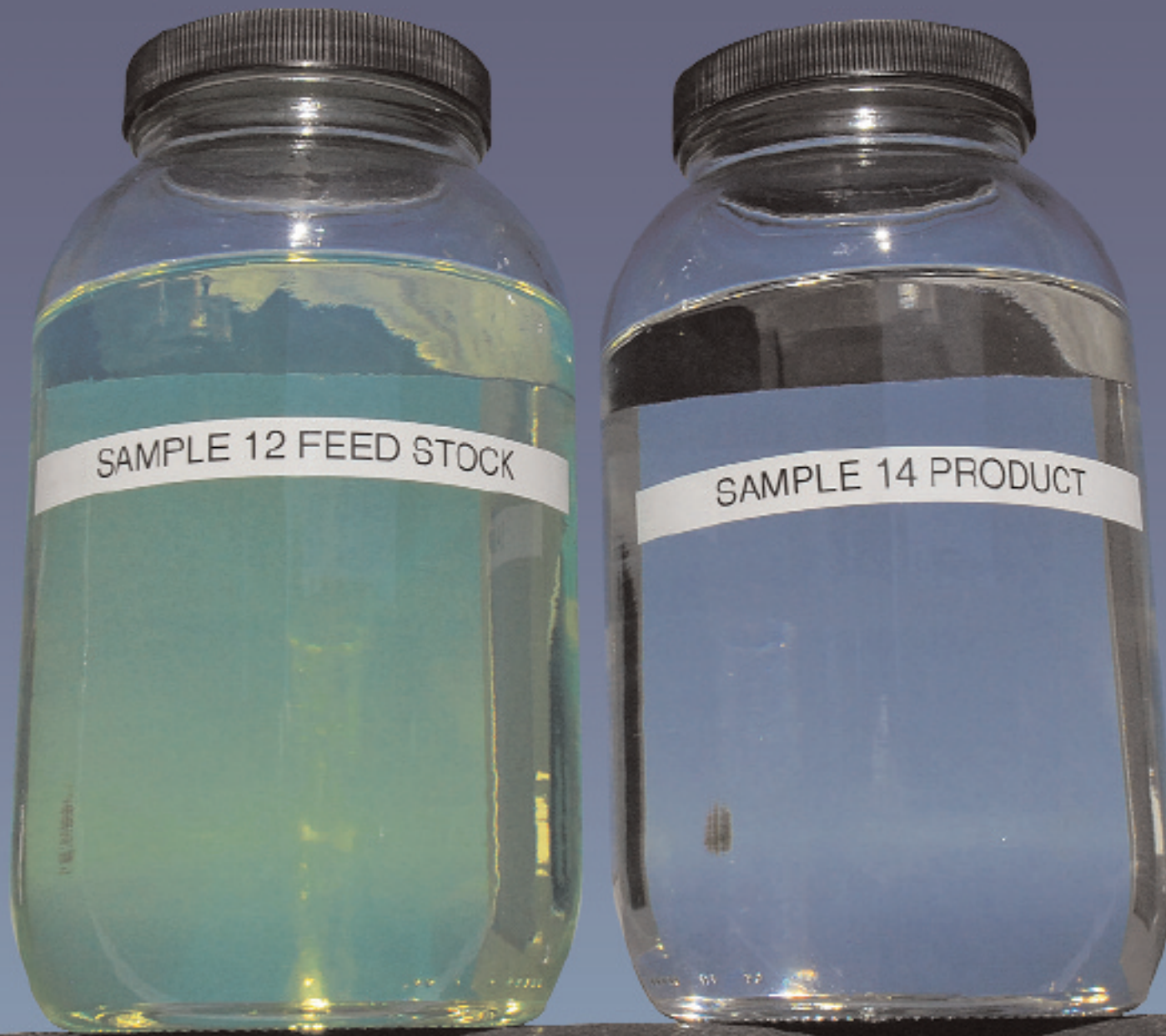


The Next Generation Diesel Fuel?

Testing A New, Cleaner And More Efficient Type Of Diesel Fuel

BY STEVE TEMPLE

PHOTOGRAPHY: STEVE TEMPLE AND COURTESY OF ADVANCED REFINING CONCEPTS



“Peak oil” is one of those controversial terms being tossed around like a hot potato. Some say we’re running out of fuel, while others point to promising new oil field discoveries and improved extraction methods. But what if a tremendously abundant source of fuel were already available from proven U.S. reserves, cleverly hidden in plain view?

In addition, this domestic energy source would be cleaner, offer better fuel economy, and cost less to produce. No, we’re not talking about biofuels made from algae or vegetable oil. Nor are we pointing to the hope of using hydrogen or carbon dioxide for energy.

