Dechlorination Of Mixed-Plastics Feedstock With Low Temperature Pyrolysis For Downstream Gasification And Hydrogen Production

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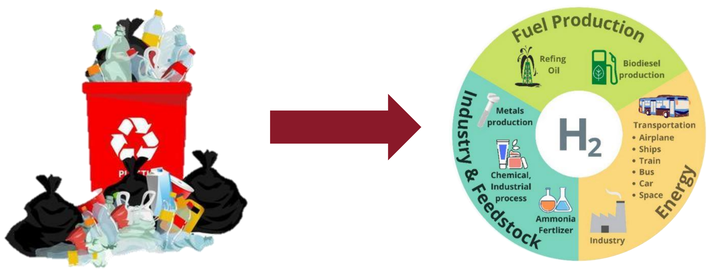
Introduction



- The majority of U.S. plastic waste is landfilled, with between 32 and 43 million tons sent to landfill sites in 2021.
- Gasification of plastic waste offers the opportunity to reduce pollution and produce clean renewable hydrogen in a reliable way.

Goals and Objectives

- Goal: To develop a low-temperature catalytic pyrolysis technology to dechlorinate mixed plastic waste material that will allow for the gasification to produce renewable hydrogen.
- Objectives: 1) Identify and obtain samples of plastics, mixed plastics, biomass/waste, and catalysts for use in testing. 2) Upgrade laboratory scale bubbling fluid bed to incorporate modifications to produce and collect dechlorinated products. 3) Conduct baseline and parametric pyrolysis testing using plastics and mixed plastics with and without catalyst. Analyze the information to develop techno-economic study of the technology.

Feedstock Procurement


Mixed Plastic


Thin Plastic


Hard Bottles


Milk Jugs


Random Plastic


Polyvinyl Chloride

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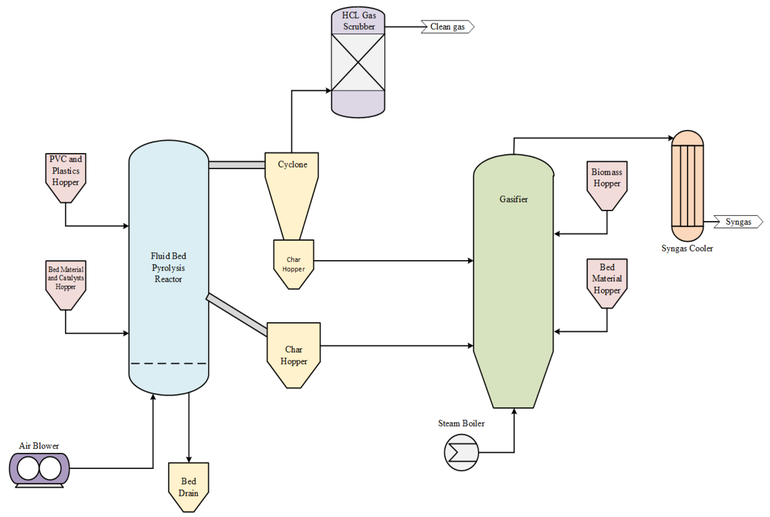
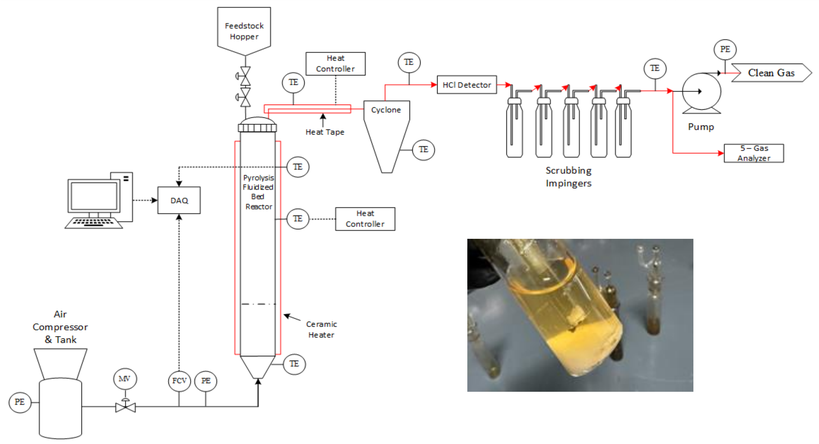
Dechlorination Technology



