

Faraday's First Law of Electrolysis:

$$V = \frac{R \cdot I \cdot T \cdot t}{F \cdot p \cdot z}$$

where V = volume of the gas [L], R = ideal gas constant = $0.0820577 \text{ L} \cdot \text{atm}/(\text{mol} \cdot \text{K})$, I = 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 H_2 , 4 for O_2).

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

$$T = 0 \text{ }^\circ\text{C} = 273.15 \text{ K}$$

$$p = 1 \text{ atm}$$

$$t = 3600 \text{ s}$$

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

Total oxyhydrogen volume is hydrogen volume + oxygen volume:

$$V_{\text{H}_2} + V_{\text{O}_2} = \frac{0.0820577 \cdot 1 \cdot 273.15 \cdot 3600}{96485.13 \cdot 1 \cdot 2} + \frac{0.0820577 \cdot 1 \cdot 273.15 \cdot 3600}{96485.13 \cdot 1 \cdot 4} = 0.418151 \text{ L} + 0.209075 \text{ L} = 0.627226 \text{ L}$$

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 $0.627 \text{ l/Ah} \cdot 11 \text{ A} \cdot 7 = \sim 48.3$ Liters per hour at STP conditions.

Note, however, that this applies only at a certain temperature (0C) 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 0C (273.15K) the production rate is 0.627 l/Ah, then at 25C (273.15K+25K=298.15K) the production rate is $298.15/273.15 = \sim 109\%$ 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 40C while it's being measured and the ambient pressure is 0.75 atm (about 1.5km elevation above sea level), the electrolyzer that produces 48.3 liters per hour at STP will produce $313.15\text{K}/273.15\text{K} \cdot 1\text{ATM}/0.75\text{ATM} \cdot 48.3\text{LPH} = 73.8\text{LPH}$.

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 the calculations.