HyPIR Electrolysis for Potassium Hydroxide Solutions at Different Laser Powers

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Abstract

Large scale hydrogen production is needed to provide a clean, sustainable fuel on a global scale. The goal of Hydrogen Production by Infrared Radiation (HyPIR) electrolysis is to optimize the amount of energy needed to produce the energy carrier hydrogen. It is based on the hypothesis that infrared radiation at a frequency that stimulates the O-H bond in water will improve the rate and efficiency of hydrogen production using electrolytic methods that are already in use today. Results of this experiment show that HyPIR electrolysis increases the rate of hydrogen production from water without producing carbon-bearing byproducts.

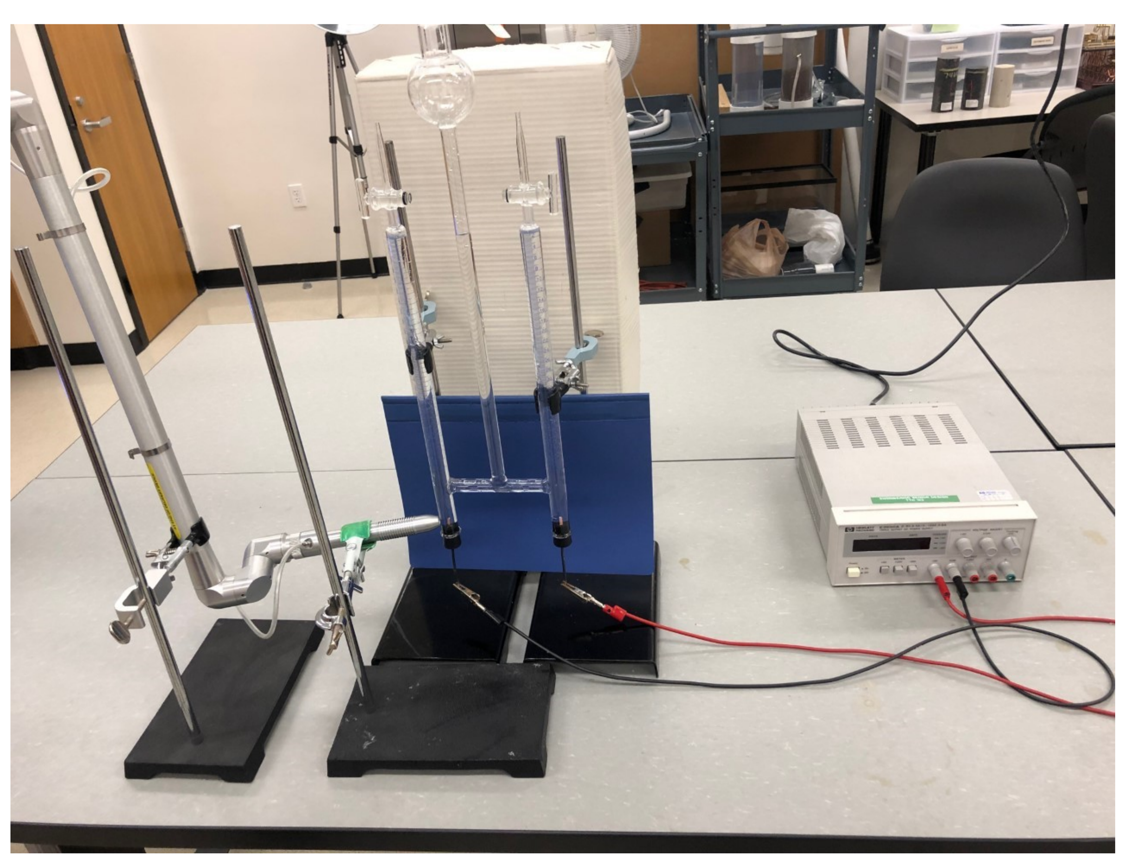
Introduction

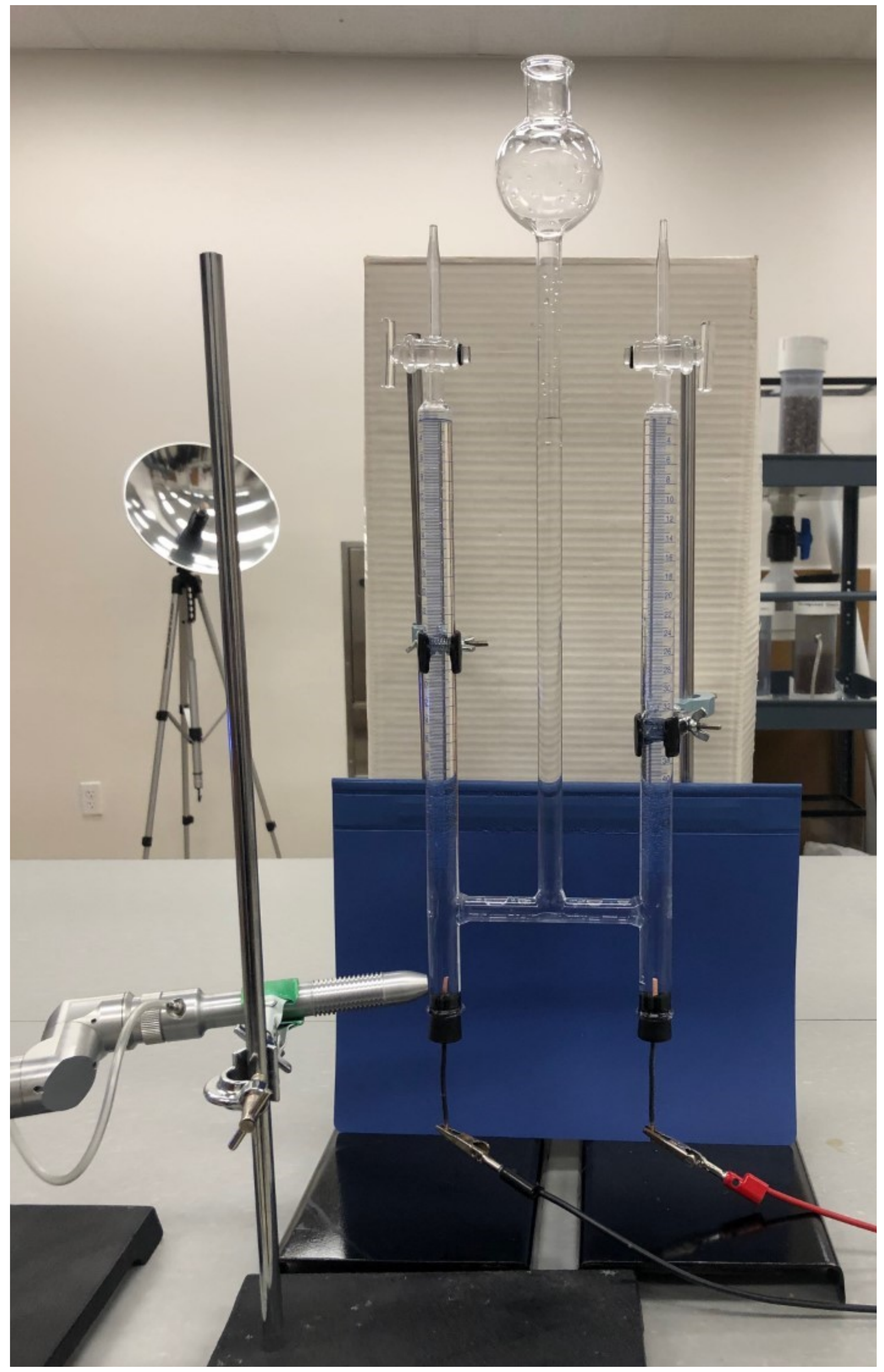
Previous studies used Epsom salt (magnesium sulfate) to form the electrolyte. The products of the reaction with the copper electrode were hydrogen, copper sulfate, and magnesium hydroxide. The formation of copper sulfate consumed the copper electrode and formed a precipitate. These undesirable results could be eliminated using a different electrolyte that would not consume the electrode and produced desirable byproducts.

We chose to use potassium hydroxide (KOH) as the electrolyte. The electrolyte solution did not interact with the copper electrode. Electrolysis with a KOH solution and a copper electrode produced hydrogen gas and oxygen gas, two desirable products. Results show that there is an increase in hydrogen production in the presence of suitable infrared radiation.

