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ENGR 115
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Input Parameters	
Temperature (K)	296.35
Pressure (atm)	1
Gas Constant R	0.0821
Energy of H ₂ (kJ/mol)	237

Final Efficiencies	
Run 1	10%
Run 2	9%
Run 3	9%
Average	9%

Run 1 Data			
Time (seconds)	H ₂ Volume (L)	Voltage (V)	Current (A)
0	0	0	0
30	0.003	11.92	0.6
60	0.005	11.92	0.615
90	0.0075	11.92	0.629
120	0.0095	11.92	0.641
150	0.012	11.91	0.655
180	0.014	11.91	0.67
210	0.016	11.91	0.68
240	0.019	11.9	0.693
270	0.022	11.9	0.704
300	0.025	11.89	0.717

Run 2 Data			
Time (seconds)	H ₂ Volume (L)	Voltage (V)	Current (A)
0	0.025	0	0
30	0.027	11.9	0.683
60	0.029	11.9	0.698
90	0.032	11.9	0.714
120	0.035	11.88	0.722
150	0.037	11.88	0.734
180	0.04	11.88	0.745
210	0.0415	11.88	0.755
240	0.044	11.87	0.764
270	0.0465	11.87	0.774
300	0.05	11.86	0.783

Run 3 Data			
Time (seconds)	H ₂ Volume (L)	Voltage (V)	Current (A)
0	0.05	0	0
30	0.052	11.87	0.769
60	0.0545	11.87	0.779
90	0.0575	11.87	0.787
120	0.06	11.87	0.795
150	0.062	11.86	0.808
180	0.064	11.86	0.812
210	0.068	11.86	0.819
240	0.07	11.86	0.826
270	0.072	11.86	0.832
300	0.075	11.86	0.838

Run 1 Calculations				
Power (W)	Electrical Energy In (J)	mols H ₂ (mols)	Chemical Energy Out (kJ)	Efficiency (%)
0	0	0	0	0
7.152	214.56	0.000123303	0.029222779	13.6
7.3308	219.924	8.22019E-05	0.019481853	8.9
7.49768	224.9304	0.000102752	0.024352316	10.8
7.64072	229.2216	8.22019E-05	0.019481853	8.5
7.80105	234.0315	0.000102752	0.024352316	10.4
7.9797	239.391	8.22019E-05	0.019481853	8.1
8.0988	242.964	8.22019E-05	0.019481853	8.0
8.2467	247.401	0.000123303	0.029222779	11.8
8.3776	251.328	0.000123303	0.029222779	11.6
8.52513	255.7539	0.000123303	0.029222779	11.4
Average				10.3

Run 2 Calculations				
Power (W)	Electrical Energy In (J)	mols H ₂ (mols)	Chemical Energy Out (kJ)	Efficiency (%)
0	0	0	0	0
8.1277	243.831	8.22019E-05	0.019481853	8.0
8.3062	249.186	8.22019E-05	0.019481853	7.8
8.4966	254.898	0.000123303	0.029222779	11.5
8.57736	257.3208	0.000123303	0.029222779	11.4
8.71992	261.5976	8.22019E-05	0.019481853	7.4
8.8506	265.518	0.000123303	0.029222779	11.0
8.9694	269.082	6.16514E-05	0.014611389	5.4
9.06868	272.0604	0.000102752	0.024352316	9.0
9.18738	275.6214	0.000102752	0.024352316	8.8
9.28638	278.5914	0.000143853	0.034093242	12.2
Average				9.3

Run 3 Data				
Power (W)	Electrical Energy In (J)	mols H ₂ (mols)	Chemical Energy Out (kJ)	Efficiency (%)
0	0	0	0	0
9.12803	273.8409	8.22019E-05	0.019481853	7.1
9.24673	277.4019	0.000102752	0.024352316	8.8
9.34169	280.2507	0.000123303	0.029222779	10.4
9.43665	283.0995	0.000102752	0.024352316	8.6
9.58288	287.4864	8.22019E-05	0.019481853	6.8
9.63032	288.9096	8.22019E-05	0.019481853	6.7
9.71334	291.4002	0.000164404	0.038963705	13.4
9.79636	293.8908	8.22019E-05	0.019481853	6.6
9.86752	296.0256	8.22019E-05	0.019481853	6.6
9.93868	298.1604	0.000123303	0.029222779	9.8
Average				8.5

