Hydrogen Sulfide Detection in Natural Gas

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The world is at a constant struggle to find clean energy solutions. Numerous different methods of creating clean energy are being explored worldwide. One of these methods uses a device called a fuel cell. A fuel cell extracts energy from natural gas. Normally to get energy out of natural gas, it must be burned. This chemical reaction causes a mechanical action, usually in the form of a spinning object attached to a piston. It is from the mechanical action that the energy is extracted. This method of obtaining energy works, but is not as efficient as it could be due to the mechanical action. A fuel cell extracts the energy directly from the natural gas, making it a much more efficient way to obtain energy. The problem arises with sulfur. Due to the elements contained within the fuel cell, for example platinum, if sulfur gets into the fuel cell it will destroy the components. Since this technology is fairly advanced these fuel cells are expensive (~$100,000), so assuring they do not break is essential. To help with the trace amounts of sulfur found within the natural gas as well as the added mercaptan (for smell) a desulfurization process called the Claus process is used. Essentially the Claus process takes hydrogen sulfide and breaks it into elemental sulfur, which then attaches itself to a catalyst. Naturally this catalyst will become saturated over time and will stop filtering out the sulfur. Due to this, a method of detecting hydrogen sulfide is essential for this process to avoid destroying the fuel cell once the filter stops working. The research performed for this project started with constructing a safe chamber for mixing different concentrations of hydrogen sulfide. Hydrogen sulfide is a highly toxic chemical, so assuring that each seal was hermetic was essential. In this chamber various concentrations of hydrogen sulfide were detected and the output voltages were recorded to find a calibration curve. This curve allows for a code to convert the voltage into concentration in real time. By using an electrochemical sensor from SGX Sensortech along with an attached t-joint, the hydrogen sulfide can safely pass through the sensor and up into a fume hood. The various concentrations were achieved by using a flow controller and air. A constant flow regulator was attached to the calibration bottle of hydrogen sulfide where the air for mixing was varied to achieve the desired concentration. Using a variable power supply and a digital multimeter, the desired air flow rate was achieved. Each concentration resulted in a different output voltage, then a curve was applied to extract concentration from voltage. The concentrations tested were from 0 ppm – 100 ppm, which was the full range of the sensor used. 0 ppm is a bit of an oversight, realistically the lower range is around 500 ppb. The concentration becomes dangerous for fuel cells around 5 ppm, during this experiment data was taken for this concentration. The next step in this project is to attach an LCD screen to the circuit where the sensor is attached, so a user can visually see the concentration. Below is a chart with the actual data collected along with the fitted curve, all calculations were done using Mathematica. The x-axis refers to concentration (0-100), the y-axis refers to output voltage (2.5V - ~2.9V).