



Waste Plastics as FUEL

Now is a good time to recover heat energy from dirty and non-recycled plastics



The Problem ...

After World War II, a labor-saving agricultural technology using plastics was introduced. Termed plasticulture, the process uses film and rigid plastics to make operations more efficient, while saving time, reducing water usage, controlling weeds, and more. Although agricultural production has soared, piles of waste plastic have continued to mount all over the world.

Common Agricultural Plastics

- HDPE (# 2): nursery pots, trays, flats, pesticide containers, drums
- LDPE (# 4): mulch, greenhouse covers, fumigation film, silage bags and wraps, irrigation tubing
- PP (# 5): row covers, nursery pots
- PS (# 6): nursery pots, tray inserts, flats, clamshell containers

The Solution ...

Plastofuel™—The Penn State Fuel Nugget

Our prototype machine works by taking waste plastics and forcing them through a heated extrusion die, melting a thin jacket which locks unmelted pieces within. A hot knife cuts the extruded material into easily stored and readily shipped nuggets called Plastofuel™. Plastofuel™ can be burned with coal in a coal-fired boiler, or eventually, combusted directly in the Korean boiler described (see back). High temperature combustion (2000°F) assures clean burns with minimal emissions.

The key to Plastofuel™ is that the production process is tolerant of dirt and debris, and since only the outer portions are melted during processing, it requires only about 1/10th the energy to form when compared to producing plastic pellets.

As seen in the table, agricultural plastics contain a high energy value that can be used to supplement or even replace existing fuels.

<u>Material</u>	<u>Btu/lb</u>
Fuel Oil	20,900
Polyethylene (PE)	19,900
Polypropylene (PP)	19,850
Cross-linked PE(PEX)	19,780
Gasoline	19,200
Polystyrene (PS)	17,800
Pennsylvania coal	13,900
Wyoming coal	9,600
Newspaper	8,000
Textiles	6,900
Wood	6,700
Yard wastes	3,000
Food waste	2,600
Avg. Mun. Waste	4,500-6,700



Prototype machine design and development is part of the student learning experience in the Department of Agricultural and Biological Engineering.



The prototype Plastofuel™ machine has four heated dies. Heated knives can cut the extrudate to any length while also sealing cut ends with melted plastic.



High-energy Plastofuel™ nuggets are shown beside the 4-channel extrusion die that produced them. Soil buildup on die openings indicates just how dirty some plastics can be.



Shown with the Plastofuel™ machine inside, the mobile processing unit is designed for demonstration and research purposes.

An Evolving Technology We Are Keeping an Eye On ...

In 1999 in Seoul, Korea, GR Technologies Company, Ltd. invented a plastic-fueled burner. Recently, a subsidiary of GR Technologies, called **GR Boilers, LLC**, has opened in the Pittsburgh, Pennsylvania area to consider marketing this combustion system in the United States.

This hot-water boiler system can be used to heat greenhouses and other agricultural structures. The 396,850 Btu/hr unit burns 20-33 lbs. per hour of pellets made from waste agricultural plastics. The unit can also burn granulated (chopped) plastic. The burner preheats with fuel oil, and once steady conditions are reached, the unit is automatically switched to burn plastic. Plans call for the boiler to be modified to someday burn the more energy efficient Plastofuel™.

Stack testing of the unit conforming to U.S. Environmental Protection Agency standards was conducted by an independent U.S. testing company at Penn State. Tests measured emissions when burning LDPE (#4) Korean pellets, granulated HDPE (#2) discarded barrels, and dirty LDPE mulch film (#4). Three main groups of pollutants were analyzed: particulate matter, gases (sulfur dioxide, oxides of nitrogen, carbon monoxide), and dioxins / furans. Test results proved that this is an extremely clean burning system.

A GR Technologies demonstration boiler is currently being installed at a family owned and operated greenhouse nursery complex, called Iannetti's Garden Center, 728 Steubenville Pike, Burgettstown, PA 15021. The unit will be used to supplement heat now being provided by a coal-fired boiler. Contact John Shea (below) for an update on system performance and fuel supply questions.



This plastic-derived fuel boiler is installed in a working greenhouse near Pittsburgh. Plastic fuel supply issues will be evaluated along with boiler operation. The inset shows the original test unit at Penn State.

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