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Biodiesel

Oil in your coffee

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A new source of fuel production

RUNNING a diesel engine on a plant-based fuel is hardly a new idea. Indeed, one of the early demonstrations shown by Rudolph Diesel, the German engineer who invented the engines at the end of the 1800s, operated on pure peanut oil. Diesel fuel made from crude oil eventually won the day because it was easier to use and cheaper to produce. Now new forms of biodiesel are starting to change the picture again. And one of the latest sources comes from the remains of a drink enjoyed the world over: coffee.

Biodiesels are becoming increasingly popular. In America, Minnesota has decreed that all diesel sold in the state has to contain 2% biodiesel (much of it from the crops grown by the state's soya farmers). Biodiesel can also be found blended into the fuel used by public and commercial vehicles and by trains in a number of countries. Aircraft-engine makers are also testing biofuel blends. Because biodiesels can be made from materials derived from plants, which use carbon dioxide to grow, they potentially have a much lower carbon footprint than petroleum-based fuels.

Coffee is also a plant product, but once the beans are ground and used they end up being thrown away or put on gardens as compost. Narasimharao Kondamudi, Susanta Mohapatra and Manoranjan Misra of the University of Nevada at Reno have found that coffee grounds can yield by weight 10-15% of biodiesel relatively easily. Moreover, when run in an engine the fuel does not have an offensive smell—just a whiff of coffee. Some biodiesels made from used cooking-oil leave a car exhaust smelling like a fast-food joint. And after the diesel has been extracted, the coffee grounds can still be used for compost.

The researchers' work began two years ago when Dr Misra, a heavy coffee drinker, left a cup unfinished and the next day noticed that the coffee was covered by a film of oil. Since he was investigating biofuels, Dr Misra enlisted his colleagues to look at coffee's potential. The nearby Starbucks was happy to oblige by supplying grounds.

They found that coffee biodiesel is comparable to the best biodiesels on the market. But unlike soya and other plant-based biodiesels, it does not use up plants or land that might otherwise be planted with food crops.

Unmodified oils from plants, like the peanut oil used by Diesel, have a high viscosity and require engine alterations. Diesel fuel is less thick and usually can be burned in an engine with little or no tinkering. The diesel-extraction for coffee grounds is similar to that used for other vegetable oils. It employs a process called transesterification, which reacts the grounds with an alcohol in the presence of a catalyst.

The researchers start off by drying their coffee grounds overnight and then pour in some common chemical solvents, such as hexane, ether and dichloromethane, to dissolve the oils. The grounds are then filtered out and the solvents separated (to be reused with the next batch of coffee grounds). The remaining oil is treated with an alkali to remove free fatty acids (which form a soap). Then transesterification takes place by heating the crude biodiesel to about 100 degrees Celsius to remove any water, and treating it with methanol and a catalyst. On cooling to room temperature and left to stand, the biodiesel floats up, leaving a layer of glycerine at the bottom. These layers are separated and the remaining biodiesel cleaned to remove any residues.



Although some people try to brew their own diesel at home from leftovers and recycled cooking oils, coffee-based diesel seems better suited to larger-scale processes. Dr Misra says that 1 litre of biodiesel requires 5-7 kg of coffee grounds, depending on the oil content of the coffee used. In their laboratory his team has set up a one-gallon-a-day production facility, which uses between 19-26kg of coffee grounds. The biofuel should cost about \$1 per gallon to make in a medium-sized installation, the researchers estimate.

Commercial production might be suitable for an operation that collects coffee grounds from big coffee chains and cafeterias. There is plenty available: a report by the United States Department of Agriculture says that annual world coffee demand consumes more than 7m tonnes of coffee, which the researchers estimate could produce some 340m gallons of biodiesel. Time, perhaps, for another cup before refilling the car.

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