End of Summer Report

My name is Ella Hardwick and my FURSCA project this summer was exploring the removal of the oxyanion, bromate, from water through catalytic reduction reactions. Primarily this research focused on looking at using pallidum embedded carbon nanoparticles made in Dr. Metz's lab as the catalyst. In order for the reduction reaction to occur, the water sample containing a known amount of bromate and a catalyst is placed under hydrogen gas conditions. Due to previous work done in Dr. Metz's lab it is known that pallidum embedded nanoparticles can reduce bromate to bromide within 24 hours. The reduction pathway of bromate to bromide is shown below in Figure 1. This is useful because bromate is a known carcinogen that is a contaminant in drinking water. Its reduced form, bromide, is safe for human consumption. My project focused on determining the exact amount of time it takes for the reaction to complete and if the catalysts are able to be reused.

I was lucky enough to get to take a trip to Trinity University in Dublin Ireland. During my time there, advantaged physical characterizations of the palladium embedded microspheres were done. These tests were largely measuring its electrode potential. The electrochemistry of the palladium embedded was the primary focus of the other research student in Dr. Metz lab. In addition to the electrochemical tests run, information was shared on how to create a setup where the amount of hydrogen gas entering into a system can be measured. This information will be very useful for my further studies regarding this project.

$$BrO_3^- \rightarrow BrO_2^- \rightarrow BrO^- \rightarrow Br^-$$

Figure 1

The primary focus of this summer research was testing the exact amount of time it takes for a 100% conversion of bromate to bromide. Tests were run originally using hydrogen gas filled balloons as the method of keeping the sample under the proper conditions. See Figure 2 for typical set up. These original experiments gave mixed results and unpromising results. See Table 1 for results of the experiments using hydrogen filled balloons. A more controlled way of keeping the samples under hydrogen gas conditions was then created.

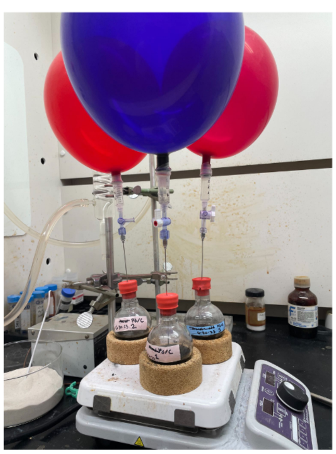
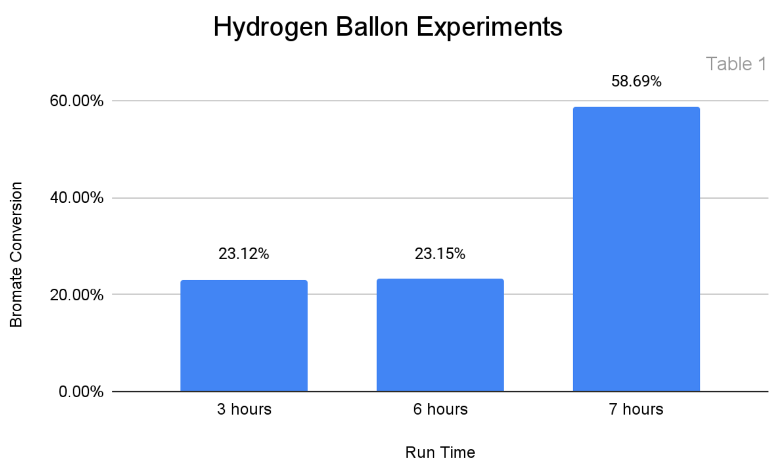
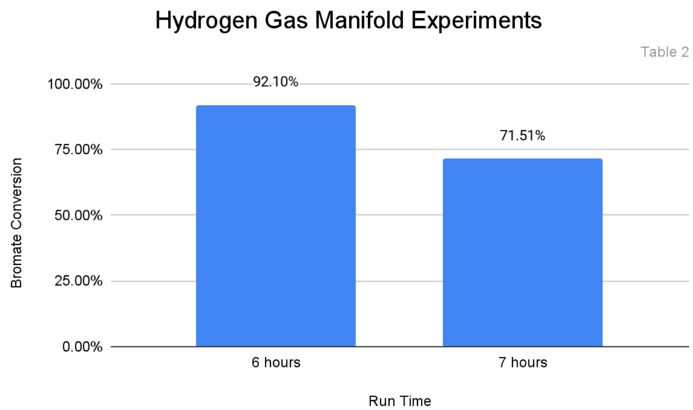


