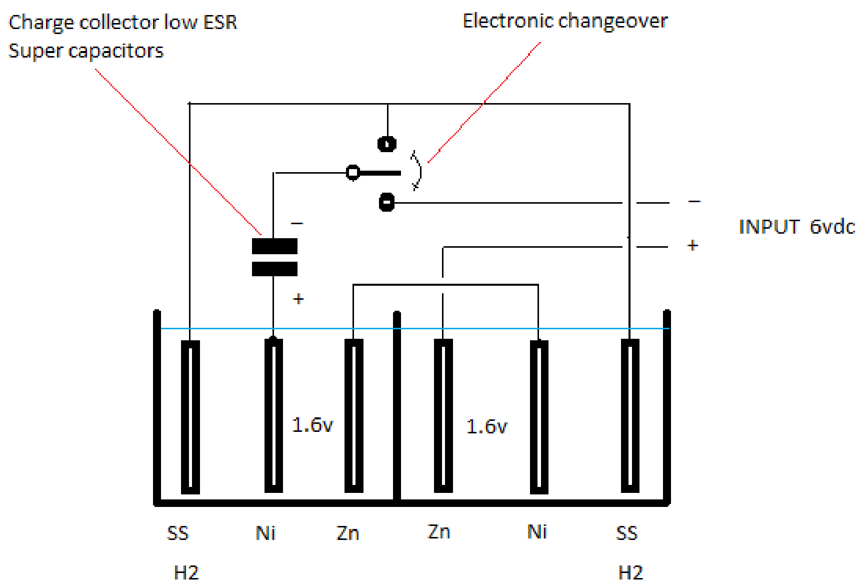

Fig: 2

In this form of SMD the Nickel electrode is Nickel hydroxide and activated carbon on a nickel mesh, which changes back and to from Nickel hydroxide to Nickel oxide hydroxide. The Zinc electrode is the permanent anode and changes to zinc oxide, this is a one way reaction and the zinc electrode will have to be replaced when all the zinc has been oxidised. Iron can be used instead of zinc, but at a cost of produced voltage, 1,2v as opposed to 1,6v, meaning more cells in series will be needed as in Fig:2. Fig: 3 shows a full Ni/Fe system with 5 cells producing 6v from oxidation. Fig: 4 shows how one cell of the five can be assembled with easy Fe electrode removal when fully oxidised.

The SMD system can reduce the cost of hydrogen from water by over 30%, and when linked to a new style Sabatier reactor, the hydrogen and carbon dioxide are combined to produce methane CH4. It is this methane that becomes our energy store, it can either be bottled like propane for future use on site, or sent directly into the natural gas pipe grid (98% of NG is methane) which is a ready made distribution system, national and international.

The new sabatier reactor is under design, it uses the latest in catalysts (carbon nano tubes coated with a nickel catalyst) which is packed into a helical path heat exchanger with water or air cooling, it is a one pass reactor with electronic temperature control set to the desired reactor temperature. This system is not only designed for a 100% convertion to methane, but also to maintain a long life for the catalyst. Once started the reactor does not need an energy input, the reaction is exothermic and will produce excess heat in the form of steam or hot air, it is planed to use this heat to produce power to run the control systems for SMD/Sabatier reactor.

INVESTMENT

Investment is now needed to bring this energy storage system into a fully working example in the shortest possible time frame. Not only in terms of money, but also in professionals in the various areas of design. As a retired industrial engineer, I have come to the limits of my capability financially, and it is now needed external finance and momentum to see this exciting project to a world benefiting conclusion.

Addendum

Nickel/Iron battery

pecific energy	19-25 [1] Wh/kg
Energy density	30[2] Wh/l
Specific power	100[3] W/kg
Charge/discharge efficiency	65%–80%[4]
Energy/consumer-price	1.5[2] – 6.6[3] Wh/US$
Self-discharge rate	20%[2][3] – 30%[3]/month
Time durability	30[4] – 50 years[2][5]
Cycle durability	Repeated deep discharge does not reduce life significantly.[2][4]
Nominal cell voltage 1.2v	

