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Electrolytic Gas

Peter E. W. Lowrie

Preamble

This paper sets out to describe why an experimental apparatus, namely:

- Mitsubishi Cyclone

engine(s) runs on electrolytic¹ gas. That is not so strange in itself as it is well known that Hydrogen is a fuel*. The benefit of using electrolytic gas is that the Hydrogen has with it, its own oxidiser – Oxygen. Already perfectly proportioned, no gas mixing is required and so complete combustion is accomplished without the need for additional air. Here's the rub; the car engine uses a separate belt driven three phase marine alternator in a “Y” winding with output rated at 150 Amps at 24 Volts which is fed into three electrolysis cells, each cell gets a single phase. Beginning at 12 Volts the cells are heated partly by hot exhaust gas and partly by way of voltage on the plates within acting as heating elements. When the cells get up to temperature (about 75° C) the alternator tickle supply is reduced to a range between 1.24 to 2.00 volts which then serves to increase electrolysis efficiency in accordance with Faraday's Law(s) of electrolysis and thus efficiencies in the order of 97.5% are achieved the cells consuming circa 600 Amps each the process becomes endothermic and provides gas more than sufficient to fuel the engine.

Thus the engine generates its own fuel (and oxidiser) with ample power to spare. Most argue that this is an impossible situation; at best the engine becomes a dynamic brake and at worst it just won't work. The explanation being that you can't get more energy out than what you put in and in citing various texts, at first glance appears quite correct. The fact of the matter – as this paper will prove – is that the texts are either wrong or fail to supply all of the information.

Electrochemical -V- Physical reactions

There are two bonds on the molecule – one for each Hydrogen atom (of course). Therefore for one molecule of H₂O 870kj will break apart the water molecule and the equivalent energy, it is said, will *initiate* the gas recombination. Gas and oxidiser atoms never being in isolation, there being billions of them in *n* volume they undergo a chain reaction until all available atoms are recombined releasing enormous energy in quick time. The plasma speed is 3.9km/sec. The ash is water. Few texts referenced to date accounts for the energy release during recombination, more information about this apparent dichotomy will be discussed.

The heat flame (plasma) total energy is calculated by multiplying the respective atoms' ionisation energies for the process. The ionisation energies² of H = 1312.06kj and O = 1313.95kj^{ie1}, (3388.33kj^{ie2}, 5300.51kj^{ie3}) upon combustion the (outer in Oxygen) electron orbits interact, merge and settle down to stable orbits:

¹ Also called: Water Gas, Rhodes Gas, Browns Gas.

² www.ktf-split.hr/periodni/en

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$$H^{ie_1} + H^{ie_1} O^{ie_1} = 3,447,962.47\text{kJ} \quad (1)$$

Where ie is Ionisation Energy and n the energy layer (three in Oxygen) and only one in Hydrogen.

In the discussion of thermodynamics relating to the subject matter the question of heat is a very important one, there being two types of heat. On the one hand is heat due to molecular motion and on the other is the heat of photons coming and going during reactions

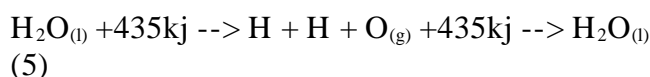
In order of energy strength...The formation of Hydrogen is a nuclear reaction there being two well known modes of it's coming into existence; primordial Hydrogen and neutron decay. Neither of which are relevant to this discussion. Oxidisation (burning) of Hydrogen is a physical reaction of the middle energy order. And electrolytic decomposition is a [n] [electro]chemical reaction. The notion of water being a fuel rests in Electrolysis, of the low energy order – a chemical reaction and Combustion – a physical reaction of the middle energy order being vastly disproportionate. This can be shown to be the case; let $\beta = 870\text{kJ}$ be the total energy consumed in splitting H_2O and ϵ be the oxidisation expenditure in equation (1) of [combustion] energy.

$$\epsilon / \beta = 3963.18 \quad (2)$$

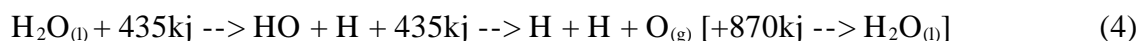
This does not describe some “hidden” energy, nor do special-pleading of over-unity claims have any relevance. The calculation reflects the starting position of the two gases. Even if the bond strength is subtracted from both sides:

$$(\epsilon - \beta) / \beta = 3962.18 \quad (3)$$

...it is apparent that the combustion product is highly energetic. So which is it? The chemical equation given:

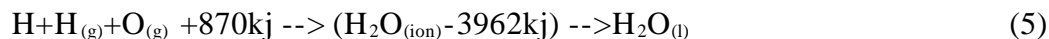


is clearly mistaken because, a) only half the required energy is given and b) there is a continuing addition of energy on both sides and appears not to factor-in any energy release. In any case equation (5) plugs in the correct values to the formula provided in the text (footnote #2) and equation (6) enlarges to include the energy release.