Figure 2

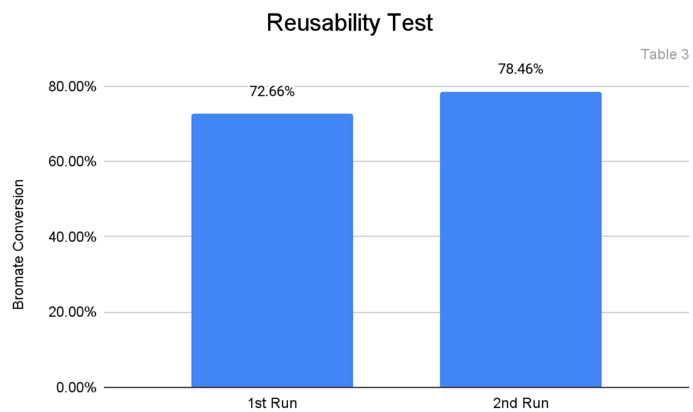


A manifold was set up next. This allowed for a much more controlled flow of hydrogen gas. These experiments resulted in better and more promising results. Due to the poor results of the 3 hour experiments using the hydrogen balloons, it was decided to only look at longer run times. The manifold setup can be seen in Figure 3. The results of the experiments can be seen in Table 2.

Figure 3



Only one test was run looking at the reusability of the catalyst. But the results were promising. The large issue with testing reusability was the ability to save the catalyst of the previous reaction. To resolve this issue the process of micropipetting the solution through a filter to get a majority of the catalyst out was used. In the future, smaller centrifuge vials will be used to separate the catalyst from the solution. See Table 3 for the reusability results.



The large differences in conversion rates between 6 and 7 hours in the manifold experiments could be due to a variety of factors independent of time, some of which are outside of my control. The amount of hydrogen gas used in each experiment is currently hard to control for. However, at Trinity I learned how to create a set up where I can measure the exact amount of hydrogen gas entering the system. I plan on applying for additional funding in the fall to purchase the equipment required for this setup. I then plan on finding the standard amount of hydrogen gas needed for the reaction to reach full completion. Then re-run the timed experiments using this amount. I also plan on running additional experiments testing the reusability of the catalyst.

FURSCA has been an incredible experience. I have learned so much about this area of chemistry and am extremely excited to continue research. Due to FURSCA I was able to collect data and advance my informational understanding regarding my project. This project will be the primary focus of my honors thesis. This experience has given me further insight into the research process. I am currently interested in pursuing chemistry graduate school and this experience has made me more confident in that pursuit. The trip to Trinity University opened my eyes to the nature of graduate school and how exciting that experience can be. There were many graduate students working in the lab at Trinity. It was inspiring to hear them speak with such passion about chemistry. I am so lucky to have been able to learn so much from them.

I would like to thank my advisor Dr. Kevin Metz for his continued support throughout this process. He has aided me in the daunting world of chemistry and has made what once seemed unachievable to myself, achievable. I would also like to thank Renee Kreger and Elizabeth Palmer for all their work on FURSCA. They truly put students' best interests at the forefront of all their work. Their endless hardwork and support is truly appreciated by myself and fellow students. Additionally I would like to thank Dr. Colavita and the Chemistry Department at Trinity University for allowing me into their lab. It was a fantastic cultural exchange where I learned so much about chemistry and its differences and similarities in another country. Finally, I would like to thank Anna and Carl Weiskittel Endowed Chemistry Fellowship and the Turner Scholarship for Experiential Learning funding this project and making my trip to Trinity University possible. This has been an incredible experience. I will never forget my time at Trinity and will never stop being inspired by those I met and what I saw there.