Input Parameters:	
Temperature (K)	296.35
Pressure (atm)	1
Gas Constant R	0.0821
Energy of H2 (kJ/mol)	237

Final Efficiencies:	
Run 1	41%
Run 2	45%
Run 3	55%
Average	47%

Run 1 Data			
Time (seconds)	H ₂ vol (L)	Voltage (V)	Current (A)
0	0	0	0
30	0.054	0.71	0.36
60	0.052	0.705	0.365
90	0.05	0.701	0.356
120	0.049	0.695	0.356
150	0.047	0.691	0.355
180	0.046	0.677	0.345
210	0.044	0.661	0.33
240	0.042	0.368	0.16
270	0.033	0.715	0.38
300	0.03	0.71	0.377
330	0.029	0.703	0.38

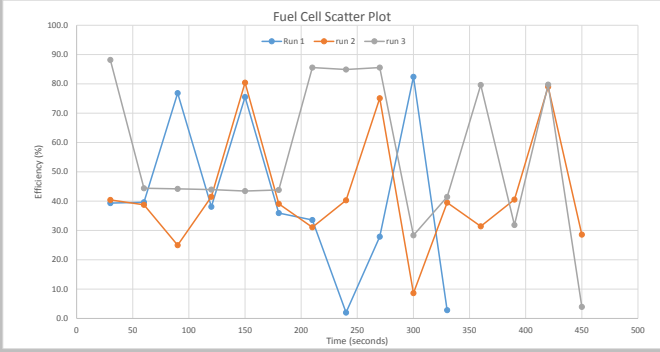
Run 2 Data			
Time (seconds)	H ₂ vol (L)	Voltage (V)	Current (A)
0	0.029	0	0
30	0.027	0.7	0.375
60	0.026	0.69	0.365
90	0.024	0.68	0.358
120	0.021	0.709	0.38
150	0.019	0.704	0.371
180	0.018	0.69	0.368
210	0.016	0.631	0.32
240	0.014	0.702	0.373
270	0.012	0.685	0.356
300	0.011	0.4	0.14
330	0.009	0.697	0.368
360	0.007	0.63	0.324
390	0.005	0.706	0.373
420	0.003	0.686	0.374
450	0.002	0.499	0.372

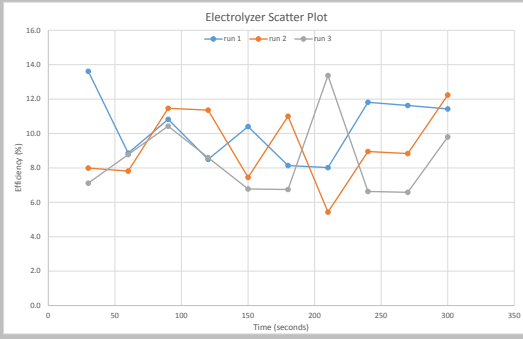
Run 3 Data			
Time (seconds)	H ₂ vol (L)	Voltage (V)	Current (A)
0	0	0	0
30	0.031	0.716	0.4
60	0.03	0.714	0.404
90	0.028	0.712	0.403
120	0.026	0.71	0.402
150	0.024	0.707	0.399
180	0.022	0.703	0.405
210	0.02	0.7	0.397
240	0.019	0.698	0.395
270	0.018	0.693	0.401
300	0.017	0.687	0.402
330	0.014	0.682	0.395
360	0.012	0.67	0.386
390	0.011	0.6	0.345
420	0.009	0.664	0.39
450	0.008	0.428	0.24