On the one hand energy is expended to break the bonds and on the other hand energy must be expended to remake them and clearly this imbalanced situation leaves a lot to be desired. What actually happens is that 870kJ/mole^{-1} is expended to begin the recombination process and 3962kJ/mole^{-1} is liberated as a net gain. The reason for this is that the ionisation process in electrolysis is [electro]chemical, the initiating energy is [electro]chemical however the resultant ionisation (combustion) process is physical.

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...and then multiply this reaction by the gas volume denoted by Avogadro's number.

The author of this paper is not in isolation insofar as these apparently anomalous results are concerned, others have addressed the issue. ³" The smallest amount of energy needed to electrolyse one mole of water is 65.3 Wh at 25 degrees Celsius (77 degrees F). When the Hydrogen and Oxygen are recombined into water during combustion 79.3 Wh of energy is released. 14 Wh more energy is released in burning Hydrogen and Oxygen than is required to split water. This excess must be absorbed from the surrounding media(environment) in the form of heat during electrolysis." [...] "At 25 degrees celcius, for voltages of 1.23 to 1.47 V, the electrolysis reaction ABSORBS HEAT. At over 1.47 V at 25 degrees celcius, the reaction gives off heat."

The electrolysis cell voltage, overvoltage may be 1.3V therefore $1.47V + 1.3V = 2.77V$ is the voltage supplied.

One mole of water weighs 18 grams.

$$1000 \text{ Grams water} = 1 \text{ Liter}$$

$$1000 \text{ grams} / 18 \text{ grams} = 55.55 \text{ moles}$$

Therefore 1 Liter H₂O produces 55.55 Moles of Hydrogen and 27.775 Moles of Oxygen. 870Kj H₂O produces as above which is then equal to 48328.50kj per Liter H₂O. Conversion to kWhr divide by 3600 (or x by .0002778) = 3.658 kWhr per Liter H₂O

1 Mole of Gas = 24.450 liters of gas at room temperature, "T" and atmospheric pressure "P". $55.55 \times 24.450 = 1,358.3$ liters of Hydrogen (and 679.15 liters of Oxygen) from 1 Liter of H₂O.

Gibbs Free Energy

Do the rules comprising Gibbs Free Energy reconcile with the energy shown in equation (1 - 7)? No. Provided there are energy co-efficients involved does GFE get turned on it's head? The Wien effect does it to Ohms Law. Why not here as well? Some reactions are spontaineous because they are exothermic $\Delta H < 0$, and others are spontaineous because they are entropic $\Delta S > 0$. The combustion of electrolytic gas is exothermic but the question of entropy is a moot point. Two disordered gases ignited combine to make water which is not an increasing entropy proposition, therefore in our calculation $\Delta S < 1$. Provided the GFE of a system at the end of the reaction is defined as the enthalpy of the system less the product of the temperature multiplied by it's entropy.

H = Enthalpy

S = Entropy

$$\Delta G = \Delta H - \Delta(TS) \quad (x)$$

³ "FUEL FROM WATER" M. A.Peavey. Merit, Inc. LCCCN 88-188956 ISBN 0-945516-04-5 Page 22.

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The usual standard-state free energy of this system ΔG° cannot be applied herein due to the rapidly changing temperatures involved in the reaction and the Enthalpy is:

$$\begin{aligned}\Delta G &= \\ H_g + H_g + O_g(1S) &= -318.402 \text{ kcal/mol} \\ &= \Delta H \\ H_g + H_g + O_g(1S) &= -151.81 \\ &= \Delta S \times 6000^\circ \\ &= \Delta H - -910,860 \text{ kcal/mol} \quad (x)\end{aligned}$$

Following combustion of the gases at 6000°C the resulting oxide cools until it reaches ambient temperature, the molecules return to their lowest energy and the amount of energy released pursuant to GFE is close to the energy taken by the other route in earlier equations, in other words – a lot more than the Hydrogen bond strength.

Alas it is not that simple though. One cannot say that the “heat” of electrolysis is equivalent to this heat of combustion their being crossovers of photonic and molecular heat during the exchanges.

Faraday's Laws⁴

$$V = \frac{R \cdot I \cdot T \cdot t}{F \cdot p \cdot z} \quad (8)$$

where:

- V = volume of the gas [L],
- R = ideal gas constant = 0.0820577 L*atm/(mol*K), = current [A],
- T = temperature [°K],
- t = time [s],
- F = Faraday's constant = 96485.31 As/mol,
- p = ambient pressure [atm],
- z = number of excess electrons (2 for H₂, 4 for O₂).

