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Abstract. A system of water electrolysis have been designed and fabricated locally by using simple home materials. Many types of water solutions and the effect of its concentrations on the electrical current have been studied. The effect of voltage and power on the quantity of gas production and the analysis quickness have been studied also. It is noticed that the current will increases as concentration increase. In addition, the productive gas quantity is increases as the voltage increases. The productive gas can be used in a welding processes, or as a hydrogen fuel for of electricity generators and cars engines.

Keywords: Hydrogen production, Hydrogen fuel, Water electrolysis, Water splitting, Renewable energy, Energy conversion.

1- INTRODUCTION

Hydrogen is the most important element in the universe. Many of planets and all stars are basically consist of hydrogen. But on the earth, the hydrogen is rarely found as a free gas. The atmosphere contains a very little amounts of it "0.07 percent". It is usually mixed with other natural gases in crustal reservoirs. However, it have been discovered in a large amounts in few wells. The principle of hydrogen energy production covered a whole array of methods, such as electrolysis, thermal photolysis, and thermo chemical cycles [1].Hydrogen energy one of most important source for Renewable energy. Many searches studied method of Hydrogen preparing. Because of that the Hydrogen is most spread in the universe, it is rarely found as a pure element in the nature [2]. But it is available as a compound. The water compound is most spread, therefore the water considered as an important and suitable for renewable energy. The hydrogen is used as a fuel for space crafts, water heating, and for cooking. It is more convenient to produce hydrogen by electrolysis using excess electricity and conversion efficient ranging from (80-95%) are achievable [3]. A theoretical and experimental studies was done about using solar thermal to produce hydrogen [4,5]. Theoretical studies has been done on vicinage effect in ions collisions with solid energy matter [6]. Hydrogen will be required to supplement, but eventually, replaced rapidly diminishing by hydrocarbon as a fuel resource for internal combustion engine [7]. Electronic capture by hydrogen projectiles in gazing scattering from Aluminum thin film with different thicknesses had been studied theoretically using perturbation method [8]. Characterization of water electrolysis cell and high frequency behavior have been evaluated in this work. The experimental electrolytic bath of the mentioned research for each one has been arranged to be differs from other setups in distance between the electrodes, electrode size, and electrolyte morality [9].

2- ESSIENTIAL CONCEPTS OF WATER ELECTROLYSIS

The water electrolysis is occurred when a DC current passing between two electrodes immersed in an electrolyte. Oxygen is formed at the anode and hydrogen at the cathode. The current passing between any two electrodes is the main parameter of hydrogen production . Well known "Michael Faraday's laws" of electrolysis illustrated that [10]:

1. "The mass of a substance changed during electrolysis at an electrode is directly proportional to the quantity of electric charge (Q) transferred".

2. "For a specific quantity of electric charge, the mass of the material altered at an electrode is directly proportional to the equivalent weight of the element. So, the equivalent weight of the substance is usually equal to its molar mass divided by the variation in oxidation state which it happens upon electrolysis. The electrodes should be resist corrosion, possess a good electric conductivity, bare a good catalytic properties, and have a suitable structural integrity. In addition, electrodes and the electrolyte should not be reacted with each other" [11]. By splitting of water, hydrogen can be produced using various processes; such as "water electrolysis, photo-electrolysis, photo-biological production and high-temperature water decomposition". Electrical water analysis one of the best method by passing the electrical current through a water solution. This method is used for many applications. It is easy to done with low cost, but it is not more efficiency. Electrolysis is the splitting of a water molecule with electricity to produce hydrogen and oxygen. The charge breaks the bond between the hydrogen and oxygen creating ions that form on two poles: the positively charged anode attracts the oxygen, and the negatively charged cathode attracts the hydrogen. One of The main disadvantage of this process is that the efficiency is relatively low, due to the indirectly generation of hydrogen via electricity. So, this process is economically feasible only in the countries which have superabundant hydro-generating quantity, or huge thermal resources. The total energy, which is necessary for water electrolysis is increasing with temperature slightly, however, the needed electrical energy decreases. When a high-temperature heat is available; a high-temperature electrolysis process might be preferable. This is important, because that the most of the produced electricity is usually based on fossil energy sources [12]. The normal chemical reaction of water electrolysis "without thermodynamic energy values" can be expressed as [13]:

