Thesis Project Portfolio

Optimization of Carbon-Neutral Production of Methanol Via Direct Air Carbon Capture

(Technical Report)

Is Easing the Labels on Products Ethical if it Helps Sell Waste-Originated Products for the Purpose of Preserving the Planet's Resources

(STS Research Paper)

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Executive Summary

Climate change poses a major threat to today's world. Dwindling resources and high quantities of greenhouse gases plague the planet, and humanity must look to take more steps to combat the ever-growing problem. In this report, I delve into a technical project revolving around carbon capture and conversion, taking carbon dioxide (CO_2) out of the atmosphere and converting it into a useable product, as well as the ethical sides of labeling products made from recycled waste sources. In order for good engineering practice, I not only must have knowledge on the technical aspects of designing a plant and its procedures, but also understand the ethics in how the products can be relayed to the public and the ethics behind how far we can go to achieve sustainability without overstepping.

In the capstone project, the Carbon Capture and Conversion group decided to design a process that would capture waste CO_2 from the atmosphere and synthesize methanol from it. On the front end, the process utilized direct air capture to take in the CO_2, followed by a process to purify the CO_2 before sending it downstream. The downstream portion utilized a reverse water-gas shift reaction followed by hydrogenation to synthesize methanol, before running the stream through a distillation column to purify the final methanol product. Carbon capture is still a relatively new procedure, and the majority of this project will be a continuation of the 2022 Carbon Capture and Conversion capstone group, as well as based on research from Carbon Engineering, a leader in the carbon capture field. The goal of the process is to capture 0.98 Mt of CO_2 and convert this captured CO_2 into methanol at 99% purity and a quantity of 0.62 Mt/year. The system is designed around a production schedule of 6000 hours per year, and is shown to need work in order to become economically viable.

In my STS research paper, I focus on the ethics behind the labeling of products, and if removing origin labels from products that originate from a waste source could be deemed ethical if it helps conserve the planets resources. The main case study utilized for this research is on potable reuse, or the process of taking wastewater and through an intense chemical process, purifying it to a level that would be safe to drink. This paper will then use the framework of social construction of technology (SCOT) paired with philosophical frameworks to analyze whether removing the label would be an ethical route to pursue. I use these frameworks to determine that while there would be some environmental benefits to removing the labels, the harm that could come from this action poses too great of a threat, and a focus on combating the stigma revolving around waste-based resources would be a better route to

pursue. While the economic benefits may seem to have no downside, the removal of some labels could enable larger companies to try and take advantage of the situation, and pose a threat to consumers.

By focusing on both the technical aspects of carbon capture and the social perceptions of labeling products, I have a better understanding of the steps that can be taken to help combat climate change and preserve the planet's resources. Both the technical and social networks are equally important to sustainability. There would be a lack of engineering designs focused on reducing greenhouse gases without technical knowledge, and the designs and usages may be unethical without considering the social and ethical implications of such designs. As I continue into the work force, I believe that the knowledge gained from both the technical project and the STS research project will serve immense use in my endeavors to have resourceful and ethical solutions to any problems I may encounter.

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