Method

Potassium Hydroxide was measured to 72.18 grams and mixed with 1000 mL of water to produce a one-molar solution. Approximately 150 mL of this solution was placed in a Hoffman cell sealed with rubber stoppers containing copper electrodes. A voltage source of 6 volts was connected across the Hoffman cell through these electrodes. Liquid displacement was measured on the side of the Hoffman cell that was grounded. A laser was pointed at this electrode to maximize hydrogen production. When measurements were being taken, a timer was started as soon as the voltage and laser were turned on. The time was taken every two milliliters of liquid displacement. To have comparable data, these measurements were taken at 800, 1000, 1200, and 1400 mJ/pulse or 3200, 4000, 4800, and 5600 mJ/sec respectively. This data was put into excel to retrieve the graphs located in results. The first two data points for each set were omitted to allow for linearity.





Conclusion

We presented a method referred to as HyPIR Electrolysis. The method increases the rate of hydrogen production from a 1 molar potassium hydroxide and water solution under 6 volts when the electrolytic solution with exposed copper electrodes is irradiated with an optimum wavelength of light. The irradiating light facilitates the dissociation of water by stretching the hydrogen oxygen bonds and increasing the rate of hydrogen production. Production of hydrogen due to the class 4 laser is altered by the specifications of laser energy, pulses per second, and spot size.