Assume that STP (Standard Temperature and Pressure) conditions and the electrolyzer runs at one Amp for one hour:

$$\begin{aligned}T &= 0 \\ C &= 273.15^\circ \text{ K} \\ p &= 1 \text{ atm} \\ t &= 3600 \text{ seconds}\end{aligned}$$

⁴ Courtesy Tero Ranta

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$$I = 1 \text{ Amp}$$

Total Oxygen-Hydrogen volume is Hydrogen volume + Oxygen volume:

$$V_{H_2} + V_{O_2} = \frac{0.0820577 \cdot 1 \cdot 273 \cdot 15 \cdot 3600}{96485 \cdot 13 \cdot 1 \cdot 2} + \frac{0.0820577 \cdot 1 \cdot 273 \cdot 15 \cdot 3600}{96485 \cdot 13 \cdot 1 \cdot 4} = 0.418151 \text{ L} + 0.209075 \text{ L} = 0.627226 \text{ L}$$

This corresponds to about 0.627 liters per hour per Amp or 1.595Ah/l per cell.

If for example you have 7 cells in series and put 11A through the electrolyzer, according to Faraday's Law you would produce:

$$0.6271/\text{Ah} * 11\text{A} * 7 = \sim 48.3 \text{ Liters per hour} \quad (10)$$

at STP conditions.

Note, however, that this applies only at a certain temperature (0°C) and pressure (1 atm). The produced gas volume will scale with ratio of temperatures in Kelvins (higher temperature = higher volume) and inversely with the ratio of pressures (lower pressure = higher volume).

If at 0°C (273.15°K) the production rate is 0.627 l/Ah, then at 25°C:

$$273.15^\circ\text{K} + 25^\circ\text{K} = 298.15\text{K} \quad (11)$$

the production rate is:

$$298.15/273.15 = \sim 109\% \quad (12)$$

larger or about 0.685 l/ Ah. With 7 cells and 11A this would be 52.5 Liters per hour.

On the other hand is the output gas has a temperature of 40°C while it is being measured and the ambient pressure of 0.75 atm (about 1.5km elevation above sea level), the electrolyzer that produces 48.3 liters per hour at STP will produce:

$$313.15^\circ\text{K}/273.15^\circ\text{K} * 1\text{atm}/0.75\text{atm} * 48.3\text{l/hr} = 73.8\text{l/hr} \quad (13)$$

So even though the volume of the gas is larger at higher temperature and lower pressure, the energy contained in the gas or the energy required to electrolyze it is the same. If you produce the gas at 40C and 0.75ATM and bring it to 0C and 1ATM, the volume will reduce by about 35%. Thus it is very important to include the pressure and temperature in calculations.

What may not be immediately clear is that different experimenters report various results that are prima facie out of step with cherished laws. Some experimenters report efficiencies that appear in excess of Faraday's Law yet others no matter how hard they try attain only low levels of efficiency. Are the over unity claims due to errors in method

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or calculation? Probably!. But then one has to consider consistent variances shown by experimenters as detailed in the analysis of their results which ultimately culminates in the preponderance of combustion energy output many times more than expected.

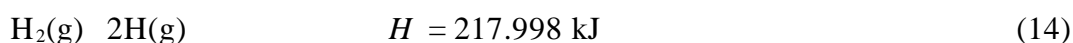
Thermodynamics of Electrolytic Gases⁵

The heat of combustion values for monoatomic and diatomic (conventional) electrolytic oxyhydrogen gas are compared below.

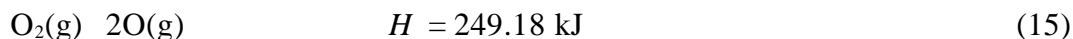
When conventional diatomic (tank gases) oxygen (O₂) and hydrogen (H₂) are ignited, the bonds between the gas atoms in the diatomic gas molecules have to be broken first. This consumes energy. Energy is then released[§] when the H and O atoms recombine into H₂O. The total amount of energy released is the sum of these two energies, where the other one has “+” sign and the other one “-” sign.

While the heat of combustion for conventional diatomic H₂ is shown in thermodynamic tables, the values for the monoatomic 2H + O, H₂O reaction is not usually shown. It is calculated in the following:

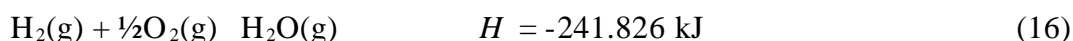
⁶Dissociation of diatomic hydrogen gas into hydrogen atoms (consumes energy):



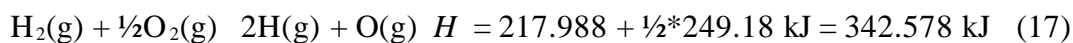
Dissociation of diatomic oxygen gas into oxygen atoms: (consumes energy):



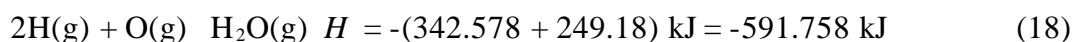
Combustion of diatomic H₂ and O₂ to form water as steam (releases energy):



