Power and Fuel from Plastic Wastes

An extraordinary amount of plastic occupies landfill space worldwide. Like a time capsule this could tell future generations an awful lot about us. Work by a few creative and resourceful people may change the message we choose to leave.
…….. By Ron Kotrba, a senior writer for *Biomass Magazine*.

Estimates suggest 200 billion pounds of plastic is produced every year. Due to the technical limitations or inconvenience of recycling, only a fraction of that material resurfaces in new plastic products. It takes no imagination whatsoever to throw away plastic and doom it to the fate of a thousand years in a landfill, but plastic waste doesn't just threaten terra firma.

The Pacific Ocean is home of the world's biggest landfill: the Great Pacific Garbage Patch. Air and ocean currents form a huge, slow-moving spiral of debris-mostly plastic-accumulated from all corners of the globe through decades. And unlike biological material, plastic doesn't biodegrade and decompose. Instead, plastic photo degrades, meaning it shatters infinitely into smaller and smaller pieces without actually chemically breaking down. Because of this, the amount of plastic debris in the Great Pacific Garbage Patch only grows.

The tiny plastic bits, called nurdles or "Mermaid tears," are reported to outnumber plankton in the vast region six-to-one and are mistaken as food by bottom feeders and other filter feeders, which poses a threat to the entire food chain. The water-bound garbage dump has gotten so large it has split into eastern and western patches. Reports indicate the eastern patch, located between Hawaii and California, is twice as big as the state of Texas.

Plastic used specifically for agricultural purposes is called plasticulture (plastic and agriculture), much of which cannot be or is not recycled for various reasons. Cal Poly, San Luis Obispo professor Sean Hurley compiled survey data from California farmers earlier this year, regarding their use of plastics in agricultural operations. According to Hurley, 43 percent of California growers indicated that they use some form of plasticulture in their operations. Hurley estimates California growers dispose of more than 55,000 tons of plasticulture every year.

Earlier this year Biomass Magazine reported on work conducted by Pennsylvania State University professor James Garthe, who has developed a prototype machine to convert waste plasticulture into Plastofuel-the trademarked name for the dense, plastic nuggets intended eventually for cofiring with coal at a power plant. Garthe, on extended leave until mid-October, was unavailable for a Plastofuel update but his PSU colleague, Professor William Lamont, says Garthe is working on the fourth edition of the Plastofuel maker and when he returns from leave will complete that work and then testing will begin. "We hope to then take nonrecyclable waste plastics from the university and convert them into Plastofuel in quantities that can be burned in a small power-generating facility," Lamont says. "We really need to convert all the plastic waste except for PVC which, at this point, cannot be recycled into fuel." PVC, or poly vinyl chloride, is considered by many experts to be the most toxic plastic of all because of its high chloride content. While Garthe strives to streamline the Plastofuel production process, a related PSU project nearing the commissioning phase is underway.

Gasifying Granulated Waste Plastics

In 1999, GR Technologies Co. Ltd. in Seoul, South Korea, invented a high-temperature burner designed to be fueled by plastics. A relationship with the Korean company and PSU developed. After years of working together in varying capacities, a subsidiary of GR Technologies Co. was formed earlier this year in Pennsylvania, Eco-Clean Burners LLC, with the purpose of deploying the plastic-burner technology in the United States. It's not combustion-oriented like the Plastofuel nuggets, but rather this project involves gasification of granulated waste plastics. Industrial makers of plastic parts generate a lot of plastic wastes, which sometimes is granulated before being dumped into a landfill so companies are not paying to dump airspace. The burner project is headed up by John Joseph Shea, a PSU economic and community development extension associate. "The Plastofuel project and this project are closely related but don't really touch each other," Shea says. While the burner was developed in South Korea, Shea has been working to turn the technology "into a user-friendly machine for the United States," he says.