"H_2O (liquid)$\rightarrow$ H_2(gas) +$\frac{1}{2}O_2$ (gas) ……..…… (1)"

Separator or diaphragm is necessary to avoid recombination of the hydrogen with oxygen to preserve efficiency in the electrolysis technology, and it is also used in fuel cells [14]. Thermodynamically**,** in water electrolysis, thermal and electrical energy are converted into chemical energy "stored in hydrogen". The energy required to achieve the reaction is the enthalpy (ΔH) of water formation. The free energy of this reaction "called Gibbs free energy change ΔG", supplies the electrodes as an electrical energy [15]. The remainder is" thermal energy", which is the product of "process temperature T" multiplies with "entropy change ΔS", and if it is known that F is "the Faraday constant (96485.3365 C/mol)", enthalpy variation can be written as [16]:

"$\Delta H = \Delta G + T\Delta S = zF\,[T\,(\partial U_{\text{rev}}\,\partial T)\,p - U_{\text{rev}}]$ ……..…… (2)"

where, "z is the number of moles of electrons transferred in the reaction", "U_{rev} is the reversible voltage", and "p is the prevailing pressure (in Pa)". The reversible voltage U_{rev} is the lowest required voltage required for the electrolysis to take place, and it is also known as "the equilibrium cell voltage", or the electromotive force. The electrical work applied by the electrolytic cell is equal to the free energy variation happened "at constant temperature, pressure and positive electromotive force" [14].

3- EXPERMENTAL WORK

The preferable way to produce hydrogen can be obtained by splitting water using electricity "electrolysis". This can be done by passing an electric current through the water. This will splits it into hydrogen and oxygen. In spite of the lowest efficiency of electrolysis with that of direct chemical path, but it offers virtually no toxic or pollution. In this study, the objectives of the work are illustrated below:

1- Metal piping: A metal pipe have been used to connect the plastic container with aid of Teflon tape to avoid gas leakage, as illustrated in Fig. 1 below.

Figure 1. Metal piping .

2- plastic containers: A plastic container (3 containers) which is always used in home for water purification have been used in this work; that it has been supplied with an O-ring to avoid gas leakage, and it is also easy to connection. See Fig. 2.

Figure 2. Plastic containers.

3- Plastic piping: Plastic piping have been used here to connected the output of containers with a storage tank.
4- Storage tank: A metal tank which is used to store cooling gas have been used as a tank for the system designed here.
5- Electrode: A rectangular shape of Aluminum sheets of (10 cm x 15 cm) dimensions have been designed as electrodes. Electrodes have been connected and separated by plastic screw using pieces of ceramic between electrodes to insulate them, where a three sheets connected to a positive electrode and the other three sheets connected to a negative by sandwich method using cupper wire to connected the electrodes with each other's and with the power supply, as demonstrated in Fig. 3.

