Energy

Record efficiency for solar cell

A two-layer solar cell developed at Sandia National Laboratories in Albuquerque, N.M., demonstrated a 31 percent sunlight-to-electricity conversion efficiency — the highest ever recorded, according to an announcement by its designers last week. The device is a stacked multijunction cell, which means it has multiple photosensitive layers, each optimized for different wavelengths of light.

The upper, gallium-arsenide layer in the Sandia device — sensitive to wavelengths from the ultraviolet through the visible portion of the spectrum — converted into electricity 27.2 percent of the light striking it. Unabsorbed light passed through to an underlying silicon-crystal layer, which is sensitive to light into the near-infrared. Even though the silicon layer is sensitive to a broader spectrum of frequencies, it's less efficient than the gallium arsenide in tapping the energy of the shorter wavelengths, points out Dan Arvizu, supervisor of Sandia's solar-cell work. That's why it was placed on the bottom, he explains. Neither the specific gallium-arsenide layer nor the silicon layer used in this multifunction photovoltaic cell is ideal for such a device, he adds; they're just the "two most mature" options available at this time.

Peak efficiencies were achieved at intensities between 35 and 50 watts per square centimeter, a 350- to 500-fold concentration of natural sunlight. In fact, these crystalline multijunction photovoltaic devices are designed for use with solar concentrators. Though the best commercially available cells for use with concentrators have efficiencies of just 18 to 20 percent, Arvizu expects it won't be long before future two-layer multijunction cells achieve solar-conversion efficiencies near 35 percent.

Diesel prescriptions: Eat some veggies . . .

U.S. diesel engines consume about 30 billion gallons of fuel each year, driving everything from tractors and trains to long-distance trucks, industrial processes and power plants. Currently, a petroleum distillate fuels them. But as domestic petroleum stocks dwindle, interest is building in potential alternatives that might sever the diesel's dependence on oil. Among some promising candidates are alcohol-modified "vegetable oils."

Engineers at the University of Illinois in Urbana-Champaign have been working with oils from corn, peanuts, castor, cottonseed, crambe, linseed, soybeans, rapeseed, sunflowers, sesame and safflower. To date, their most promising cocktail is a microemulsion of ethanol, soybean oil and a touch of detergent. The concoction can accept up to 40 percent alcohol and perform well, says mechanical engineer Lester Savage. And by "cracking" the soybean oil — heating it until it begins to break down — then adding a little anhydrous ammonia, the researchers can essentially "build in" the detergent needed to stabilize the microemulsion. At this point, Savage says, all it takes is some still-grade (150-proof) ethanol to make a fuel. This raises the possibility that many farmers could become energy-self-sufficient.

A second approach is to mix an alcohol — ethanol, propanol or methanol — with an oil and dessicant to form an ester. At Illinois, Carroll E. Goering has successfully run tractor field tests with 2,000 gallons of soybean-oil ester. Its main drawback is cost. Unlike the microemulsion fuel — which researchers say might be developed for $1.60 per gallon, or a little less than twice the current cost of diesel fuel — the ester fuels might cost $3 to $4 per gallon. However, in a pinch — such as another Arab oil embargo — it offers a fallback.

Austrian researchers are exploring a related option that might prove more cost-effective while eliminating a troublesome waste. Martin Mittelbach and Peter Tritthart at Karl Franzens University's Institute for Organic Chemistry in Graz created a methyl ester from 441 pounds of used vegetable oils collected from restaurants and households. The oil varied from liquid to solid and "was heavily polluted with pieces of food and cooking residues," they write in the July JOURNAL OF THE AMERICAN OIL CHEMISTS' SOCIETY.

Without attempting to purify the oil, the researchers added methanol and potassium hydroxide, then stirred. They separated a glycerol layer that formed — containing most of the impurities — and then washed with water the resulting ester layer. An organic layer was dried and filtered out.

This fuel offered about 10 percent less power than regular diesel fuel, but burned cleaner (except for a slight increase in nitrogen oxide emissions). Most notable were its lower smoke emissions — generally less than half those emitted when diesel oil was burned. The frying-oil ester was also used in a 50-50 mix with standard diesel oil and burned in a Volkswagen Rabbit diesel. "No changes in operation whatsoever could be observed," they say. However, they note, "a faint smell of burnt fat was detected."

. . . and stop that idling

It's not uncommon to see a legion of long-distance diesel trucks parked noisily — with their engines idling — outside major turnpike rest stops. But this din may quiet as truckers learn the findings of a study conducted by Argonne (Ill.) National Laboratory. While it focused on quantifying the high fuel cost of idling, the study also drew together data on other adverse effects of engine idling.

Long-distance truckers idle their parked engines an average of about three hours daily, the study's authors found, largely to keep engines and fuel warm in winter and to heat or cool their cabs if they're resting in them long — even all night. The study shows that this widespread practice not only wastes fuel but also risks damaging the engine.

One hour of idling causes the same amount of engine wear as two hours — or 80 to 120 miles — of driving, the researchers say. For the 800 or so hours of idling that a typical long-distance truck may run annually, this translates into the engine-wear equivalent of driving an extra 64,000 miles, according to Larry R. Johnson, director of Argonne's Center for Transportation Research.

More important, he notes, idling engines run about 10°F cooler than what's required for peak operation. This causes water vapor to condense in the crankcase. As it mixes with sulfur oxides produced during combustion, sulfuric acid forms. Though lubricating oils contain additives to neutralize this acid, Johnson says, idling appears to deplete them faster than the manufacturers had anticipated. As a result, bearings, cylinder liners, piston rings, wrist pins and valve stems can become pitted by acid — requiring early replacement. And because fuel isn't burned efficiently at idling temperatures, more soot is produced by idling than by road driving — a factor that can increase oil consumption, the need for oil changes and the risk of more engine damage. Over the long haul, this study found, excess idling by long-distance truckers necessitates overhauling an average engine about once every five years — about one year sooner than if it had been road-driven only.

Altogether, truck idling may waste up to 400 million gallons of fuel annually in the United States and cost long-distance haulers as much as $900 a year per truck in extra fuel, the researchers found. Ironically, Johnson notes, products already marketed can achieve each function a trucker now uses engine idling to accomplish — and at less ultimate cost. Most, like cab and engine-block heaters, will pay for themselves in less than a year from the fuel savings.