According to a PSU document, stack tests conforming to U.S. EPA standards were conducted on the burner unit by an independent testing company based in the United States. The emissions testing evaluated the burner fueled with pelleted No. 4 low-density polyethylene (LDPE) from Korea; granulated No. 2 high-density polyethylene from discarded plastic barrels; and granulated, dirty No. 4 LDPE mulch-film. Three main categories of pollutants were tested: particulate matter; gases (sulfur dioxide, nitrogen oxide and carbon monoxide); and dioxins/furans. "Test results proved that this is an extremely clean-burning system," the document states.

"It's complete gasification," Shea tells Biomass Magazine. "There's no melting or slagging. The burner takes the granulated plastic, sized in diameter between 2 and 10 millimeters, from a solid to a liquid to a gas immediately in the combustion chamber, Shea explains. "That gas is actually producing the heat we need to transfer into the boiler system." During the gasification of the granulated waste plastic, temperatures are so high-1,850 degrees Fahrenheit-the studies indicate emissions profiles cleaner than that of natural gas. "It's amazing," Shea says. "I've run this machine for years-demos and such-and you could stand right next to it and there's nothing coming out of that barrel but a flame and heat."

In Pennsylvania, the department of environmental protection doesn't regulate emissions from combustion units with a heat-input rating less than 2.5 million British thermal units an hour (MMBtu/hr) and, therefore, units sized less than 2.5 MMBtu/hr require no permits to begin burning, or gasifying, waste plastics.

Eco-Clean Burners and Shea are finishing installation of an 800,000-Btu/hr plastic-burner unit at a greenhouse called Iannetti's Garden Center in Burgettstown, Pa. "Here at Iannetti's is the first place we've installed one of these burners," Shea says. "We haven't actually run it yet. We've been installing it all summer and now we're waiting for some cold weather to try it out and do some heating. By next spring we should be able to tabulate the numbers and see how effective it will actually be." He says the system is designed to gasify 30 to 33 pounds an hour of granulated waste plastic.

Catalytic Pyrolysis of Waste Plastics

While interest in combusting and gasifying plastic appears to be growing, there is another route to making practical use of all the waste plastics modern society produces. Through what it calls catalytic pyrolysis, Polymer Energy LLC, a division of Northern Technologies International Corp., has developed a system to convert waste plastics into liquid hydrocarbons, coke and gas, which can then be used as boiler fuel for power generation. "The technology uses lower temperatures than gasification-significantly lower-so it's more energy efficient to produce," says Kathy Radosevich, business development manager with Polymer Energy. Through "random depolymerization," or selective breaking of carbon-to-carbon bonds, in addition to feeding in proprietary catalytic additives, the reactor melts and vaporizes waste plastic in one step at temperatures between 840 and 1,020 degrees F. The company reports that, on average, 78 percent of every pound of plastic fed into the Polymer Energy system is converted to liquid hydrocarbons, coke and gas. The resultant coke can be further processed to produce additional fuel oil.

Polymer Energy's catalytic pyrolysis system processes polyolefins like polyethylene and polypropylene with up to 5 percent other plastic materials, plus up to 25 percent additional nonplastic waste, such as paper, glass, sand and water-making it ideal for processing municipal wastes.

Radosevich says the company has already sold nearly 20 of these systems in Europe, India and Thailand. "The interest in the United States and Canada is huge but I expect that we won't be marketing units in North America until next year some time," she tells Biomass Magazine. Hitherto the markets for these units outside North America have been "more conducive" mainly because higher fuel prices in places such as Europe and India have increased the desire for such alternative-fuel production units. "In the United States I'm doing preliminary testing for EPA approval, although I don't anticipate we'll have any problems. The only item that would be of interest to EPA that I can think of would be any type of contaminants in the ash." According to Polymer Energy, the output oil contains no chlorine, sulfur, nitrogen or heavy metals. Any of that material would remain in the ash, which Radosevich says would differ on an individual usage basis depending on the average makeup of the plastic-waste feedstock. "What we would do is sample the input plastic and the [post-processed] ash, and cross-check that with local requirements the community has for permit approvals," she says.

Clearly there is growing interest in doing something different with waste plastic than dumping it in landfills or the oceans. The global community must force itself to change its present path and become truly concerned about the environment in which its descendants will be raised, for what people do today affects everyone tomorrow.