Abstract
Life Cycle Assessment (LCA) examines the inputs and outputs of a product and the effects they have on the environment. Using the Argonne National Lab GREET® LCA software (Greenhouse gases, Regulated Emissions, and Energy use in Transportation), outputs for E10 reformulated gasoline and pyrolysis oil gasoline were calculated and compared. The inputs to the LCA are known as the Life Cycle Inventory (LCI). This research details the main steps and analysis involved in producing the LCI used by programs such as GREET to give the final overall LCA of the two gasoline types. Switchgrass was pyrolyzed using the HP-HT Pressure Reactor provided by the Parr® Instrument Company. The products were then analyzed for use as LCI inputs.

Introduction
Switchgrass has been used in numerous bioenergy conversions processes. Switchgrass is capable of undergoing pyrolysis, which is thermal decomposition sans oxygen. From this procedure, syngas, bio-oil, and biochar are generated and analyzed. These analysis are the origins for the information in the LCA model GREET. The data received from the analysis's provide models such as GREET with information needed to conduct an LCA. For this research endeavor, switchgrass was pyrolyzed and its syngas and bio-oil were analyzed using Gas Chromatography and Mass Spectrometry respectively.

Mass Spectrometry
The liquid product of pyrolysis provides the basis for what will eventually become biofuel used in transportation and other energy activities in lieu of fossil fuels. The bio oil obtained is analyzed using a mass spectrometer. This machine ultimately identifies all of the components of the liquid product. Below is a graph showing the contents of bio oil that was pyrolyzed switchgrass.

Biochar Analysis
After pyrolysis of biomass has occurred, a solid known as biochar is generated. The content of what would be produced from switchgrass via pyrolysis is 20% biochar and 80% ash. The ash accounts for the elements listed in the graph below (Brewer et al).

Gas Chromatography
The syngas obtained from the reaction underwent gas chromatography. It is a common type of chromatography used for identifying compounds in gaseous samples. Nitrogen is the most present in the sample

Bio Oil Analysis
The bar graph shows that Furfural is the most present in the bio oil. Furfural is an organic compound derived from a variety of agriculture byproducts. Its chemical formula is C₆H₄CHO. Furfural is a skin irritant.

Syngas Analysis
The pressure reactor produces three different products. The liquid product, known as bio oil, can be converted into a fuel which can be used in transportation vehicles. In addition, the fuel can also be used in other energy transformations as a substitutes hazardous fossil fuels.

Commercial Application
The pressurized reactor produces three different products. The liquid product, known as bio oil, can be converted into a fuel which can be used in transportation vehicles. In addition, the fuel can also be used in other energy transformations as a substitutes hazardous fossil fuels.

Fossil Fuel Versus Biofuel
The results generated LCI data only accounts for the pyrolysis reaction. To further complete the LCA, GREET determines the Well to Wheel (WTW) portion. Below are graphs comparing reformulated E10 gasoline to pyrolysis gasoline(switchgrass).

Conclusion

- Pyrolysis gasoline reduces Greenhouse Gas emissions by 5% compared to reformulated E10 gasoline.
- E10 gasoline produces significantly more Carbon Black than pyrolysis gasoline.
- However pyrolysis gasoline produces more CO and NO₂ than its competitor

References

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