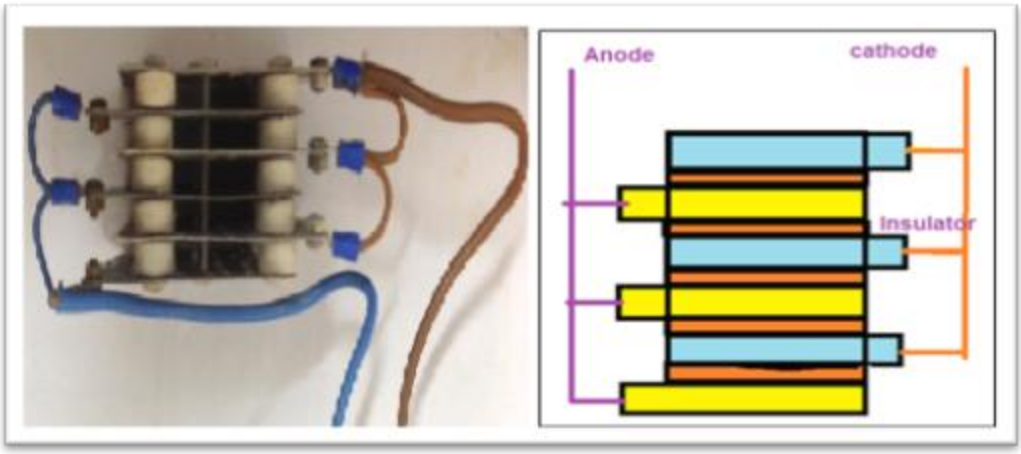

Figure 3. The electrodes assembling**.**

6- Power Supply: Variable voltage power supply of (30 V ,10 Amp.) has been used.

4-SYSTEM ASSEMBLING

Fig. 4 illustrates the diagram of four plastic containers connected with the terminals of electrodes with the power supply in parallel. A multimeter have been used to measures the current and the voltage.

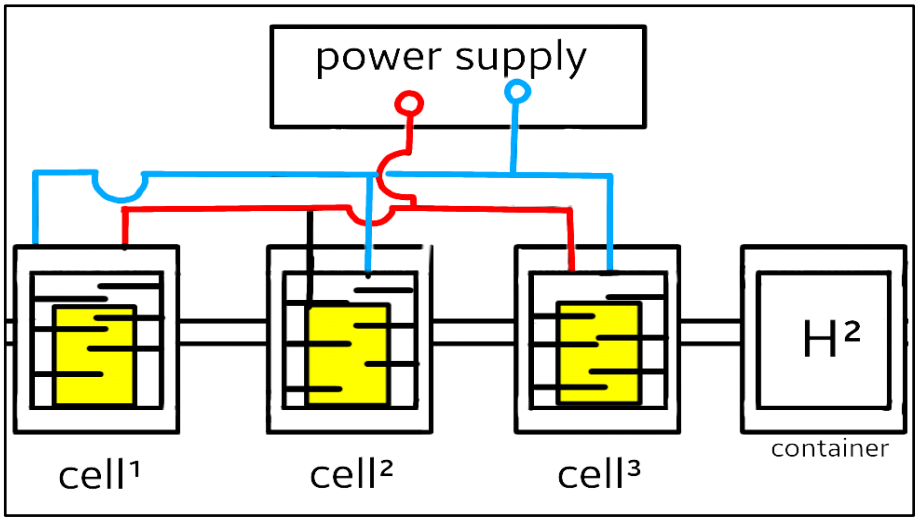

Fig. 4: Electrical Water analysis system diagram**.**

5-PERIMENT(1)

After filling the plastic containers with 8 liters of mineral water, and connecting the power supply of (12 Volt voltage & 2 Amp. Current) for 20 minutes, the gas increased in the storage tank. The test steps are repeated at 24 & 30 Volt. The results shown in Fig. 5.

