SWITCHGRASS TO FUELS

Amanda Drabek and Kang-Lih Chey

The United States has been striving to develop alternate sources of energy to standard petroleum fuels. The motive for this is both the need for independence from foreign oil markets and an increasing interest in earth-friendly and renewable resources. To pursue this goal, the U.S. began a Biomass Research and Development Initiative to develop bioenergy and biobased products. Also, the federal government has issued an energy bill that sets requirements that increase annually for the percentage of fuel that must come from renewable resources.

The purpose of this Capstone project is to develop a pyrolysis process for producing bio-oil and to determine if there is an economically feasible method of upgrading the bio-oil to fuel suitable for automobiles. Three options will be considered: 1) selling the bio-oil to generate electricity without upgrading, 2) upgrading the bio-oil through hydrotreating, 3) upgrading the bio-oil using a zeolite catalyst. A simulation of a pilot plant was created using excel spreadsheets, using a basis of 100 tons of switchgrass feed per hour. It was assumed that the biofuels process would run in connection with a petroleum refinery to save on transportation and separation costs. For the third option, four additional scenarios were considered, changing factors from the original scenario. The factors considered were 1) the amount of catalyst used, 2) the number of regeneration cycles for the catalyst, 3) the selectivity of the catalyst for the product oil, and 4) running the biofuels process as a separate plant, unconnected to a refinery. The purpose of considering these alternate scenarios was to determine which factors had significant impact on the economic feasibility of the catalytic deoxygenation option. It was found that increasing catalyst selectivity or decreasing the amount of catalyst used had the most impact on the profitability of the plant.

The conclusion of this project is that option 1 gives us the highest ROI of 10%. However, the goal of our project is not met with the first option. Option 2 produced liquid fuel that can be suitable for automotive engines but the plant is running on a negative net profit. Even after optimizing the option, the ROI of the second option was only about 5%. Option 3 gives us a negative net profit as well, but by looking at different scenarios, a positive net profit can be achieved. Furthermore, by optimizing the third option, a reasonable ROI of 8% is achieved as well. Renewable energy sources are assuming an important role in the energy industry due to government mandates, public interest, and environmental policy. It is important that these alternative energy sources are environmentally friendly, but they must also be profitable or they will not be pursued by business interests. Though there is more work that needs to be done before bio-oil can be economically upgraded into automobile fuel, progress is being made. We feel that this project presents a good overview of the design of a biofuels plant based on the pyrolysis method and the potential economic means of upgrading the bio-oil.