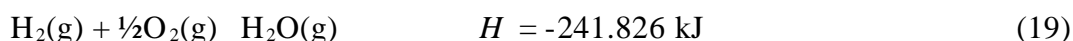
Dissociation of diatomic H₂ and O₂ molecules into monoatomic form (consumes energy):



Combustion of monoatomic H and O to form water as steam (releases energy):



Combustion of diatomic oxyhydrogen into water in the form of steam (releases energy):

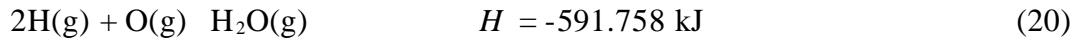


Combustion of monoatomic oxyhydrogen (releases energy):

⁵ Courtesy Tero Ranta

⁶ CRC Handbook of Chemistry and Physics, 84th ed.

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Combusting a certain amount (by weight) of oxyhydrogen in this calculation releases about 2.45 times more energy if the oxyhydrogen is monoatomic instead of diatomic. Monoatomic oxyhydrogen has twice the volume for the same weight than does diatomic oxyhydrogen. This means that igniting one liter of monoatomic oxyhydrogen releases only about 1.23 more energy than the same volume of diatomic oxyhydrogen. However the theoretical energy consumption to dissociate one liter of monoatomic oxyhydrogen from water is half of that required to dissociate one liter of conventional diatomic oxygen and hydrogen gases.

§It may also be noted that when the two Hydrogen atoms merge photons in the UV band are released. In order to inhibit this merger it may be possible to subject the Hydrogen to strong UV (class C) radiation

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Electrical features in Electrolysis

The theoretical decomposition voltage for electrolysis is 1.23 volts at room temperature (16 – 20 degrees C), however because of over-voltage of H on the cathode and also due to cell resistance itself voltages of 2.00 to 2.25 volts are usually required. Over voltage relates to charge held in the cell, the cell acting as an inefficient battery (resistance, capacitance, inductance).

1. $E = I \times R$. $I = E / R$. $R = E / I$.
2. 12 volts (nominal) / 3 cells = 4 volts per cell
3. To determine current: E / R .
 $E = 4$
 $R = 12 \times 10^6$
 $I = 10 \times 3^6$

When lowering the electrolyte impedance to c.1.2k the current will be 300 Amps, theoretically.

Volts	Electrolyte kOhm	Amps
4	1200	300
4	1000	250
4	100	25
4	10	2.5
4	1	0.25

Table 2

...takes no consideration any voltage drop at the electrodes. On Mk1.1 the reactor experienced an 8 to 10 Volt drop when powered at 12 – 14 Volts. If three cells are connected in series the voltage at each is 4 volts, the voltage drop therefore renders the reactor inoperative and in series only the centre cell produces significant quantities of gas. As electrolyte is added and the cell impedance drops the power consumption increases as does the gas output.

Ohms Law dictates the current and voltage levels in the cell are relative to resistance, however clear signs emerge during testing that there is a kink in this Law. Whereas the cell resistance at 10k , 1.23 Volts - load should equate to 0.13 milli-Amps in fact the reciprocal of this value is obtained. In all electronic/electrical circuits heat is generated. When powering the cell with increased voltages ranging from 6 to 40 volts heat is generated and the cell warms up as would be expected in an exothermic system. When voltage is reduced to that dictated by Faraday's Laws of Electrolysis the cell cools and begins to absorb energy from the surrounding atmosphere, that is; the circuit becomes endothermic. In order to keep the cell temperature at that required for highly efficient electrolysis IR radiation must be introduced to keep the electrolyte warm.

This breakage in Ohms Law is repugnant to most and many have stated that it is impossible. The clamp meter does not lie, how can Ohms Law be rent asunder in this manner? The answer lies within thermodynamic systems reported by Willhelm Wein in

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studies of Black Body radiation and is defined in the Wein Displacement Law ⁷The increase of the mobility of an ion in high electrical field. The mobility of an ion is somewhat decreased by the presence of the ionic atmosphere because the predominantly oppositely charged ions surrounding the central ion will tend to hold it back. This effect is included in the normally measured mobility. However, when the ion is exposed to very high electrical field, it will move so fast that it will, in effect, leave behind its atmosphere which does not have time to reform, and the mobility of the ion (consequently the electrical conductivity of the solution) will increase. See also the Debye-Falkenhagen effect..:

$$b = I_{max} T = C^2 / 4.96511423$$

And that electrolysis does not follow the usual VI curve usually associated with electronic circuits. ⁸"The v-i transfer function always applies. Impedance is the instantaneous slope of that function". Mathematically this can be stated resistance: $R = dV / dI$. Ohm's law, as stated, is just a specific case of the above where dV / dI remains constant for a (in practice limited) range of voltage and current. Materials where R is constant over a useful range of voltages are sometimes referred to as 'ohmic'. The "big R" in $R = dV / dI$ is NOT intended to denote a constant, since the differential term dV / dI (or slope) is only a constant in the linear case. R is a variable representing a variable resistance. R is a constant r is a variable. The issue is that the resistance of a cell is nonlinear which means that it exhibits different resistances at different operating points of voltage and current. At any given point of current and voltage, ohms law very much does apply. When you measure the resistance with a simple ohmmeter, you are measuring it at one point, a point with a very low sense voltage. The resistance is high at this voltage, the cell is barely in conduction. At a different, higher voltage, say several volts, the cells conduction increases, the resistance drops and the current comes on as observed. If you had an ohmmeter that measured at that higher voltage, it would show the appropriate low resistance. There are many electrical devices that exhibit non-linear behavior besides electrolytic cells. The common diode comes to mind. There the resistance is a function of polarity in addition to being nonlinear in the forward direction. At a few millivolts of forward voltage, most diodes have a resistance of megohms. This decreases down to an ohm or below as the voltage exceeds .7 volts. Note that these non-linearities have nothing to do with reactance as applied to AC circuits with inductors and capacitors.

⁷ <http://electrochem.cwru.edu/ed/dict.htm#w01>

⁸ <nntp://sci.energy.hydrogen>

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*Hydrogen is NOT *just* an energy carrier

Don Lancaste in his paper ⁹EnergFun claims that Hydrogen is not in fact a fuel but merely an energy carrier.

There are only three elements in combustion, known as the combustion triangle, namely; Fuel, Oxidiser and Heat. If this is the case then Hydrogen is clearly a fuel. Every fuel known to mankind features Hydrogen in the mix: Hydrocarbons, fuel gas(es), coal and even wood all contain various amounts of Hydrogen and in the Hydrocarbons, the lengths of the Hydrogen-Carbon chains determine it's combustive potency; Ipso Facto Hydrogen is a Fuel.

Facts of the matter so often overlooked, in particular in the Internet newsgroup; <http://groups.google.com/sci.energy.hydrogen> by group participants is that Hydrogen is highly explosive in air. So explosive, in fact that it is considered a ¹⁰concussive, as opposed to an incendiary explosion. And even more explosive still when the Hydrogen gas is proportionately mixed with Oxygen – there being insufficient Oxygen available in air to provide complete Hydrogen combustion. What is missed is that the explosive (photonic heat) energy far exceeds the disassociation energy and then the onset of molecular cooling sets in.

Flame speed:

- | | | |
|----------------------|-----------------|------------|
| • Hydrogen in Oxygen | 3900 meters/sec | concussive |
| • Petroleum in air | 30cm/sec | incendiary |

From a safety standpoint it may be propitious that when Hydrogen *goes off* there is little risk of colateral fire the event being over so quickly that in most cases nearby combustables cannot get enough heat for a long enough period to spontaneously catch alight. Certainly there will be colateral damage to surrounding materials, but then- again; the event is so rapid that the force accelerates past and heavier items will remain largely unaffected. Hardware involved in the event, the gas containment device – for example, will exhibit fractures and other effects of explosive energy.

The Infrastructure Hobgoblin

In our consumer society much ado is made of our dependence on multinational corporations to provide materials for our sustenance and advancement. Notwithstanding anecdotal stories of cloak-and-dagger conspiracies, I contend that ill fate suffered by inventors in the energy field has been perpetrated by other jealous inventors and not by way of corporate shenanigans. Even if, in times past such corporations have embarked on criminal activities the world has changed dramatically. The political assemblies becoming more representative of a wider range of populace are somewhat more enlightened than was the case in the relatively recent oil crisis in 1974, dodgy dealings are less likely to be perpetrated now. In 2005 the world faces new energy

⁹ Reproduced, see Appendix 1

¹⁰ Properties of Hydrogen Combustion. NACA report 1383.

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crises. On one hand the globe is nine ¹¹ times over-subscribed in electricity generation the detraction being found in transmission inefficiencies and on the other hand global conflict and excessive demand has had a negative effect on oil supply thrusting the price of oil to record highs. There is no evidence that the world is running out of oil and there is also no evidence that it is not. Petrochemicals will always have a place in society providing us with useful products including industrial chemicals, lubricants, fuels and plastics. What is a moot point is whether recent discussions about the “Hydrogen Economy” bear any relevance insofar as Hydrogen Infrastructure is concerned. Hydrogen may be produced in almost any location on Earth, the Author envisages appliance sized gas plants placed in homes, plugged into the wall and generating Hydrogen and Oxygen by electrolysis for automotive use. The proponent drives the vehicle into the garage and connects to the Hydrogen source which replenishes the tank (s) thus emptying the stored Hydrogen. After driving off again the appliance continues operating 24/7 refilling tanks for later use.

