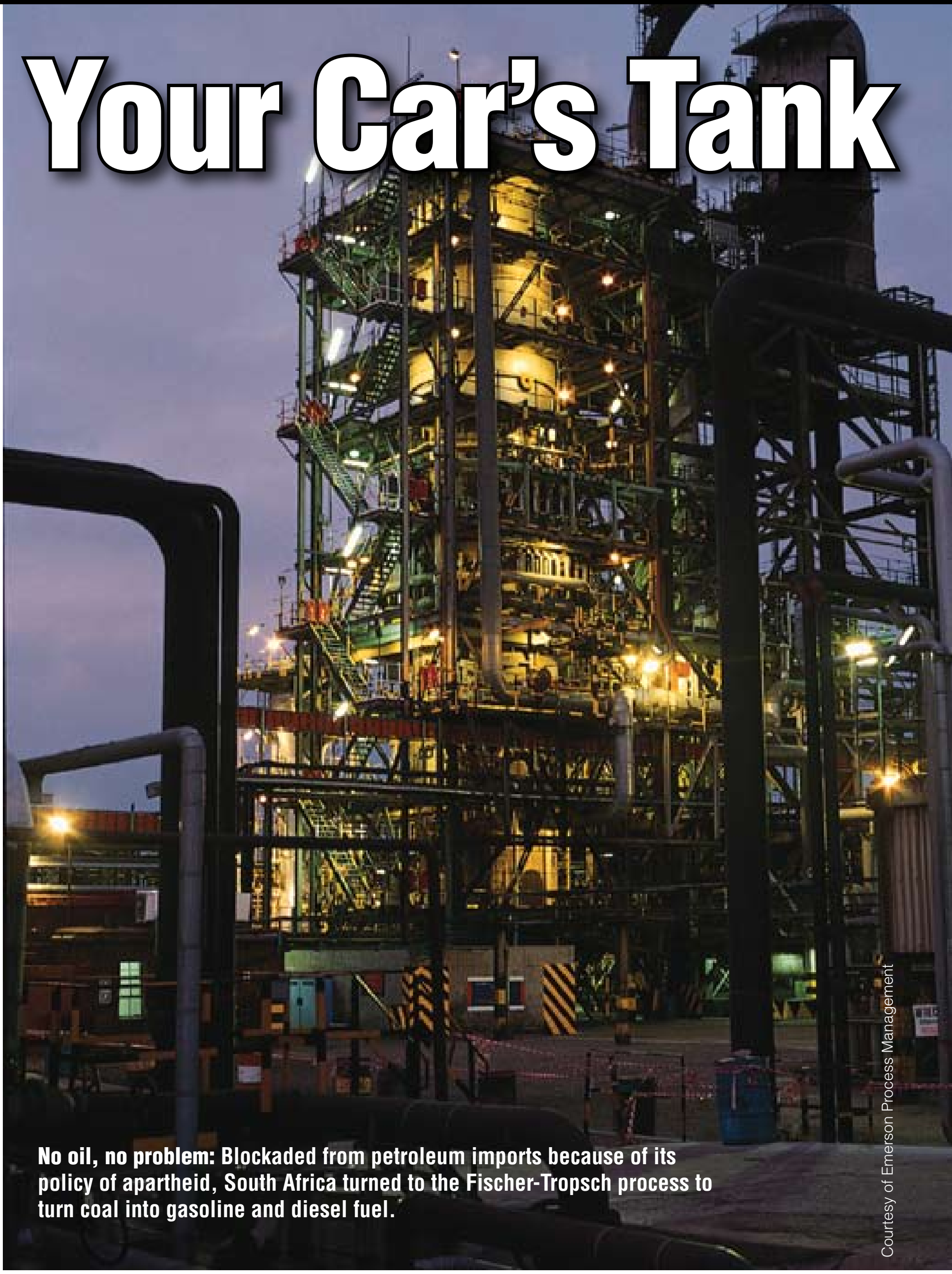
Coal in Your Car's Tank

American-dug coal could be altered to produce clean-burning fuels for our vehicles. Here's how we could do it, and what might stop it from happening.

by Ed Hiserodt



No oil, no problem: Blockaded from petroleum imports because of its policy of apartheid, South Africa turned to the Fischer-Tropsch process to turn coal into gasoline and diesel fuel.