We’re talking about a new, innovative way of combining conventional diesel with natural gas to produce a fuel that’s better than the sum of its parts. Called GDiesel (for its mix of gas and diesel, currently in a ratio of 1:2), it was developed by Advanced Refining Concepts (ARC) using a proprietary process called Clear Refining. This method not only increases the liquid volume of the fuel produced by 50 percent for a lower cost per gallon, it also dramatically improves its composition, resulting in both cleaner emissions and improved combustion efficiency, according to the company.

Clear Refining is not some lab experiment – it’s being used to make a real, high-grade fuel in Reno, Nevada, which we’ve tested in our own diesel pickup. More about those test results shortly. First, though, a bit of background



At the development center for Advanced Refining Concepts, these two tanks represent the basics of the Clear Refining process. Inside the silver tank on the right, heated diesel and natural gas are mixed and fed through a filter containing four metal catalysts. These catalysts facilitate the chemical bonding of the diesel and gas (but don’t actually become part of the fuel). The fuel then condenses and cools, running through a heat exchanger between the two tanks. The green tank holds the refined GDiesel.

on the principals behind the company and how Clear Refining works.

In the Beginning

The inventor behind it all, Dr. Rudolf Gunnerman, has a 40-year history in the development and marketing of waste-to-energy-related technologies. His various companies have developed and marketed processes for the production of pelletized fuels from

waste raw materials (such as wood, sugarcane and sorghum), along with the production of ethanol and emulsified fuels, and also upgrading of crude oil through the use of ultrasound. In addition, Dr. Gunnerman was a partner in a 25-megawatt agricultural waste powerplant that supplied electric power to PG&E in California. Peter Gunnerman, Dr. Gunnerman’s son, is the partner and director of ARC.

We met with both gentlemen and toured ARC’s development and manufacturing facilities on the same day that they announced groundbreaking of a new refinery that’s designed to initially produce 100,000 gallons per day (using 10 tanks with the capacity to produce 10,000 gallons each). While the state of Nevada has approved the production and sale of the company’s new fuel, Advanced Refining Concepts is in the final stage of obtaining federal permits and patent approval.

Testing

In the meantime, we were provided with a 50-gallon test batch obtained from the company’s development center to run in our Cummins-powered ’96 Dodge Ram for analyzing both on-road performance and emissions. Our initial reaction

Conventional diesel (left) is visibly different from GDiesel (right). As you might expect from looking at these samples, GDiesel burns cleaner. We’ve also found it can provide better fuel economy, anywhere from 15 to 30 percent, depending on the type of usage.



Peter Gunnerman, Director of Advanced Refining Concepts, walked us through the assembly plant that manufactures the Clear Refining units. The company's refinery under construction east of Reno, Nevada, is planning to have 10 tanks that can produce up to 10,000 gallons each per day of GDiesel by early 2010.

is that we'd frankly never want to go back to using conventional diesel ever again. GDiesel emitted little or no smoke (possibly because a small amount of conventional diesel was still in the tank when we filled up). Of even greater interest, though, was the marked improvement in mileage — as much as 30 percent.

Typically our Dodge Ram's 5.9 Cummins (modified with a K&N intake, No. 8 fuel plate, ATS exhaust manifold and turbo and Banks exhaust) gets anywhere from 17 to 19 mpg on the highway. The higher figure has been achieved previously on long-distance runs on flat terrain by using the Gear Vendors gear-splitter that drops the revs down with a double-over-drive setup.

For this test, though, we were driving through the Sierra Mountains from Reno to Sacramento and back, without the gear splitter engaged. We observed an immediate improvement to 22 mpg (1,400 miles on 50 gallons).

Dr. Gunnerman has been running GDiesel in a Mercedes SUV, and also a Hummvee with a 6.5L Duramax. He reports that the latter vehicle went from burning 8 mpg to as much as 12 mpg on GDiesel. Other independents test report gains of as much as 36 percent. While ARC makes no specific claims about mileage improvements (in part due to the different types of diesels and driving styles), the company says improvements in fuel efficiency are likely due to the natural gas reducing the amount of unburnt fuel.

As for emissions, we took our truck to a local smog station for a baseline test. The opacity readout on conventional diesel



We filled up our '96 Dodge Ram with 50 gallons of GDiesel at the ARC development center, and drove the truck through the Sierra Mountains for more than 1,200 miles on this single fill-up. That calculated out to 22 miles per gallon on a combination of city, highway and rural roads. The GDiesel blended smoothly with the few gallons of conventional diesel still left in the tank, and later on when we filled up with some additional diesel. These two fuels appear to be easily interchangeable on the same vehicle with no modifications required.

was already pretty good (0.4, with 30 being the upper limit, usually seen on older Mercedes sedans. These low emissions might be due in part to the aftermarket upgrades we've added to the truck to optimize performance).