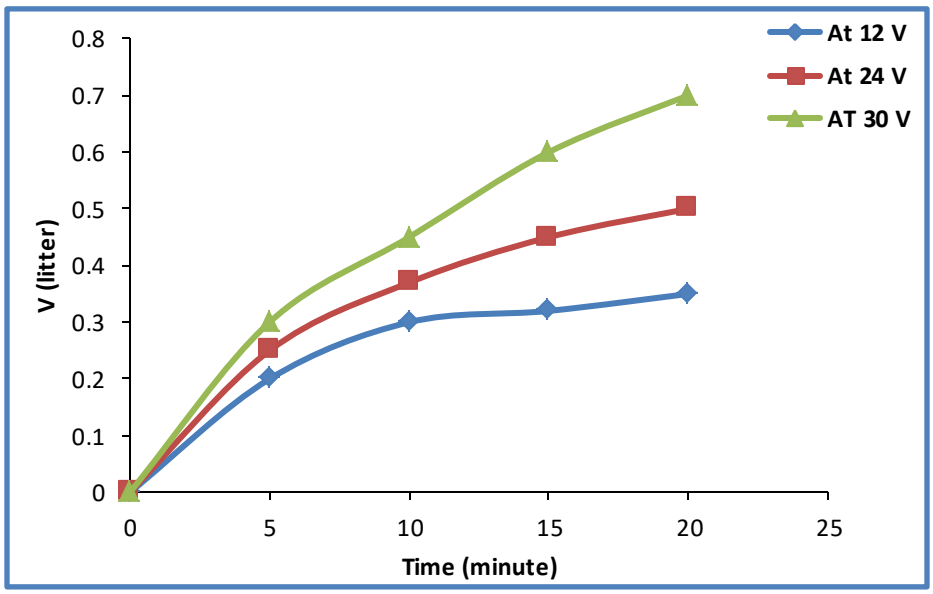

Fig. 5: Relation between volume of gas with time for mineral water.

EXPERIMENT (2)

This experiment have been done by repeating the same procedures in experiment (1), but a normal water (home water) is used, which consists of metal salts (K, Na,..). The results shown in Fig. 6.

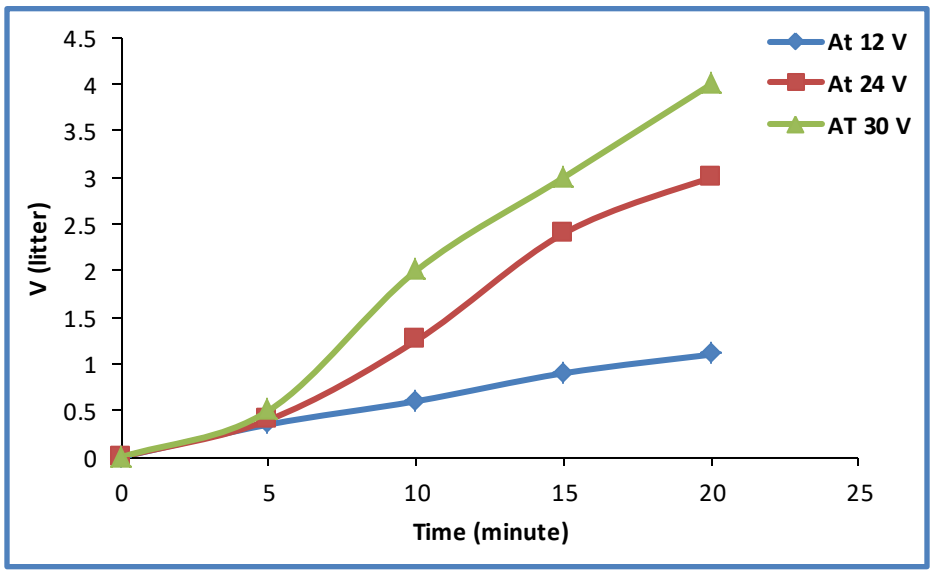

Fig. 6: Relation between volume of gas with time for normal water.

EXPERIMENT (3)

By adding 1 cm^3 Acid to each 1 liter of normal water used above, the same steps in the previous experiments have been followed in this experiment. The consequence is shown in Fig. 7 below.