Courtesy of Emerson Process Management

In 1943, when Germany had virtually no sources of petroleum to fuel its Luftwaffe, U-boats, and Tiger tanks, its scientists (arguably among the best in the world at that time) didn't turn to solar and wind power. Evil does not equate to naïveté. Hitler's technical advisers turned to another energy source to keep their Wehrmacht running steadily for several years without petroleum. They used the Fischer-Tropsch process to convert coal into diesel fuel and employed the Bergius hydrogenation (or liquefaction) process to convert coal into aviation gasoline and high-quality truck and automobile gasoline.

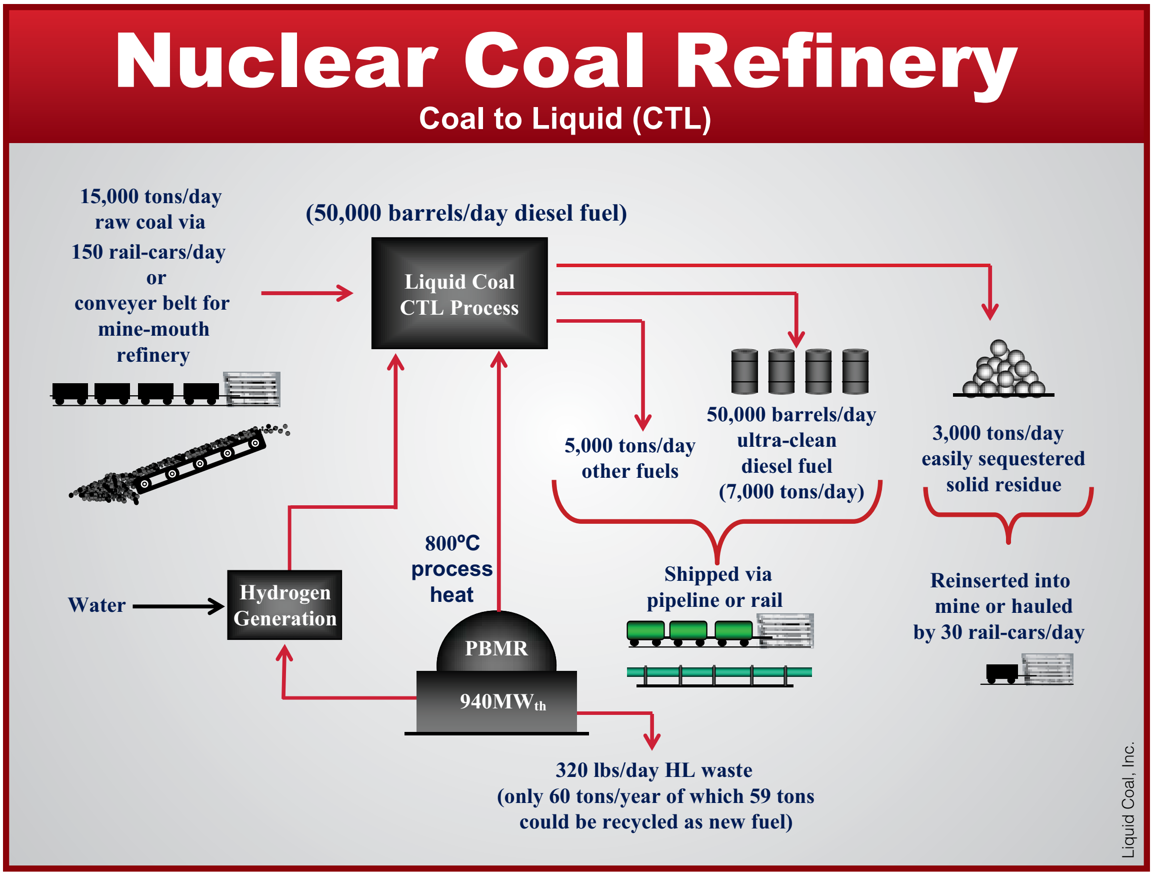
Coal-to-liquid Technologies

Gasoline and diesel fuel are hydrocarbons. The name gives us a clue as to how to convert coal to liquid fuel: combine hydrogen and carbon. Hydrocarbon fuels are designated by the number of carbon atoms in their molecules. For example, methane, the main constituent in natural gas, has one carbon and four hydrogen atoms. Ethane, butane, and propane are gaseous at room temperature and have two, three, and four carbon atoms respectively.

There are many hydrocarbons, and each has its own unique properties. Pentane, hexane, and heptane are liquid hydrocarbons but not desirable as fuels for internal-combustion engines as they have low ignition temperatures and cause "knocking" or premature combustion that can seriously damage an engine. Octane, with 8 carbon and 18 hydrogen atoms, is the optimum for standard engines, while cetane with 16 carbon and 34 hydrogen atoms is most desirable as a diesel engine fuel.

Nothing about the chemistry of coal has changed since WWII, and it is still possible to synthesize fuel from coal, which ranges from about 65 percent to 95 percent pure carbon. All that's required is hydrogen, heat, and pressure. Worldwide, such production is done only in limited amounts although one country is a significant producer: South Africa. Just as the Nazis were isolated from petroleum sources during WWII, South Africa's policy of apartheid brought about an oil boycott from most sources. To survive, they adopted the Fischer-Tropsch process to convert their substantial coal reserves into gasoline and diesel fuel. This is no pie-in-the-sky "someday" technology. The Sasol Ltd. plant in Secunda, South Africa, alone converts coal to 150,000 barrels (6.3 million gallons) of liquid fuel each day.