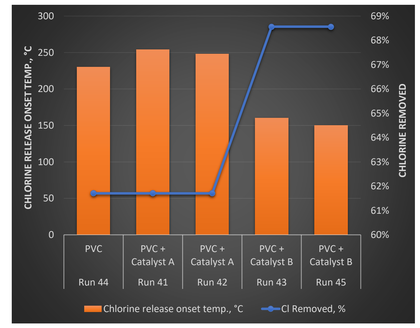
The dechlorination technology comprises two primary components: 1) Fluidized bed pyrolysis reactor and 2) Gasifier. Chlorine-rich plastic feedstock is introduced into the fluidized bed reactor along with bed material and catalyst. Within this reactor, a pyrolysis temperature of 325°C is maintained to facilitate dechlorination. The resulting dechlorinated plastic char is then collected and directed into the gasifier, where it is combined with biomass and other mixed plastic samples. This feedstock undergoes gasification to produce an H_2-rich syngas, suitable for a range of industrial applications including energy production, metal and fertilizer manufacturing, and chemical processes.

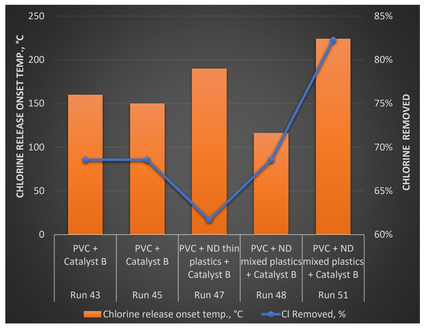
Lab Scale Setup



- The lab-scale fluid bed reactor consists of a feed system, an externally heated two-inch diameter fluidized bed equipped with HCl sensor, cyclone, and an impinger train.
- Materials Used – PVC, Mixed Plastics, Catalysts, and Inert Bed Material
- Test Temp. Range – 100°C – 400°C.
- Environment – Nitrogen and Air.
- Pressure – Atmospheric.

Results and Discussion





- The project team conducted a total of 59 dechlorination test runs using the fluidized bed setup to determine the effectiveness of different operating parameters including bed temperature, catalyst type and plastics blend composition on percent chlorine removal.
- Three catalyst were tested : Catalyst A, Catalyst B and Catalyst C.
- PVC Pyrolysis (Run 44) – Chlorine Release Onset Temp - 230 °C and 62% Chlorine Removal
- PVC + Catalyst A (Run 41 and 42) - Chlorine Release Onset Temp - 250 °C and 62% Chlorine Removal (similar to baseline).
- PVC + Catalyst B (Run 43 and 45) - Lower Chlorine Release Onset Temp - 150-160 °C, Higher Chlorine Removal of 69%.
- PVC + Thin plastics + Catalyst B (Run 47) - Chlorine Release Onset Temp - 190 °C and 62% Chlorine Removal.
- PVC + Mixed plastics + Catalyst B (Run 48 and Run 51 - Chlorine Release Onset Temp – 116 °C -224°C and 69%-82% Chlorine Removal.

Conclusion

- Microbeam's innovative dechlorination technology offers a transformative solution for the recycling industry, particularly in tackling the challenge of mixed plastics containing chlorine-based polymers. By effectively removing chlorine compounds from plastic waste streams, our technology facilitates the conversion of these materials into high-quality gasification feedstock. This advancement not only enhances the feasibility and efficiency of plastic recycling processes but also significantly mitigates environmental pollution associated with the incineration or landfill disposal of chlorinated plastics.
- Catalyst B initiates chlorine removal at lower temperature. The lab results indicate that Catalyst B can effectively achieve > 70% dechlorination.

Acknowledgement

This project is supported by the U.S. Department of Energy (DOE)
National Energy Technology Laboratory (NETL)
DOE Award # DE-SC0023858

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