The foregoing becomes academic in the face of on-board, on-demand fuel systems contained within the engine bay which produces all of the engines' needs in which refueling is accomplished either by way of introduced distilled water or by the rain water falling on the vehicle during use that is then collected and distilled in a heat exchanger also within the engine bay. The question then is; what point infrastructure?

Credit where it's due

For the most part the prototypes constructed to demonstrate the power and practicability of EGas as a fuel rest with work done in the 1970's by an English immigrant to New Zealand, namely; Archie Blue. What this writer has done is to take the kernels of Mr. Blue's work, develop and improve upon it in order to bring about devices that not only work but that also may be held up for industrial standards, materials safety data sheets and for dissemination of the information to a world-wide audience.

In this section the writer will discuss the originating invention and the work performed to improve upon it.

In the early 1970's Archie Blue demonstrated his electrolysis device to engineers in both New Zealand and Guernsey. Practical limits where the Mini that it ran on would only accomplish low speeds, use copious amounts of water and dissolved aluminium electrodes such that, although it worked, it did not work for long periods.

The original devices sighted by the author were in Agee preserving jars. Clearly the wrong material to use. Furthermore, the power supplied to the electrolyzers was taken straight from the vehicles electrical system which caused excessive heating and melted wires. No work was performed by Mr. Blue to explain the devices in terms of Faradays Laws of Electrolysis. The electrolyte was Sulphuric Acid (Battery Acid) and on the application of electrical current the aluminium electrodes began to dissolve releasing EGas in the process. This EGas was then fed into the modified S.U. brand carburettor for direct induction to the combustion chambers.

What has this author done to improve upon and develop the original invention?

¹¹ <http://www.wired.com>

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- The electrolysis units have been constructed of stainless steel
- Heavy duty check valves are placed at the top of each cell
- Potassium Hydroxide is added as electrolyte
- Sacrificial electrodes have been dispensed with in favour of stainless steel.
- The pressure source is added from the bottom of the cells
- The electrical supply is induced at the bottom of the cells so that no surfaces are exposed to EGas
- The pressure source is provided by gas from the exhaust
- A separate power supply has been added that allows for voltage adjustment
- Electrical characteristics have been defined
- Harmonic resonance has been induced to electrodes

The crux of the invention has been retained as it relates to using three electrolysis cells, the output from the one cell feeding the input to the next which appears to enrich the gas evolved from the output of the third and final cell. Direct injection to the modified S.U. brand carburettor has been dispensed with in favour of using an Impco brand natural gas regulator. The new and improved unit also has safety features built into it such as pressure relief valves

Experimental devices

Variable Power Supply

Description and Theory of Operation

Design an electromechanical power supply with varying output at high current.

The supply's belt drive couples to crankshaft. It is 3 phase "Y" winding rated at 24 Volts, 150 Amps. All alternators require a field voltage which determines the output voltage. As the voltage is lowered the Amperage increases proportionately, therefore:

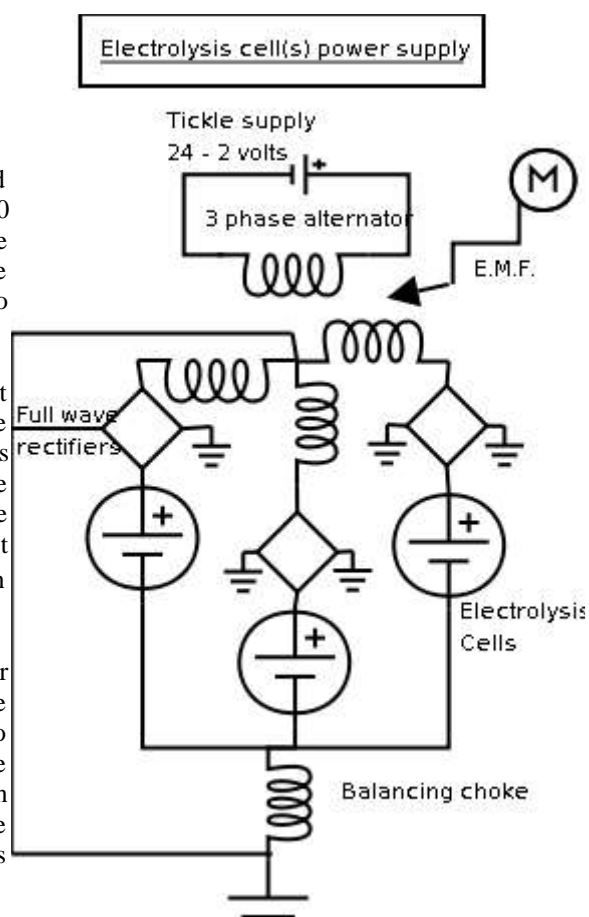
Supply	Current
24Volts	150Amps
12	300
6	600
2	1,800 ¹²

The built-in DC rectification is not used. At full power and at about 2500RPM the alternator outputs 24 volts and 150 Amps. As the electrolyte heats up the tickle supply voltage is wound back to about 2 volts. At reduced voltages the built-in rectifier drops-out. Using the single DC output to drive three cells is unreliable.