Run 1 Calculations				
Power (W)	Chemical Energy Input (kJ)	mols H ₂ (mols)	Electrical Energy Out (J)	Efficiency (%)
0	0	0	0	0
0.2556	0.019481853	8.22019E-05	7.668	39.4
0.257325	0.019481853	8.22019E-05	7.71975	39.6
0.249556	0.009740926	4.1101E-05	7.48668	76.9
0.24742	0.019481853	8.22019E-05	7.4226	38.1
0.245305	0.009740926	4.1101E-05	7.35915	75.5
0.233565	0.019481853	8.22019E-05	7.00695	36.0
0.21813	0.019481853	8.22019E-05	6.5439	33.6
0.05888	0.087668337	0.000369909	1.7664	2.0
0.2717	0.029222779	0.000123303	8.151	27.9
0.26767	0.009740926	4.1101E-05	8.0301	82.4
0.26714	0.282486863	0.001191928	8.0142	2.8
Average				41.3

Run 2 Calculations				
Power (W)	Chemical Energy Input (kJ)	mols H ₂ (mols)	Electrical Energy Out (J)	Efficiency (%)
0	0	0	0	0
0.2625	0.019481853	8.22019E-05	7.875	40.4
0.25185	0.019481853	8.22019E-05	7.5555	38.8
0.24344	0.029222779	0.000123303	7.3032	25.0
0.26942	0.019481853	8.22019E-05	8.0826	41.5
0.261184	0.009740926	4.1101E-05	7.83552	80.4
0.25392	0.019481853	8.22019E-05	7.6176	39.1
0.20192	0.019481853	8.22019E-05	6.0576	31.1
0.261846	0.019481853	8.22019E-05	7.85538	40.3
0.24386	0.009740926	4.1101E-05	7.3158	75.1
0.056	0.019481853	8.22019E-05	1.68	8.6
0.256496	0.019481853	8.22019E-05	7.69488	39.5
0.20412	0.019481853	8.22019E-05	6.1236	31.4
0.263338	0.019481853	8.22019E-05	7.90014	40.6
0.256564	0.009740926	4.1101E-05	7.69692	79.0
0.185628	0.019481853	8.22019E-05	5.56884	28.6
Average				42.6

Run 3 Calculations				
Power (W)	Chemical Energy Input (kJ)	mols H ₂ (mols)	Electrical Energy Out (J)	Efficiency (%)
0	0	0	0	0
0.2864	0.009740926	4.1101E-05	8.592	88.2
0.288456	0.019481853	8.22019E-05	8.65368	44.4
0.286936	0.019481853	8.22019E-05	8.60808	44.2
0.28542	0.019481853	8.22019E-05	8.5626	44.0
0.282093	0.019481853	8.22019E-05	8.46279	43.4
0.284715	0.019481853	8.22019E-05	8.54145	43.8
0.2779	0.009740926	4.1101E-05	8.337	85.6
0.27571	0.009740926	4.1101E-05	8.2713	84.9
0.277893	0.009740926	4.1101E-05	8.33679	85.6
0.276174	0.029222779	0.000123303	8.28522	28.4
0.26939	0.019481853	8.22019E-05	8.0817	41.5
0.25862	0.009740926	4.1101E-05	7.7586	79.6
0.207	0.019481853	8.22019E-05	6.21	31.9
0.25896	0.009740926	4.1101E-05	7.7688	79.8
0.10272	0.07792741	0.000328808	3.0816	4.0
Average				55.3





- 1) From the data collected, I was able to determine that the fuel cell's average efficiency was 47 percent, and the electrolyzer was only 9 percent efficient. My calculations concluded that the average efficiency of the entire system was only 2.8 percent.
- 2) The charge/ discharge efficiency of a 12V lead-acid battery is approximately 71 percent. The benefits of choosing a hydrogen fuel cell vehicle over a battery electric vehicle is that the energy comes from a renewable resource, and can reduce our dependency on non renewable sources. Also the amount of hazardous waste from lead-acid batteries
- 3) I would improve the electrolyzer because its average efficiency was significantly less than the the fuel cell.
- 4) To measure the efficiency of the fan motor, we could attempt to measure both the revolutions per minute, as well as the amount of heat lost by the motor.
- 5)When scaling this up to an industrial pevel, I would expect to see a significant increase in the efficiency of producing hydrogen gas and an increase in energy output by the fuel cell.