Plastic to Fuel Summary

Introduction

There are tons of plastic that get sent to landfills each year because they are considered contaminated and therefore can't be easily or readily recycled. This is a waste of material and money since much of that plastic can be converted back into fuel, or other useful product. Plastic to fuel conversion is important not only because it reduces the amount that goes to landfills but it can also be an energy source, making plants more energy efficient. Currently there are 6 methods of converting plastics to energy:

- Incineration
- Gasification
- Hydrolysis
- Anaerobic digestion
- Pyrolysis
- Chemical Feedstock Recovery (Depolymerization)

4R Sustainability Inc, research group [(1)] conducted a study on the latter two, with more emphasis on pyrolysis, and had promising results in plastics to fuel.

Process

Depolymerization is the process of turning scrap plastics back into monomers that will have properties and performance of virgin resins to rebuild plastics. The plastic is chopped into small pieces and wetted with water before it is sent into a pressure vessel reaction chamber where it is heated at a constant volume. After a period of time, majority of the water is boiled off by rapidly releasing the pressure in the vessel leaving behind crude hydrocarbons and solid minerals. The minerals are removed before sending the crude hydrocarbons to a second reaction vessel to break down the longer hydrocarbon chains; after which they are sorted by fractional distillation. Depolymerization is used in the recovery of PET, polyamides (exp. Nylon), and polyurethanes (exp. Styrofoam).

Pyrolysis is the decomposition or transformation of a compound caused by heat. There are 5 common steps in the process of pyrolysis. The first is treatment where size is reduced, then plastic is cleaned, and moisture is removed. Following the treatment, plastic is converted into gas (pyrolysis). The gas is converted to a liquid in the third step using a condenser. The newly converted fuel goes through an acid removal step so that the fuel doesn't cause corrosion to the engines its being put into. The final step includes separation/refining by distillation to meet ASTM standards. The three products of pyrolysis are natural gas, fuel, and char. Char can be

land filled or incinerated for energy while some suggest a more green way of reusing the char by using it in roads, carpet, and roofing material.

Pyrolysis, incineration, and gasification are all similar in that high temperatures are used to break down the plastic. The difference in the three methods is the amount of air/oxygen that is allowed during the heating process. Incineration allows for vast amounts of air so that there will be combustion, where as gasification only a small amount of air is used but not enough for combustion to occur, and pyrolysis is done in complete absence of air(2).

Thermal depolymerization and hydrolysis differ in that hydrolysis usually uses a catalyst along with the water to break down the polymer chain(3) where as thermal depolymerization just uses water. Anaerobic digestion differs from all the other processes in that it uses microorganisms to break down the polymer chains(4).

Commercial-Scale

The development of a pyrolysis pilot-scale is 3 to 5 years (2015). If the pilot-scale is converted into a commercial-scale 7,500 to 10,000 tons per year of plastic must be processed by the facility. The return on investment for a commercial-scale is 2 to 5 years if cost condition and product price holds steady. Although plastic to fuel is not eligible to receive grants or tax credit for recycling it does have the potential to receive tax credits for creating jobs, and grants from the US Department of Agriculture for building its facility on a rural site.

Obstacles in Plastic to Fuel

Plastic to fuel technology classification is unclear which causes obtaining permits for a facility that uses pyrolysis to be confusing; resulting in having to get permits that weren't anticipated. The conversion of plastic to fuel through pyrolysis isn't considered recycling which causes the disentitlement of recycling grants. Many of the obstacles come from the United States of ISO 1527 standards that have cracking, gasification, and depolymerization which are chemical recycling/feedstock recycling under the definition of recovery.

Conclusion

Much of the plastic that can't be recycled due to contamination can be converted into fuel/energy through depolymerization and pyrolysis. One of the main restraints of pyrolysis becoming more commercial is that pyrolysis isn't considered recycling which makes it ineligible for recycling grants although it might still be eligible for other tax credits and grant for sites built in rural areas. Pyrolysis plants at commercial scale have promising economic results with return on investment being 2 to 5 years. Pyrloysis could be one of the solutions to problems in the future such as scarce land-fill space and lack of energy sources.

(1) "Conversion technology: A complement to plastic recycling." American Chemistry Council, Apr. 2011. Web. 11 July 2011. <http://plastics.americanchemistry.com/Plastics-to-Oil>.
(2) " Briefing Pyrolysis, gasification and plasma." *http://www.foe.co.uk*. Friends of Earth, Sept. 2009. Web. 21 July 2011. <http://www.foe.co.uk/resource/briefings/gasification_pyrolysis.pdf>.
(3) Holmes, Kim. "Plastic to fuel question." Message to the author.23 Aug. 2011. Web.
(4) "Anaerobic Digestion." *Oxford English Dictionary*. 3rd ed. 2008. N. pag. Western Michigan University Libraries. Web. 30 Aug. 2011. <http://www.oed.com/view/Entry/248590?redirectedFrom=anaerobic%20digestion#eid12065052>