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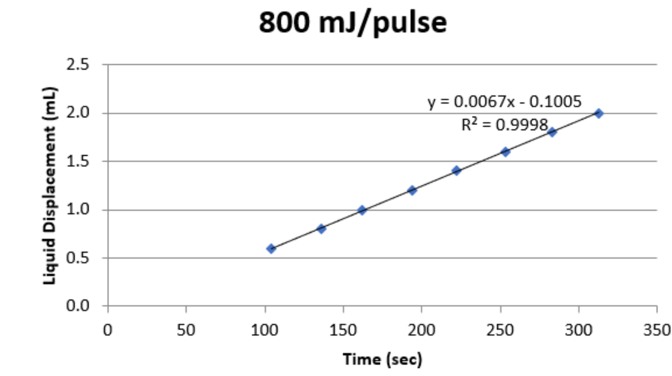
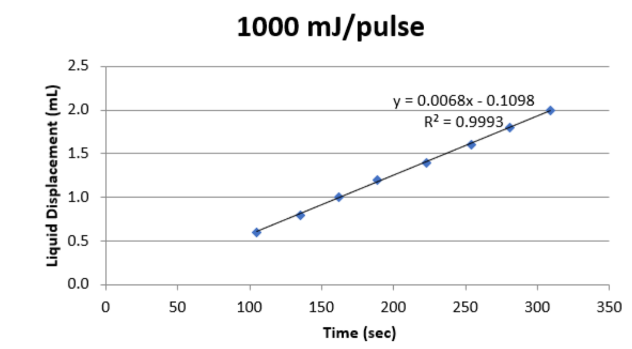
Results

The laser selected for this experiment is the Erbium-YAG laser. It provides a collimated, coherent beam of infrared light with a wavelength of 2.94 microns.

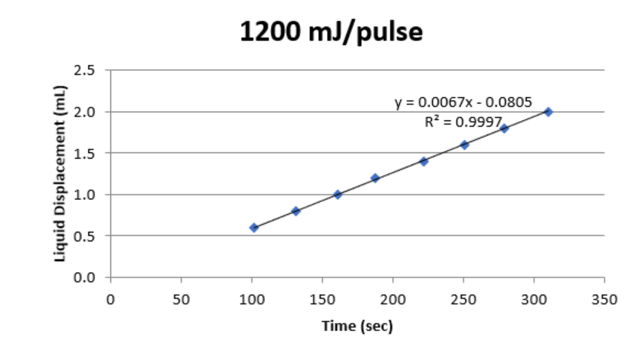
Molar Solution (M)	1.0	Voltage (V)	6.0		
		Time (sec)	Liq displacement (ml)	Diff (sec)	Rate (ml/sec)
Laser (mJ/pulse)	800	0	0.0	0	
Pulses per sec (Hz)	4	45	0.2	45	4.44E-03
Spot size (mm diam)	1	74	0.4	29	6.90E-03
Laser power (mJ/sec)	3200	104	0.6	30	6.67E-03
		136	0.8	32	6.25E-03
		162	1.0	26	7.69E-03
		194	1.2	32	6.25E-03
		222	1.4	28	7.14E-03
		253	1.6	31	6.45E-03
		283	1.8	30	6.67E-03
		313	2.0	30	6.67E-03
				Avg	6.51E-03



Laser (mJ/pulse)	1000	0	0.0	0	
Pulses per sec (Hz)	4	34	0.2	34	5.88E-03
Spot size (mm diam)	1	72	0.4	38	5.26E-03
Laser power (mJ/sec)	4000	105	0.6	33	6.06E-03
		135	0.8	30	6.67E-03
		162	1.0	27	7.41E-03
		189	1.2	27	7.41E-03
		223	1.4	34	5.88E-03
		254	1.6	31	6.45E-03
		281	1.8	27	7.41E-03
		309	2.0	28	7.14E-03
				Avg	6.56E-03



Molar Solution (M)	1.0	Voltage (V)	6.0		
		Time (sec)	Liq displacement (ml)	Diff (sec)	Rate (ml/sec)
Laser (mJ/pulse)	1200	0	0.0	0	
Pulses per sec (Hz)	4	35	0.2	35	5.71E-03
Spot size (mm diam)	1	70	0.4	35	5.71E-03
Laser power (mJ/sec)	4800	102	0.6	32	6.25E-03
		131	0.8	29	6.90E-03
		161	1.0	30	6.67E-03
		188	1.2	27	7.41E-03
		222	1.4	34	5.88E-03
		251	1.6	29	6.90E-03
		279	1.8	28	7.14E-03
		310	2.0	31	6.45E-03
				Avg	6.50E-03



Laser (mJ/pulse)	1400	0	0.0	0	
Pulses per sec (Hz)	4	36	0.2	36	5.56E-03
Spot size (mm diam)	1	67	0.4	31	6.45E-03
Laser power (mJ/sec)	5600	95	0.6	28	7.14E-03
		124	0.8	29	6.90E-03
		155	1.0	31	6.45E-03
		185	1.2	30	6.67E-03
		213	1.4	28	7.14E-03
		243	1.6	30	6.67E-03
		273	1.8	30	6.67E-03
		302	2.0	29	6.90E-03
				Avg	6.65E-03