Heating for electrolysis is also accomplished via hot exhaust gas entering cell #1¹³. At all points of use the electrolysis cells maintain their own charge, this is called electrode overvoltage. Faradays Law determines the optimum voltage for electrolysis to be 1.27 volts above this. The alternator supply tickle is therefore maintained at electrode overvoltage plus 1.27 Volts. Full gas production is not accomplished at elevated voltages.

For full wave rectification each phase has its own rectifier which is fed into the electrolysis cells. Each cell therefore gets up to 600 Amps in this configuration. There is no reason why larger alternators cannot be used with one proviso; the AC outputs must be accessible. The built-in alternator rectifier fails at low voltage and this is the reason for using customised delta wound alternators provide more current than do "Y" wound devices.

The choke between cathodes and earth is there to balance the inductance of the alternator windings.



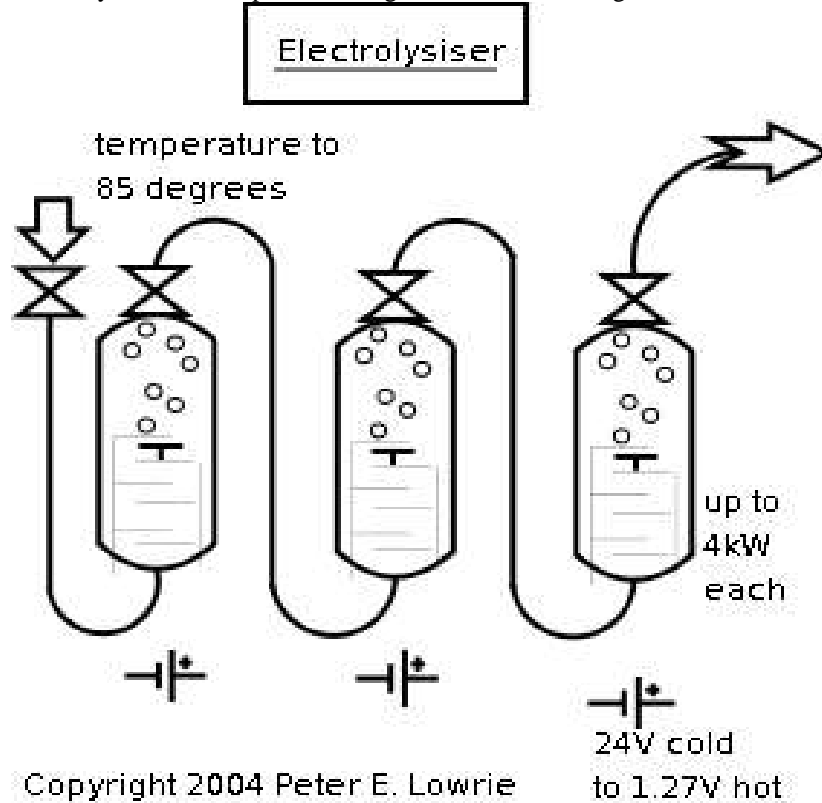
¹² Field losses by way of coil resistance, capacitance and inductance are not shown.

¹³ Details on another diagram

Electrolysers

Description and Theory of Operation

Design an efficient electrolysis cell that provides high volumes of rich gas.



A metered supply of hot¹⁴ engine exhaust gas is introduced to the bottom of a stainless steel pressure vessel. The gas percolates through four electrodes knocking off some gas bubbles on its way up through the electrolyte. The gas output from cell 1 is repeated in cells 2 and 3 which helps to provide a *richer* concentration of gas called electrolytic Gas. This is a fuel gas.

The electrolyte consists of distilled water with Potassium Hydroxide added to a concentration no more than 30%. Potassium Hydroxide KOH is the conductive base with the highest electrochemical potential. It does not cause significant degradation to electrode surfaces.

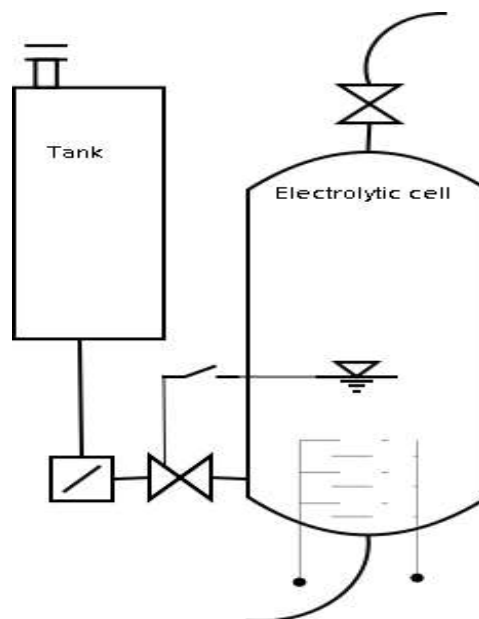
The cells measure 100mm dia by 250mm, have 2 each cathodes and anodes which are rated at 14kw. The pipes between cells increase in diameter from 5mm to 19mm. Atop each cell is a stainless steel check valve to prevent flowback of gas and this in turn keeps the fluid in the cells.

