Laidlaw Scholars Program 2021: Research Proposal

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Since the United Nations Framework Convention on Climate Change, it has been critically important to evaluate effective technologies for carbon dioxide capture and storage (CCS), and assess the factors limiting their application on the basis of coordinated, international action. The need for such technologies grows as the alleged "tipping point" for Earth's climate approaches. As such, my research aims to develop and test a novel technique for carbon capture, centered upon both reusability and effectiveness.

Over the six weeks of the program, my goal will be to explore carbon capture through the role of the CO_2 scrubber, a currently popular means in industry for capturing carbon dioxide. In my research, I intend to use monoethanolamine (MEA) as my target scrubber, and in doing so, anchor the natural scrubbing action of this compound to a gel-like structure, through a technique known as gel-spherification.

The variant of gel-spherification I intend to implement is centered around a compound called alginate, a biopolymer naturally generated within the cell walls of algae. Pipetting drops of a source of calcium ions (Ca^{2+}) within a soluble solution of alginate spontaneously generates solid, bead-like gels. Mixing a solution of alginate with MEA would then allow for the attaching of the scrubber onto the gel beads, which may show promise in terms of regeneration and reuse of the scrubbers within.

My experiment will be divided into three main phases. In the first phase, I will determine the effect of aquatic temperature on scrubbing ability. I will measure scrubbing action using data loggers to measure changing concentrations in carbonic solutions (dissolved dry ice, a proxy for water). As temperature is my initial independent variable, I intend to test scrubbing ability in temperatures corresponding to the temperatures of most aquatic bodies on Earth, from 0˚C to 24˚C. Having determined the optimal temperature, the second phase will hold that ideal temperature constant, determining the effect of varying MEA concentrations on scrubbing ability. Finally, the third phase will be a physical "stress-test" of the beads, examining factors such as gel permeability, changes in durability in acidic environments (such as those brought about by acid rain), and physical malleability of the beads themselves.

Ultimately, the value of this project hinges upon the scrubbing complex's ability to perform well both under chemical tests (phases 1 and 2) and physical tests (phase 3). However, beyond its effectiveness, the prospect of application of this method requires that it is cost-effective, an area I aim to take under consideration over the 6 weeks of the project.

In order to address anthropogenic global warming, all active parties must approach the issue on a unified, international front. I hope to develop a scrubbing complex in which production can be both accessible and affordable for both developing and developed countries, as this is one of the most crucial factors necessary for application of any technology.