Nickel/Zinc battery

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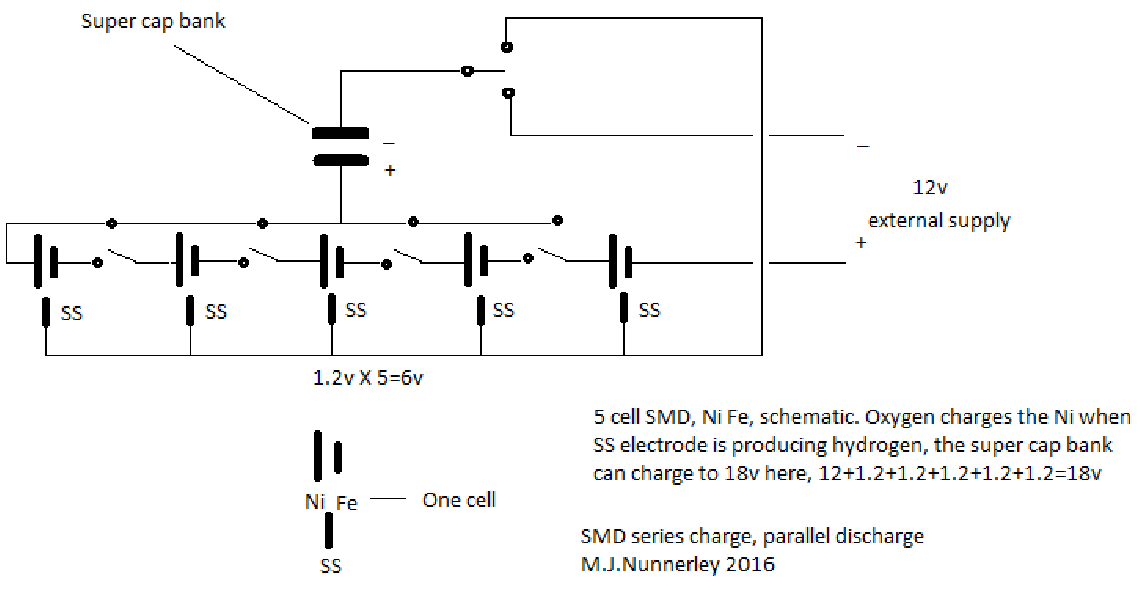

Fig: 3

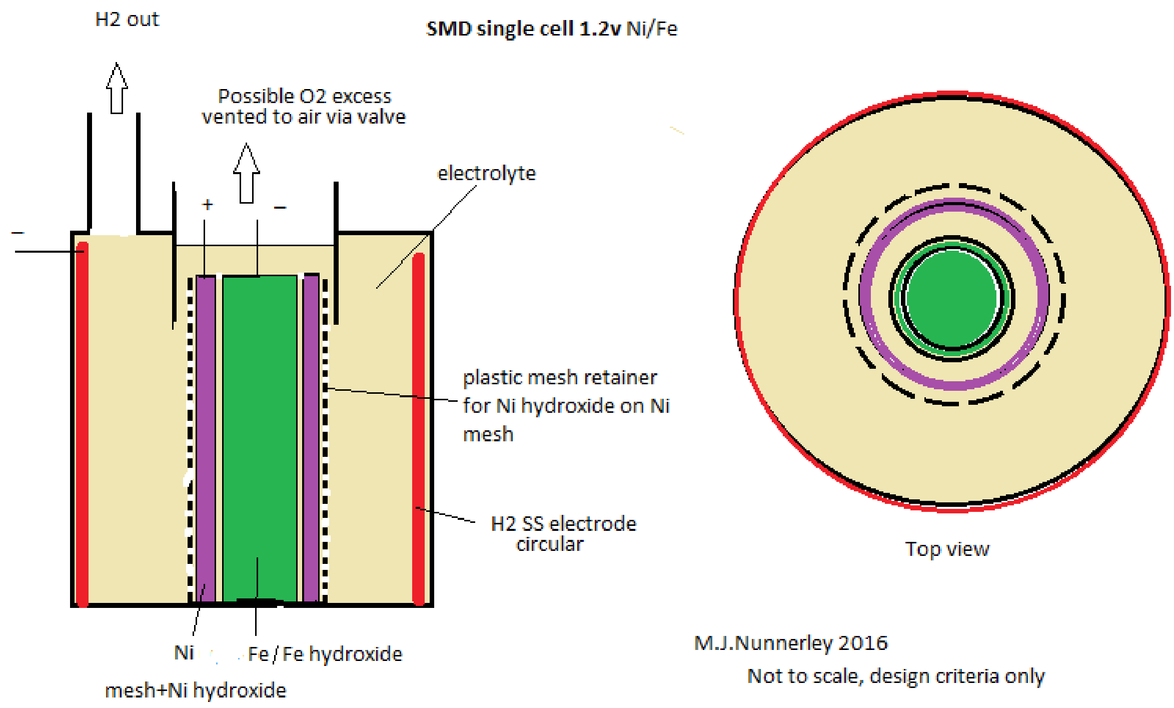

Fig: 4

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