Thesis Project Portfolio

BIOSOURCED POLYMERS: PROCESS DESIGN FOR THE LARGE-SCALE PRODUCTION OF POLY-4-HYDROXYBUTYRATE

(Technical Report)

THERMODYNAMIC PERSPECTIVE ON THE ADVANTAGES OF A CIRCULAR PLASTIC WASTE ECONOMY

(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

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Table of Contents

Sociotechnical Synthesis

The motivation for both the technical and STS portions of my thesis portfolio stemmed from the same motivations that attracted me to the discipline of chemical engineering. I am driven by benefiting people and serving the public to my highest capability in hopes of a brighter future. I chose chemical engineering because the broad and diverse skill set it offers appealed to me as the best option to maximize my service. My work ethic and virtues are a testament to this dedication, and I consider this thesis to be the beginning of my career as an engineer that may make a positive impact on the beautiful planet we inhabit.

The technical portion of my thesis attempts to provide an economically feasible design for a large-scale poly-4-hydroxybutyrate (P4HB) production process. P4HB is a biopolymer produced naturally by several bacterial strains, is capable of being produced by other bacteria through advances in biotechnology, and has promising potential to replace the use of plastics made from petroleum. Since P4HB is a biologically inherent, it is far safer for humans and the environment. Moreover, P4HB has a much faster degradation time and may significantly reduce the rate of plastic pollution. This design draws from existing research of using *Escherichia coli* and genetic engineering to produce P4HB at an optimal rate and purity that meets FDA standards for medical applications such as sutures, implants, and scaffolding.

In my STS research I have reviewed and extracted meaning from a plethora of publications that describe the ideal plastic waste economy. This literature predominantly considers the lifecycle of plastics, and the consequences of different courses of action to diminish society's dependence on plastics. Although the existing publications on the ideal plastic waste economy establish the benefits of such an economy, we are still a long way from having one. For this reason, I have taken a creative approach to my STS research paper that draws on the power of analogies to provide a novel and accurate perspective on the severity of our current waste economy. Throughout my education in chemical engineering, one of the most profound concepts I have gained is the power of abstraction and comparison. The importance of revamping the public's understanding towards plastic use and plastic pollution is paramount for a sustainable future.

My STS research connects highly complex principles I have learned in chemical engineering to waste management reform in a way that is relatable and easily digestible. Considering that the further adoption of bioplastics is a promising solution to achieve a more sustainable plastic waste economy, the STS paper is meant to advocate the pursuit of production processes similar to the one proposed by my technical portion. The results of the technical portion of this portfolio are meant to yield proof of concept for a novel design process that would aid in the progress towards an ideal plastic waste economy.

I would like to acknowledge professors George Prpich, Joshua Choi, and Kathryn Neeley for all of the crucial understandings I have gained in their courses that shaped my thesis portfolio. I dedicate my determination to receive an education and pursuit of a brighter future to my deceased twin sister Ruth Amelia Bledsoe.