2022-2023 Green Labs Incentive Report

Blakey Lab Goes Green: Green Reaction Development with Photochemistry

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Awarded: $4981.68; **Spent:** $4981.68

Description for Communication:

This project aimed to replace the use of an energy-wasteful photoreactor with a more energy-efficient photoreactor (the Penn Photoreactor). In doing this, we reduced the total energy consumption of the lab, increased the safety of the reaction setup process, and expedited advancements in the field of green chemistry.

Objective:

The object of this project was to reduce the total energy consumption of the lab and increase the ability of our lab to develop photocatalytic methods for organic synthesis, a much greener alternative to the transition metal catalysis our lab has historically been involved in. This was achieved through the purchase of the aforementioned photoreactor.

Results and Lessons Learned:

Key Findings:

The data described below support our hypothesis that moving to the Penn photoreactor from our old photoreactor would save significant energy, especially over an extended period of time. An unexpected but exciting finding of this project was the increase in safety when moving from the prior photoreactor to the Penn Photoreactor. Previously, researchers were exposed to a large amount of blue light, which causes damage to sight upon exposure. With the Penn photoreactor, the blue light is nearly entirely contained, with automatic safety protocols set in place to minimize the hazards of exposure.

Additionally, our group has been able to expedite the advancement of our photochemical reaction development. Since receiving the grant, we have published one photochemical methodology paper (Cecilia M. Hendy, Cameron J. Pratt, Nathan T. Jui, and Simon B. Blakey *Org. Lett.* **2023**, *25*, 9, 1397–1402. DOI: 10.1021/acs.orglett.3c00126) and have three photochemistry manuscripts in preparation.

Method:

Utilizing the Kill-a-Watt purchase in a previous Green Labs Incentive grant, we measured the difference between our original photoreactor and the new Penn photoreactor.

Results:

The results indicated that the Penn photoreactor was more efficient than our old photoreactor. Taking readings over 4 hours, we observed that the Penn photoreactor used 0.09 kwh, compared to the

old photoreactor's usage of 1.09 kWh, an over tenfold decrease. Typically, the reactions we run in these reactors run for 16 hours. Oftentimes, the reaction ends during a time when researchers are not there to unplug it. When looking at the out-of-use energy usage, we observed that it only used 0.03 kWh over 16 hours. The previous photoreactor does not have this manual-off function. Over the course of a year, we are now likely avoiding the use of 2,236 kWh, the equivalent of 1.6 metric tons of carbon dioxide.

Table 1. Kill-a-Watt data over the course of 4 hours.

Time (h)	Old Photoreactor (kWh)	Penn Photoreactor (kWh)
4	1.09	0.09
16 (out-of-use)	N/A	0.03

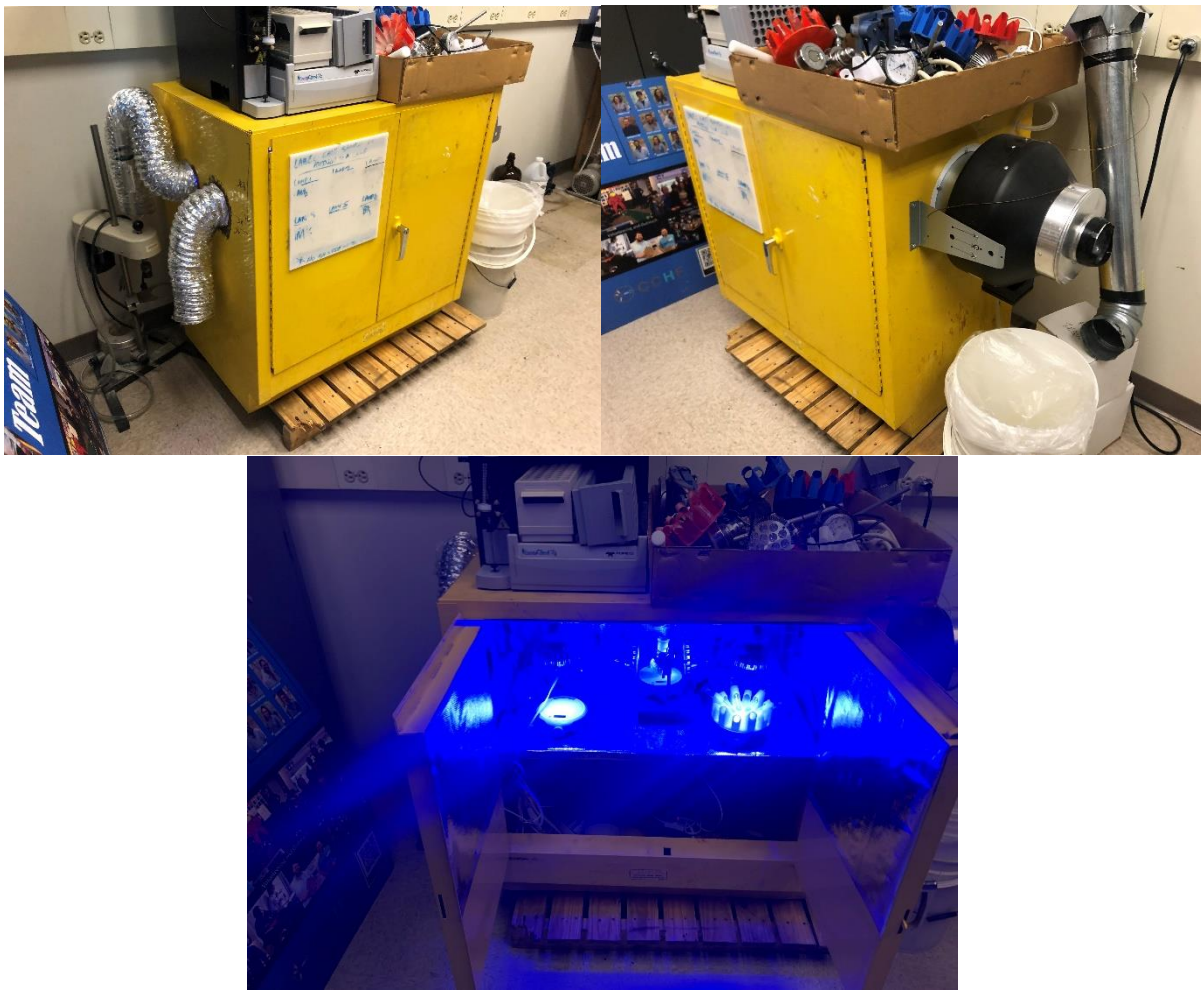

Figure 1. Old photoreactor setup, containing large fan, multiple high-energy lights, and several stir plates. Bottom figure shows the blue light exposure when setting up reactions.

Figure 2. New photoreactor with integrated fan, LED light, and stirring functionalities. Top left: photoreactor in resting state (can be turned on and off with a switch on the side). Top right: inside of photoreactor contains reflective material and a cover to ensure reflection of blue light and minimization of blue light pollution. Bottom: photoreactor in use; shows minimal blue light exposure for reaction setup.