Studies of Co-pyrolysis of Biomass and Plastic Wastes with the Combined Scheme of Kinetics and Machine-Learning Method

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Motivation

Biomass as a renewable source can be utilized to generate biochar, biogas, and bio-oil through pyrolysis. Bio-oil can be upgraded to produce biofuels as an alternative to crude oils. Plastic waste is one of major waste sources and is hard to be recycled. Through the co-pyrolysis with biomass, plastic waste can be used to produce high-quality biofuels.

Project Description

The design and optimization of co-pyrolysis is challenging due to the complexity of biomass and plastics. In this project, a series of experiments will be conducted to study the co-pyrolysis kinetics. Several types of biomass and plastic wastes will be mixed and tested at various ratios. The impact of working conditions on the process will be examined to explore optimal conditions of the co-pyrolysis. A kinetic model as a knowledge-based model will be combined with an experience-based model, a multi-layer artificial neural network (ANN) model. The combined knowledge-experience based model will be applied to predict co-pyrolysis at various working conditions.

Context

Co-pyrolysis is a promising technology, because both of biomass and plastic wastes can be recycled to generate valuable chemical such as bio-oil, which can be upgraded to generate biofuels. However, since biomass and plastics are polymers, the kinetics of co-pyrolysis are complicated, and the design of co-pyrolysis is challenging.

To address this issue, the kinetics of co-pyrolysis will be investigated in this project. The findings from this work will be utilized to facilitate the design of co-pyrolysis and explore optimal working conditions for the process at a commercialized scale.

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Presenting Fundamental Understanding of the Co-pyrolysis of Biomass and Plastic Wastes with a Combined Knowledge-Experience Model.

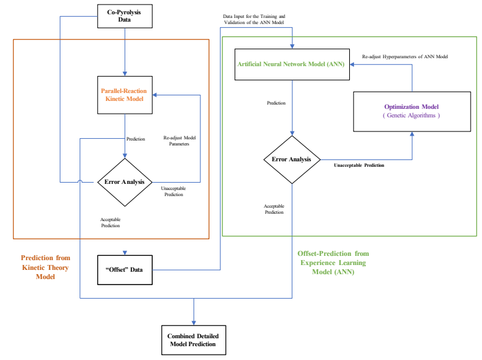

Chart 1: The Combined Scheme of Kinetic and ANN Model

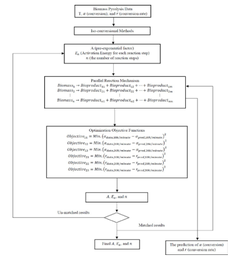

Chart 2: The Parallel Reaction Mechanism

Chart 3: The Genetic Algorithms for the hyperparameter optimization of ANN model

Project Deliverables

- Conduct TGA analysis on the mixing samples of biomass and plastic wastes in 6 months.
- Develop a knowledge-based and experience-based models. Combine these two models to predict co-pyrolysis between 7th- 12th month.
- After 1 year funding period, the study will be focused on the optimization of co-pyrolysis in a bench-scale reactor, based on the reaction kinetics developed from the previous stage.

Potential Impact

- The proposed scheme of the knowledge-experience can provide more detailed and accurate description on co-pyrolysis.
- The findings from the project can facilitate the design and optimization of co-pyrolysis.
- The proposed combined scheme can be applied to provide timely and accurate prediction in other areas such as robust process control and financial market modeling.

Acknowledgements

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