Electrolyte level within the cell is maintained by way of a float switch that connects power to a solenoid valve. Behind the solenoid valve is a check valve to prohibit backflow.

The tank must not be conductive, if it is then it must be isolated from earth to stop the water from making a circuit that turns the cell body into a cathode. The electrodes are fitted from the bottom of the cell and comprise two each perforated stainless steel plates. Conductors are 8mm threaded rod. The electrodes must be keyed to prevent them twisting and shorting to the cell body.

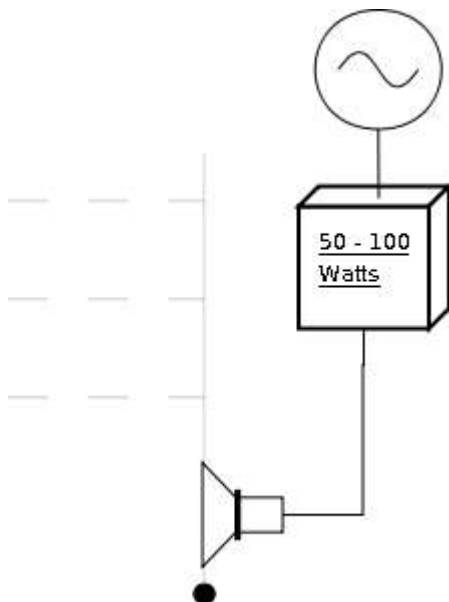
¹⁴ Faradays Laws of Electrolysis determine the optimum temperature to be in the range 70 to 80 degrees Celcius.

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The tank contains distilled water – the electrolyte is maintained within the cells. Because KOH does not dissipate into the gas flow the concentration is maintained within for a considerable time.

Attached to the cathode conductor is an electromechanical device, piezzo, high output speaker or similar that vibrates. Following manufacture of electrodes of precisely similar dimensions, ie; mass production, an electrode is placed into the vice which is tightened down at the point where the conductor passes through the cell body. Attached (glued) to one of the electrode plates is a compound microphone that is coupled to an oscilloscope¹⁵. In sample and hold mode the oscilloscope records the vibrations emanating from the electrodes when it is *played with a violin bow*. This determines the electrodes' resonant frequency.



A function generator tuned to the resonant frequency¹⁶ of the electrode is amplified and transmitted to the speaker device attached to the cathode. It is put on the cathode because this is the Hydrogen gas source the anode will resonate in sympathy due to it being submersed and that it has exactly the same resonant frequency as the cathode. This causes the electrodes to vibrate violently within the electrolyte the effect being a virtual increase in surface area and thus more gas production and the side-by-side movement

¹⁵ That also displays frequency.

¹⁶ Usually in the order of 5 – 600 hz

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causes gas bubbles to release from the surface at the rate determined by it's oscillation (nifty!).

Electrolysis can be made very efficient and high nineties (percent efficiency) is not difficult to accomplish. With the combination provided by way of Faradays Laws wherein temperature is maintained at c.75°C, voltage at 1.27 volts (above electrode overvoltage) and power in the kilowatts efficiency of 97.5% is not unrealistic. It must be pointed out that at these parameters the electrolytic process tunnels into an exothermic state. Although, stricktly speaking all circuits generate heat and therefore losses, they operate endothermically and all physical laws are complied with. Not-so electrolysis, clearly this state of change has an effect – in particular Ohms Law appears to break. One must now approach the calculations vis-a-vis efficiency within the bounds of Blackbody Radiation and the Wein Effect. Coming back to this “combination”, whereas Tero Ranta's data shows that better than 100% efficiency can be accomplished without addition of any other tricky bits the notion of providing electromechanical motion using small quantities of power to release larger amounts of gas in this system will add to the output efficiency.

Summary

Before there was water there was only gas. In space water is formed by electrical discharges through reasonably dense atomic/molecular clouds. Terrestrial water was formed by three routes:

1. Water captured from space.
2. Electrical discharges, and latterly;
3. Cellular metabolism.

A small electrical discharge sets in motion chain reactions between Hydrogen and Oxygen in a physical event that releases orders of magnitude more energy than is required to then, in an electrochemical reaction, break apart the resulting oxide - there being no detractions from physical law when these facts are processed in their correct order. The oxide does not exist prior to the gas!.

So far as Electrolytic Gas' use as an internal combustion fuel is concerned it must be noted that the first ever internal combustion engine¹⁷ invented in c.1807AD used electrolytic gas as its fuel.

¹⁷ DeRivas