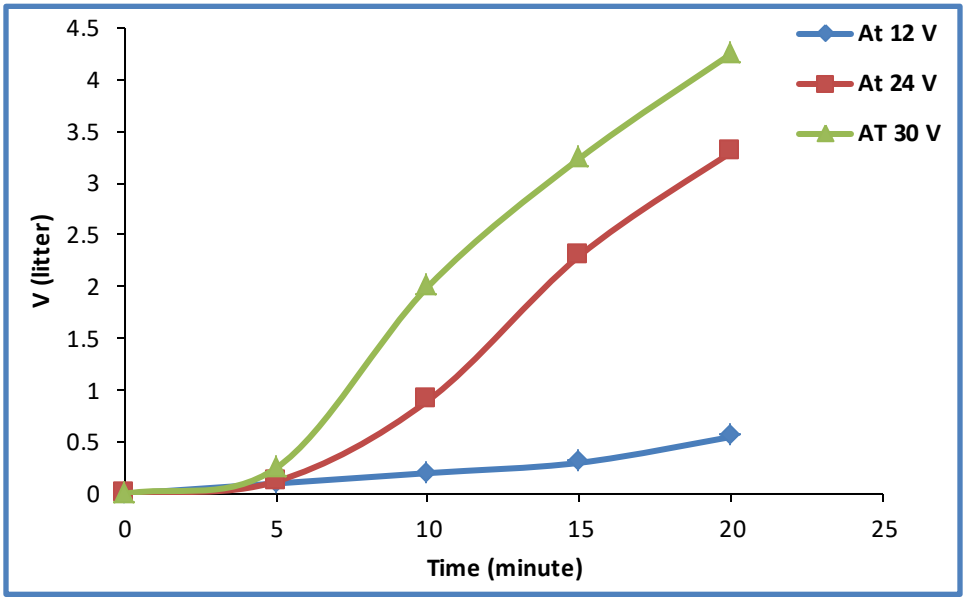

Fig. 7: Relation between volume of gas with time, by adding 1 cm^3 Acid to each 1liter of normal water.

6- RESULTS AND DISCUTION

The outcome of the three experiments mentioned above in this work, the electrical characteristics of the system designed here are shown in the following table 1.

Table 1:Electrical Voltage, Current, and Power for experimental work.

No.	Water type	V (volt)	I (Amp.)	P (Watt)
1	Mineral water	**12**	**2**	**24**
2	Mineral water	**24**	**3.5**	**84**
3	Mineral water	**30**	**5.3**	**159**
4	Normal water	**12**	**2.4**	**28.8**
5	Normal water	**24**	**4.2**	**100.8**
6	Normal water	**30**	**6**	**180**
7	Normal water with acid	**12**	**2.6**	**31.2**
8	Normal water with acid	**24**	**5.3**	**127.2**
9	Normal water with acid	**30**	**7.5**	**225**

From all the obtained data, the results of this work can be summarized in two points:

1- The electrical voltage and current: if the voltage, current passed in water solution with power more enough to heat the electrode, the molecules will be heated, moved, and vibrated. If the frequency of vibration coincides with the lattices vibration, resonance occurred to brakes the bonds of water to releasing hydrogen and oxygen in the solution. When the voltage and current increase, the quantity of released gas (oxygen and hydrogen) is also increases, because of the increasing in collisions between molecules due to the high temperature of electrodes [17].
2- Concentration result: Increasing in concentration of water solution will increase both of the electrical current and the reaction rate due to increase in collisions and vibrated resulting molecules break the bond to releasing gases (hydrogen and oxygen) and reduces the water solution resistance [18, 19, 20]. This continues until the solution will be saturated, whereupon, the water solution should be exchanges.

7- CONCLUSIONS

There are many advantages to use of H_2O as hydrogen source for applications, because it is easy and clean (no contaminations). In this paper, it is found that the suitable water solution should be chosen depending on the purpose of the work. If low power is needed, mineral water must be used with slow releasing of gas. But if high speed for releasing gas and high quantity at the same time is needed, high power (up to 30 Volt with high current 10 Amp.) must be used. So, the sea water can be used instead of normal water mixed with acid. The collected gas (enough quantity) can be used for wilding processes, or as an engine's fuel for electricity generators and cars.

ACKNOWLEDGMENT

We would like to express our sincere appreciation and gratitude to the Physics Department in the College of Sciences in Tikrit University for their kind support during the period of the research.

Our deeply grateful also to the Physics Department in the College of Sciences in Karbala University and to the supervisor committee of the 6th Karbala conference for sciences for their efforts in preparation of this conference.

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