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A Plastic Wrapper Today Could Be Fuel Tomorrow



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Dr. Richard Gross at Polytechnic University in Brooklyn with bioplastic, which is made from vegetable oils.

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WASHINGTON, April 8 — Scientists worldwide are struggling to make motor fuel from waste, but Richard Gross has taken an unusual approach: making a “fuel-latent plastic,” designed for conversion. It can be used like ordinary plastic, for packaging or other purposes, but when it is waste, can easily be turned into a substitute diesel fuel.

The process does not yet work well enough to be commercial, but the Pentagon was impressed enough to give \$2.34 million for more research. The technique could reduce the amount of material that the military has to ship to soldiers at remote bases, because the plastic would do double duty, first as packaging and then as fuel. It would also reduce trash disposal problems, according to the Defense Advanced Projects Research Agency, known as Darpa.

Dr. Gross, a professor of chemistry at Polytechnic University, in Brooklyn, is turning plant oils, of the kind already used to make biodiesel, into “bioplastic.” The plastics can be films or rigid, as are commonly found in food packaging. Then he uses a naturally occurring enzyme to break down the plastic into fuel.

“It works in very mild conditions, lukewarm tap water,” he said. The enzyme, cutinase, is present in nature, made by parasites to eat through the shiny surfaces of tree leaves, so the parasite can suck nutrients out of the inner parts.

A gene-splicing company, DNA 2.0, has taken some of the DNA from that parasite and spliced it into an e. coli bacterium, to mass produce the enzyme. The e. coli was chosen because it reproduces more readily than the original parasite.

Conversion begins with shredding the plastic. An office paper shredder will do, Dr. Gross said. Then the shreds are immersed in water with a small amount of the enzyme. In three days to five days, the process is complete, and the biodiesel floats to the top.

To meet Environmental Protection Agency standards for road use in the United States, biofuel would have to go through additional chemical processing, but Darpa believes the resulting fuel can be poured directly into the fuel tank of a diesel generator to make electricity.

A soldier generates on average more than seven pounds of packaging waste a day, according to Darpa, and simply getting rid of the trash requires “personnel, fuel and critical transport equipment.”

Even if some of the energy was lost in reprocessing the plastics, the wastes could provide more than enough fuel to make the electricity that a military base would need, according to Darpa.

The Pentagon calls it the Mobile Integrated Sustainable Energy Recovery program, or Miser. Jan Walker, a spokeswoman for Darpa, said that in the range of projects that her agency sponsors, this one was “not real technical,” although it was still in a preliminary stage.

According to Dr. Gross, a gallon of soy oil will yield the same amount of biodiesel whether it is converted directly or goes through an intermediate stage as plastic.

The trick, he said, is to take a class of chemicals in the oil called fatty acids, from soy oil or another crop source, and alter them so they have the chemical equivalent of a “hook” at one end. Then they can be linked into long chains, a building block of plastics. Add cross-links that run from chain to chain, and the plastic goes from a film to a rigid material.

Converting the soy oil to fatty acid is also done with an enzyme. A gene-altered yeast does that job. Jeremy Minshull, the president of DNA 2.0, said yeast was chosen because that conversion takes energy, and the yeast will provide that when fed cheap food.

Then e. coli, using DNA borrowed from a fungus called *Candida Antarctica*, converts the hydroxy fatty acid into a polymer, a material that can be heated and shaped into useful plastic shapes. And after its career as a plastic container is over, it can be shredded and then chemically broken down into diesel fuel.

Mr. Minshull said that one challenge now is to tinker with the enzyme that turns the plastic back into liquid, so a smaller amount will do the job. That will lower costs, he said, and reduce the amount of enzyme that is fed into the diesel engine.

While biodiesel is produced commercially in this country, it is not competitive with diesel fuel from petroleum without a government subsidy. But if oil prices stay high enough, or if the government puts a tax on carbon emissions, bioplastic-to-biodiesel could become viable without subsidies. Using plants for plastic or fuel saves carbon because the next year's crop will reabsorb carbon from the atmosphere.

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