The question arises: "Why, if the process is relatively simple, isn't more coal converted into oil?" For years, the answer to that question was cost. It was simply too expensive compared to pumping oil out of



Efficient, environmentally friendly process: An estimated 200 plants operating as illustrated above would reduce imported oil by 83 percent and have very little environmental impact.

the ground, reported to cost the Saudis less than $1 per barrel. Robert Wright of the Department of Energy said in 2007 that coal-to-liquid technology would only be economical once oil prices were at $40 to $50 a barrel. Now that prices are well above that mark and will likely remain there, the problem has become the environmentalists who fear pollution above economic hardships brought on by high-priced motor fuels. But what if we can all have our cake and eat it too?

Taking Pollution Out of Coal

The Fischer-Tropsch coal-to-liquid (CTL) process has three reactions to yield hydrocarbon fuels. These reactions require a great deal of heat, heat derived from coal combustion. This process is referred to as *Indirect Liquefaction*. A major disadvantage of the technique is that the amount of coal used for heat in the coal-to-liquid process is greater than the amount converted to fuel. As a result, this process produces large amounts of ash, fly ash, sulfur dioxide, and nitrogen oxides, not to mention a waste of coal.

The *Direct Liquefaction* process developed by Nobel Laureate Friedrich Bergius in 1921 requires only one step where hydrogen is combined directly with pulverized coal under high pressure and temperature to produce various hydrocarbons depending on process variables. Since there are no naturally occurring sources of hydrogen like "hydrogen wells," the H_2 in existing coal-to-liquid plants (and in WWII Germany) is produced by the same chemical reactions used in the initial step of the Fischer-Tropsch process, i.e., it is obtained from heating coal with high-pressure steam producing hydrogen and carbon monoxide ($C + H_2O \rightarrow H_2 + CO$).

The bulk of pollutants created from direct liquefaction, the Bergius process, are created in the making of hydrogen for the process, but the creation of these pollutants can be largely avoided by separating the hydrogen with heat from a new generation of super-safe nuclear reactors.

