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Economic Feasibility of Mixed Plastic Waste Pyrolysis Using Twin Reactor System in Northwest Arkansas

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For my thesis and senior design project, I was able to compete with a team of University of Arkansas students in New Mexico State's WERC Environmental Design Contest. This contest calls for students to design chemical engineering processes that can positively impact the environment. Our report, included as an appendix to this paper, is titled "Economic Feasibility of Mixed Plastic Waste Pyrolysis Using Twin Reactor System in Northwest Arkansas." We researched the economic feasibility of the implementation of a commercial pyrolysis unit in Northwest Arkansas to turn mixed plastic waste into a crude oil, sold as fuel. We were also able to perform experimental work through a bench scale pyrolysis experiment in the lab. As a team, we were able to defend our report to a panel of judges experienced in chemical engineering, sustainability, and business startups. Our team had the honor of receiving the 1st place award for our category, the Freeport McMoran Award for Innovation and Sustainability, and the 3rd place award for our business-style flash talk presentation. In this paper, I wish to explain my contributions to the team throughout this process.

The initial phase of our project consisted of research, data collection, and schedule planning. My research was focused on pyrolysis and the equipment necessary to carry out this process. I utilized published reports on both previous and ongoing pyrolysis procedures in order to gather information to present to the team. I summarized these reports and any information that was pertinent to our process, and I was able to present this research in our weekly meetings. As our team moved out of research and into the process design phase of our project, my focus shifted to designing the "front end" of a commercial pyrolysis process. This includes all collection and plastics preparation steps that must take place before the plastic feed can enter the pyrolysis reactor system. First, I helped to design a collection and sorting procedure to get mixed plastic waste from households in Northwest Arkansas to the pyrolysis unit. This procedure included the utilization of an existing Materials Recovery Facility to sort plastics and send eligible waste to the pyrolysis unit. Next, I researched equipment sizing for units such as plastic granulators and shredders based on our expected plastic feed, and I found pricing data for this equipment by contacting vendors. This pricing data was used in a 10 year economic analysis for the commercial pyrolysis process we designed, in order to discuss economic feasibility. I was able to assist in designing a Process Flow Diagram (PFD) to summarize the front end of this commercial design process.

In order to verify data that we researched and provide a proof of concept for mixed plastic pyrolysis, our team created a bench scale pyrolysis process to turn plastic waste into a sweet crude oil. To assist in this process, I attended meetings in the lab in order to prepare the plastic feed and run pyrolysis experiments. I crushed plastics to be fed into the reactor, assisted in setting up the reactor and condensing system, managed voltage increases used to heat up the reactor, and assisted with cleanup. During the WERC competition, I presented on the community relations plan and conclusion of our poster and bench scale presentation to a panel of judges. Alongside my team, I fielded questions about our project and our bench scale experiments.

During the WERC competition, I was chosen to represent our team in the Flash Talk event. This segment of the competition consisted of a business style pitch to a panel of judges with experience in business startups and project management. I prepared a PowerPoint that summarized our project and the business aspects of its implementation, and I was able to present this pitch to the judges. Prior to the competition, I ran through this presentation with my team in order to practice and get valuable feedback from my peers. Following my Flash Talk presentation, I fielded questions from the judges about any praises or concerns that they had for

our project. As previously mentioned, I helped our team to receive a 3rd place award in this category.

This project was a valuable experience that taught me about the impact that can be made when students work together towards a common goal. The implementation of our project would help to decrease plastic waste pollution in our environment, and it is my hope that people will be able to build on the foundations of our report in the future. While Covid-19 introduced new challenges through the necessity of virtual meetings and safety protocols, our team was determined to overcome adversity. I am truly thankful for the dedication shown by our team and the continuous guidance and support given by our mentors.