So other than the visual reduction in tailpipe smoke already noted, we did not encounter a significant difference in this admittedly basic measurement. Instead, we reviewed more



GDiesel is also being tested in a Humvee with a 6.5L Duramax and a Mercedes SUV. Both are still running cleanly on GDiesel after tens of thousands of miles.

detailed results published in an independent report prepared for the EPA in August 2009 by Dr. Spencer Taylor, who has 20 years of R&D lab experience at British Petroleum. Overall, he stated that, "The product properties have been found to be consistent with No. 1 grade diesel fuel."

More important, he points out that the, "The sulfur content of



A computerized electronic system monitors both the process control and the volume of GDiesel being produced.

the GDiesel (1.9 mg/kg) is well below the current specification limit of 15.0 mg/kg." (Hydrocarbon emissions were slightly higher, but GDiesel is lower in NOx and particulates.)

Diesel fuel with a lower sulfur level can be a two-edged sword, however, as that's good for the environment, but would require some lubricity additives. Taylor notes, as well, that the



This is the first of many tanker trucks planned for delivering GDiesel to both fleet owners and fuel blenders. Details on retail distribution to consumers are still being ironed out.

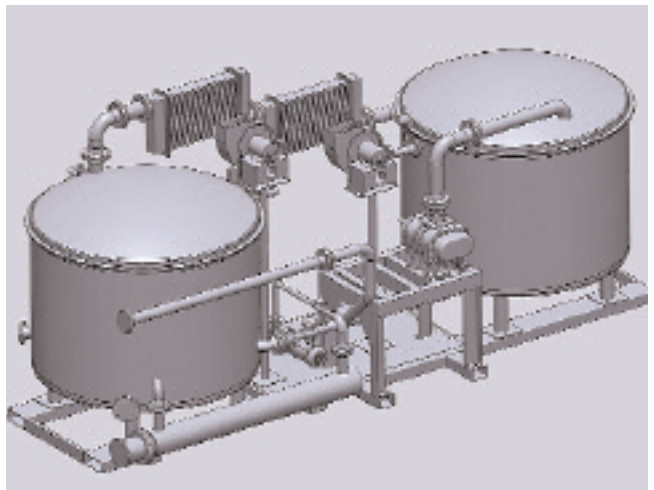
cetane properties of GDiesel just meet the requirements of a No. 1 diesel, but could be enhanced further with an additive. Moreover, unlike biodiesel, which has been found to gel at a comparatively high temperature (depending on the feedstock), GDiesel has an extremely low cloud point of -53 degrees C.

How It Works

How does ARC achieve these levels of clarity and performance? The basics of the Clear Refining process are fairly straightforward, something a high school chemistry student could grasp. It starts out with a standard diesel fuel that you'd buy at the pump, slightly pressurized in an industrial tank to 5 psi and heated to 300 degrees. Natural gas (methane), the same type used for cooking and heating, is then fed into the diesel, and the resulting mixture swirls through a circular wire mesh containing four different metal catalysts (cobalt, among others).

As you might recall from your chemistry class, a catalyst is a substance that starts or speeds up a chemical reaction, but doesn't undergo any permanent change in itself. Hence, these catalysts (which look like wire wrapped around the spokes of a large metallic wheel), don't actually become part of the fuel, as proven by independent lab tests. The GDiesel then flows through a layer of plastic pellets to facilitate condensation, and then a heat exchanger for cooling. Lastly, the GDiesel flows through a 15-micron filter before it's pumped into a vehicle's tank.

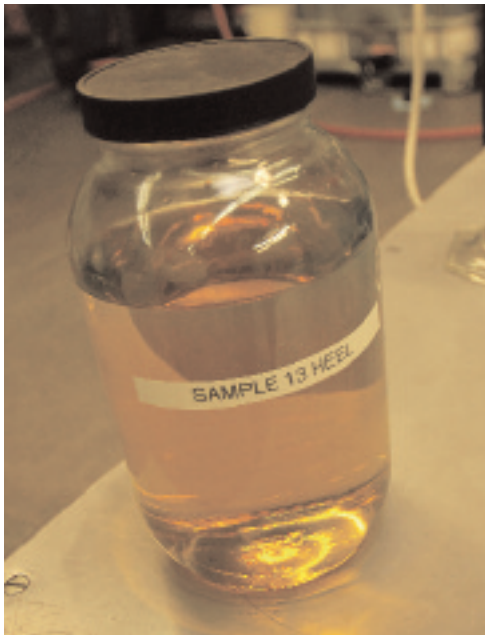
When the oil/gas mixture reacts with the catalysts, Dr. Gunnerman says it forms longer fuel molecules, with the natural



