Thesis Project Portfolio

Scale-Up Design for Biodegradable Vanillin-Based Polymer Production

(Technical Report)

Altering Consumer Behavior: Business Strategies for Adoption of Renewable Plastics

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

Christopher Hall Brodie

Spring, 2020

Department of Chemical Engineering

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Sociotechnical Synthesis

Establishing the Groundwork for a Societal Transition to Sustainable Plastic Use

The amount of plastic contained in landfills is projected to double by 2050.These plastics can take up to 1000 years to decompose, leading to an accumulation of material that will not disappear. My STS and technical projects develop the groundwork necessary for a society to transition into using sustainable plastics. My technical project yields a detailed design and economic analysis for a production process for sustainable poly(dihydroferulic acid) (PHFA), a plastic which could functionally replace PET. This shows that this production process is likely to be profitable but requires more development. My STS research addressed the discrepancy between availability and adoption of sustainable materials, focusing on consumer behavioral changes and how they can be altered from changes in business practices.

My technical work culminated in an entire production process to convert vanillin, which could be sustainably sourced, into PHFA, a biodegradable mimic to PET. While our project is detailed enough that someone could follow our design and specifications and build the plant in its entirety, there are some flaws with our analysis. The reactions are not well understood, and kinetic data is not available for them. Our intermediate molecules in this process are also not present in chemical databanks and so their thermodynamic data is not available. We had to use similar reactions that had available kinetic data and Aspen Plus software to estimate thermodynamic parameters. While our economic analyses show that this process is profitable, much more development, such as lab work and construction of a pilot plant, is necessary before moving forward with this project. With development and further design, our process is capable of making a sustainable polymer readily available for consumer use.

Availability of renewable alternatives for traditional plastic products does not complete the picture and lead to a sustainable transition in society. My STS research studied how business can change their practices in order to develop sustainable behavior in their consumers. This found that consumers respond and behave differently when faces with taxes and fees than they do rewards or benefits, which completely counteracts how consumers might want to be treated. Rewards for sustainable behavior are ineffective in short or long-term behavioral change, while taxes on unsustainable behavior, like fees for using single use plastic bags, have an immediate effect on how consumers act. Businesses that understand this can implement policy changes to push their consumers to consider sustainable alternatives and ultimately choose them for an economic benefit. This work is aimed at businesses that want to contribute to a sustainable transition in society, creating a framework that they can follow or adapt in order to bring out sustainable behavior in their consumers.

My technical and STS research projects bring both the supply and availability of a renewable and biodegradable plastic, as well as guidance for businesses to push consumers to adopt and use this renewable alternative. With both availability and demand, these works culminate in creating a foundation for a sustainable transition towards adoption of renewable plastics can occur. As society establishes itself upon this foundation, an ethical understanding of their previous behavior may settle in, driving communities to continue down the path of sustainability.