While anti-nuclear activists have stymied the construction of any new power reactors in the United States for over 30 years, they have not been able to stop the development of new reactor technology, much of which has been done outside the United States. Third-generation modular reactors are designed to make meltdowns physically impossible. Among these developments is the "Pebble Bed Modular Reactor" that uses several hundred thousand baseball-sized fuel spheres, each of which contains 15,000 coated, grain-of-sand-sized fuel kernels. The pyrolytic graphite and silicon carbide layers coating the fuel kernels have melting temperatures far above that of the maximum equilibrium temperature of the reactor, making a meltdown impossible.

In traditional nuclear power plants (which are already extremely safe), water is used as a "moderator" to slow down neutrons so the nuclear reaction can occur, and also as a coolant and heat-transfer medium. In a Pebble Bed Modular Reactor, cooling is accomplished by piping helium through the pebble bed, with the spaces between fuel spheres serving as "pipes." The pyrolytic graphite coating of the fuel kernels serves as the moderator. Since the helium is not made radioactive by the neutron flux in the reactor, it can be sent directly though a turbine generator to produce electricity or, in this case, used to provide ample heat for the Bergius process.

This is no pie-in-the-sky "someday" technology. The Sasol Ltd. plant in Secunda, South Africa, alone converts coal to 150,000 barrels (6.3 million gallons) of liquid fuel each day.

Posma Puts the Pieces Together

Bonne Posma, a successful Canadian businessman who owned a mining technology company and a company specializing in electronics for mining and who previously worked for the South African Council for Scientific and Industrial Research, expanded his company to the United States in 1983. He eventually moved to Ft. Myers, Florida, and became a U.S. citizen. He recently sold the electronics side of his business but maintains a controlling interest in Saminco Electric Traction Drives, devices to power equipment for underground mining applications and public-transit vehicles. A dedicated believer in the free market, Posma's passion is to see an America free of OPEC extortions and all the dangers that financing its terrorist members represents.

Posma and his Liquid Coal Inc. (www.liquidcoal.com) appear to have a common-sense plan to unleash American engineering and capital and to cause a sea change in our current dependence on unfriendly foreign energy suppliers: that plan consists of using third-generation nuclear power to provide the heat to create oil from coal. Remarkably, this is a technology that even most of those fearful of human-caused global warming could support, having a smaller "carbon footprint" than even electric cars. This holds true because the overall efficiency of a coal-fired power plant (where most electric energy is derived for electric cars) is limited by thermodynamic laws to about 35 percent, while use of a reactor for heat to run the Bergius coal-to-liquid process is nearly 100-percent efficient. Hence, in the CTL process, the carbon from coal is used only for producing fuel that is converted to propulsive energy. Conversely, only one-third of the "carbon footprint" of an electric car powered by the output of a coal-fired plant is for propulsion, with the remainder lost as waste heat.

The process works like this. One hundred and fifty 100-ton rail cars bring the coal feedstock for the conversion process each day. This is about 50 percent more coal per day than used in a typical 1,000 MW power generating plant. The feedstock is fed into the coal-to-liquid processor where the crushed coal is liquefied by heat derived from a Pebble Bed Modular Reactor.* Additional reactor heat is used to generate hydrogen from water. The hydrogen and coal react to produce a variety of hydrocarbon fuels based on the process temperatures and pressures, with diesel fuel being the most desirable according to Posma.

Diesel fuel, which has the highest specific energy of the hydrocarbon fuels, provides "gas mileage" twice that of ethanol and 40 percent higher than gasoline. And this isn't the "dirty diesel" of years gone by. For those of you accustomed to the smell of exhaust from diesel fuel containing 500 parts per million (ppm) of sulfur, times are a'changing. Low-sulfur fuel now on the market has only 15 ppm. Diesel derived from the CTL process has 5 ppm and is virtually odorless.

Liquid Coal's projections indicate that it would require 200 CTL plants to produce 10 million barrels of oil per day, reducing our dependence on current imports of 12 million barrels per day by 83 percent. While this may seem like a huge number of CTL plants, energy industry sources report between 132 and 137 major coal-fired power plants currently under construction.