This schematic drawing shows the layout of the Clear Refining processor. The reaction tank on the left mixes the natural gas and diesel, flowing them through a mesh of metal catalysts. After this mixture condenses and cools, using a chiller unit between the two tanks, the product tank on the right collects the resulting GDiesel.

gas becoming part of the liquid diesel. Note that this comparatively low-energy conversion is not the same as the Fischer-Tropsch gas-to-liquid (GTL) process used to make diesel from gas, since the chemistry involved is different. While the specific details of ARC's patent-pending process are confidential, the results are obvious.

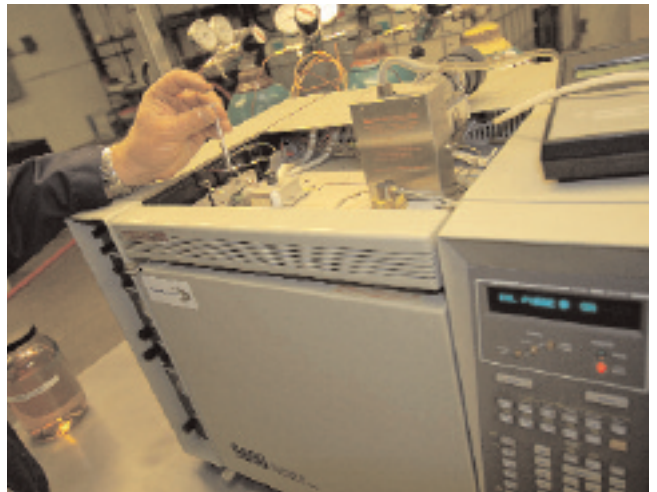
GDiesel looks purer and more refined than the original diesel feedstock, as the photos attest. Conventional diesel is yellowish in color, while GDiesel is as clear as bottled water. During the



The "heel" is a residue that settles out during the Clear Refining process. This darker, brownish liquid can be used for heating of the mixture of gas and diesel, to minimize any waste.

Clear Refining process, a darker, amber-colored residue (called the "heel") settles out to the bottom, which can be used as an energy source for heating the feedstock and powering the Clear Refining machinery, so there's no liquid waste product.

The implications of this new method are significant on a number of levels. In addition to diesel, ARC is also working on applying this process to gasoline and kerosene (jet fuel). The



A gas chromatograph precisely checks the chemical composition of the GDiesel, ensuring its purity.

source of natural gas used might also be a boon to the environment, as the company says it could conceivably be drawn from landfills, sewage, coal-bed, drilling wells and other polluting sources. Since natural gas (methane) can be far more damaging to the ozone layer than carbon dioxide emissions, repurposing it as a fuel might have other far-reaching benefits.

In the meantime, the domestic U.S. reserves of natural gas are massive, with newly revised estimates amounting to more than a 100 years' worth, at current consumption levels. Of



We tested our diesel pickup at a local smog station, and the opacity was already quite low (possibly due to the aftermarket upgrades on the truck). We observed a marked reduction in the amount of smoke coming from the tailpipe when burning GDiesel.

course, some experts point to the use of natural gas directly as a transportation fuel, which is entirely feasible, and could reduce carbon dioxide emissions by as much as 25 percent on a given vehicle, but that would require a conversion kit. The advantage of GDiesel is that it can be added directly into the tank and mixed with conventional

diesel, without any mechanical modifications, which our own testing confirms.

As for the economics of the process, even if a commercial (pipeline) source of natural gas is used for fuel production, ARC notes that the cost to produce the fuel is still much less than conventional No. 2 diesel, due to the lower price of natural gas. Currently the company blends the energy equivalent of a half-gallon of natural gas to one gallon of diesel, producing 1 1/2 gallons of GDiesel. And that ratio of gas/diesel might be increased to 1:1 in the future.

Even at the current mixture levels, though, GDiesel holds out the promise of making an enormous impact on domestic U.S. fuel supplies, reducing dependence on foreign oil, along with improving both emissions and fuel economy.

As of this writing, plans for wide availability of GDiesel are being finalized, with initial supplies intended for fuel blenders and fleet sales. ARC is still working on how to provide GDiesel to individual consumers on a large scale. But once that's done, we plan to be at the head of the line.

SOURCE:

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