Essential information on car batteries

It is essential that the battery of a vehicle in which a HHO system is installed , is in good condition .
As a car battery ages , the internal resistance of the battery also increases . This increasing internal resistance reduces the percentage of the available battery energy that can be used for electrolysis

Internal resistance increases with age and as the battery's internal chemical energy is used up. The value for a new lead-acid car battery is of the order of 0.02 ohm . (not 0.02 watt)

In this case when a current of 18 amp is being used by the car to run the electrolysis unit , then the voltage drop within the 12 volt battery is 18 x 0.02 = 0.36 volt

This means that the available voltage for the HHO system has dropped from 12 volt to 11.74 volts. This voltage drop is not significant and a 5 cell unit can easily operate -----(each cell using approx. 2.2 volts for the Hydrogen redox reaction) – 5 x 2.2 volts = 11 volts , and the available voltage is 11.74 volt.

However in the case of a damaged battery , an old battery , or a battery close to the end of its lifespan, the internal resistance of the battery itself will increase significantly .

Eg……… if the internal resistance rises from 0.01 ohm to 0.2 ohm the voltage drop within the battery itself when 18 amp of current is flowing = 0.2 x 18 = 3.6 volts

This means that although the battery is still providing 18 amp of current ………. (which is achieved by using a stronger electrolyte solution in the HHO cells)…………….. , the available voltage to power the cells has dropped from 12 volt to 8.4 volt. (you need at least 11 volts for 5 cells)

At this voltage the cell production is significantly reduced as there is insufficient voltage to support the Redox reaction to produce Hydrogen in the cells.

So where is the extra energy gone?.................. Into heat within the battery and system

Conclusion = Make sure your battery and alternator are in good condition and avoid any avoidable line losses which can rob your HHO system of the energy needed to make Hydrogen from water using electrolysis.

Theory

For an electrical current to flow in a conductor, there must be a driving force to move the electrons. This driving force is called electromotive force (meaning electron-motion-force) across the ends of the conductor. Electromotive force may arise from some external device which transforms some other form of energy into electrical energy. A battery is such a device. It is the chemicals within the battery that produces the source of electromotive force. Some other sources of EMF are generators, photocells and solar cells.
The electromotive force of a battery E is the work that is needed to move a charge Q through it. The ratio of the amount of work in Joules to Q in Coulombs is called the VOLT after the Italian physicist Count Alessandro Volta (1745-1827). Thus 1V = 1J/1C.
An electrical current is the flow of electric charge. The rate of flow of charge of one Coulomb per second is called the AMPERE after the French physicist Andre Ampere (1775-1836). Thus 1A = 1C/1s.
Whenever a current flows in a conductor, a potential difference is developed across it. The relation between potential difference in volts to the current in amperes was first investigated by the German physicist Georg Ohm (1787-1854).He found that the ratio of the potential difference across a conductor to the current through it is a property of the conductor which we call resistance. The relation $V = I \times R$ is known as Ohm's Law . The unit of resistance is the OHM.
Every source of electromotive force has some resistance within it which limits the amount of current that can be drawn from it. This is called its internal resistance . Values of internal resistance vary from 1/2 to 1 W for D and C cells to several Ws for AAA cells. Internal resistance increases with age and also as the battery's energy is used up. The value for a new lead-acid car battery is of the order of 0.02W .
When a battery is being discharged, part of the electrical energy is converted into heat within the internal resistance. The potential difference across the battery V is then *less* than the emf of the battery E by an amount equal to the potential difference across the internal resistance, Ir, or

$$V = E - Ir.$$

I is the current drawn from the battery and r is its internal resistance. If we multiply this relation by It (the product of the current and time t), the quantity VIt represents the electrical energy delivered by the battery, EIt

represents the chemical energy used up in the battery, and I^2rt represents the heat energy generated within the battery.
The maximum current that may be drawn from a battery occurs when V = 0 in the above relations, or

$$I_{max}=E/r.$$

This is called the short-circuit current. It is essentially the CCA (cold cranking amperes) rating for car batteries. The value of I_{max} for a 12V car battery of internal resistance 0.02 ohms is 600A and for a C or D-cell battery of internal resistance 1/2 ohm, about 3A. The 9V radio batteries consist of 6 small 1.5V cells each of about 1.5 ohms internal resistance, in series. The short circuit current of these batteries is then about 1 A.
The power delivered by a battery to an external resistor R is equal to $I^2 R$ or $\{E/(R+r)\}^2 R$. By differential calculus, we obtain the result that the maximum power delivered by a battery occurs when R = r . The value of maximum power output of a battery is then is given by

$$P_{max} = E^2/4r$$

The maximum power output of a battery is inversely proportional to its internal resistance. The smaller the internal resistance, the large is the maximum available power.
The specific maximum power is the maximum power (in W) divided by the mass of the battery (in kg or g).
The capacity of a battery is the product of the current that may be drawn from it and the time for it to be exhausted. For example, a 60A.hr car battery may deliver a current of 5A for 12 hours, or 120A for 30 minutes.
The product EIt is the energy of the battery. It is equal to the capacity of thr battery times its emf. The energy density of a battery is equal to EIt/volume.
The purpose of this laboratory exercise to measure the emf and internal resistance of a variety of batteries and then to determine several important quantites such as maximum power, specific maximum power, energy and energy density of them.
Consider a series circuit consisting of a battery of electromotive force E and internal resistance r connected to a meter of resistance r_m and a resistor R as shown below.

The current flowing in the series circuit is given by Ohm's Law,

$$I = E/(R + r + r_m), \text{ and by rearranging, } R = E(1/I) - (r_m + r)$$

Thus, a graph of R (on the y-axis) versus 1/I (on the x-axis) should be linear with a slope equal to the EMF of the battery E and whose negative intercept on the R axis gives the value $r_m + r$. If a value of the internal resistance of the ammeter r_m is known (typically 0.5 to 0.5 W), a value of the internal resistance of the battery r may be determined.

Alternatively we may rewrite the above equation as $RI = E - (r + r_m)I$, so that a graph of RI (on the y-axis) versus I (on the x-axis) should be linear with a slope equal to $r + r_m$ and intercept on the y-axis equal to E.