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Temperature Programmed Desorption (TPD) Design Overhaul

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Background

Hydrogen is a cheap and environment friendly energy source and finding reliable hydrogen storage strategies will foster progress towards clean energy. Dr. Schubert and his team currently use a TPD device to assess hydrogen storage methods. However, the device is imprecise and needs to be updated.

The goal of this project was to enhance the way the lab collected and processed the data from their TPD device. The fragility of the system and the need for the device to be in operation throughout the duration of this project pushed us towards focusing on the processing of gathered data. Data processing is done by hand and by separate applications. Our goal is to automate processing through one application.

Requirements

- Automate the processing of the data
- Properly document the entire system from schematic to user manuals
- Guarantee accurate readings
- Guarantee integrity and security of the collected data

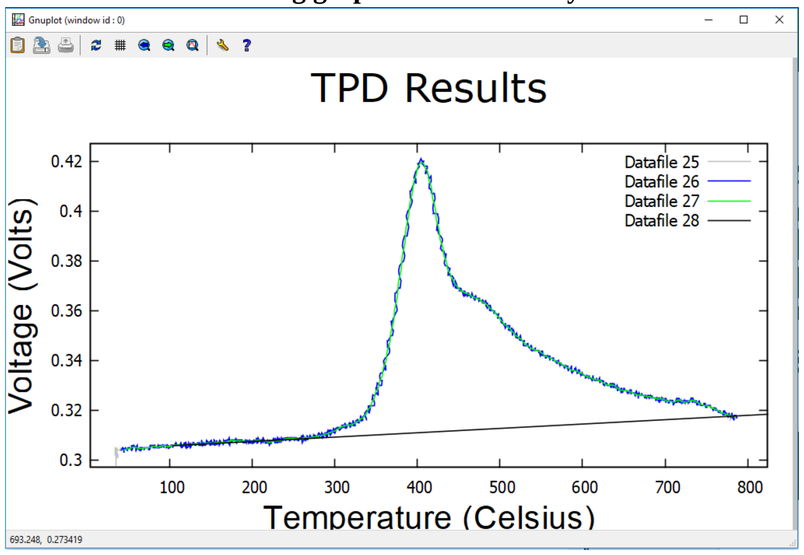
Results

- Integrity of the data was ensured through the use of parsing techniques that do not alter the original source.

Results(cont.)

- The processing of the data was fully automated through an external software application. The application takes in the raw data file and generates a graph. The program then uses a numerical integration technique chosen by the user.

Resulting graph from data analysis



Numerical Integration methods

Trapezoidal rule

- $\int_a^b f(x)\,dx \approx \sum_{k=1}^{N} \frac{f(x_k-1)+f(x_k)}{2} \Delta x_k$

Simpson's Rule

- $\int_a^b f(x)\,dx = \frac{\Delta x}{3}[f(a) + 4f(x_1) + 2f(x_2) + 4f(x_3) + \cdots + 2f(x_{2m-2}) + 4f(x_{m-1}) + f(b)]$

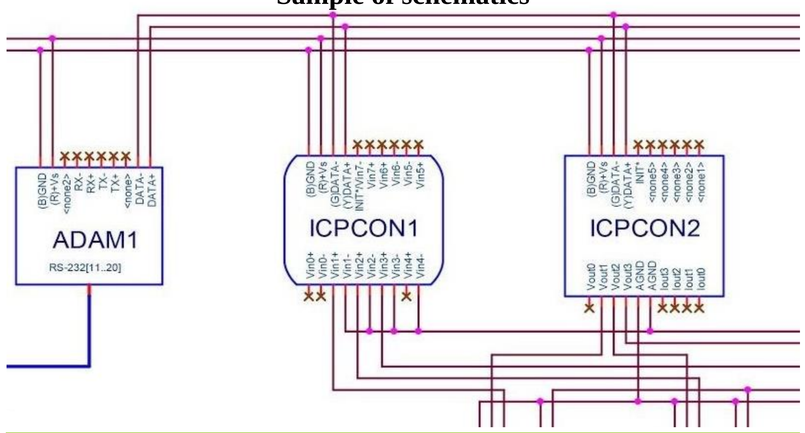
Durand's Rule

- $\int_{x_1}^{x_n} f(x)\,dx = h(\frac{2}{5}f_1 + \frac{11}{10}f_2 + f_3 + \cdots + f_{n-2} + \frac{11}{10}f_{n-1} + \frac{2}{5}f_n$

Results(cont.)

- Schematics have been created in order to document the system.

Sample of schematics



Conclusion

Due to the fragility of the system and the need for it to remain in operation during this project, we were unable to improve the collection mechanism itself. Instead, we built a software application to help Dr. Schubert and his team to more efficiently analyze the data that the current device produces.

Suggestions for Future Work

Designing and constructing a new TPD in order to address the low precision and low accuracy of the data collection. Improving accuracy would require new parts with a higher resolution than the that of the current TPD.