Why Not?

Of course there are obstacles standing in the way of the building of such plants to

* Alternate technologies such as the General Atomics GT-MHR reactors are also able to supply process heat in the 700- to 1,000°-C range, far above the 300° C temperatures current pressurized- or boiling-water power reactors can provide. High process heat temperatures are critical to the production of hydrogen for CTL technology. Heat from the process can be "scavenged" to produce steam for electrical generation.

The "Saudi Arabia of Coal"


AP Images

With 27 percent of global reserves, the United States is far and away the leader in coal resources. Using current mining techniques, some 275 billion tons are considered to be recoverable out of a demonstrated reserve base of 491 billion tons. With an annual production rate of 1.2 billion tons, nearly 250 years of use is currently available. This, however, could be greatly extended by generating electric power with plentiful nuclear fuel instead of using 86 percent of coal production for that purpose.

Commercial coal mines operate in 26 states, with 1,331 mines east of the Mississippi and 93 west of the river. Most eastern mines are underground while western mines are almost entirely high-production surface mines allowing the West to "outstrip" the East by 672 million tons to 490 million tons per year. ■

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Tax disincentives and costly regulatory penalties are high on the list of hurdles to overcome. The current cost of licensing *each* nuclear reactor is $60 million to $100 million.

wrest transportation fuels from coal using methods that are both economical and have little impact on the environment — even satisfying most of the global-warming crowd. Tax disincentives and costly regulatory penalties for projects are high on the list of hurdles to overcome.

An example of the above is the current cost of licensing *each* reactor, regardless of whether it is an exact clone of an earlier design: $60 million to $100 million, even though, according to Posma, the Nuclear Regulatory Committee's attitude toward new applications has become more reasonable. Besides the regulatory cost disincentives, which in reality would end up getting passed on to consumers through higher energy costs, the big collar and chain holding back nuclear power's freedom are litigation and the bureaucratic licensing process. Posma elaborates:

To streamline the approval process, the Nuclear Regulatory Commission (NRC) has recently introduced the COL concept (Combined Operating License), which grants a combined construction and operating license to applicants meeting the NRC's COL requirements. Trouble is, not all of these regulations have been finalized, so the utilities still take somewhat of a financial gamble because past practice mandated issuing a nuclear operating license only after a reactor is constructed — and this is a beautiful opportunity for enemies of energy to start tedious litigation to bankrupt the plant. This is what happened with the Shoreham nuclear power plant. But there is progress: on April 8 this year, the NRC granted our country's first COL for Georgia Power's Vogtle 2 and 3 nuclear power sites by considering the existing draft regulations as sufficiently complete to be used as a basis. If all goes well, this COL alone will allow 2,300 MW of electric power to come on line in 2015. Eight more COL approvals should follow shortly.

While ever ready to put up roadblocks to proven sources of reliable energy, environmentalist influences in our government are quick to use tax dollars to subsidize expensive, unreliable wind and solar projects. The subsidy for wind generation is 1.9 cents per kWh alone — more than the cost of nuclear power production, including operations, fuel, depreciation, decommissioning, and spent-fuel storage. Solar-generation subsidies appear purposely unfathomable, but likely off the chart. Both these technologies, being intermittent power sources because of changes in wind speeds and things like cloudiness, night, and precipitation, need to be backed up by conventional power plants that must be kept constantly running (spinning reserves) so as to be able to produce power when needed.†

There are other significant hurdles to overcome before beginning the building of these plants, obstacles that fall under the category of general "environmental concerns," such as the dangers from nuclear power-plant wastes. Besides the fact that the dangers from plant wastes are greatly exaggerated (see "Nuclear Waste: Not a Problem" in our February 18 issue), such concerns should be weighed against other, larger environmental concerns. For instance, what could be a bigger "environmental concern" than for the United States to go through an oil drought that would destroy industries, jobs, families — indeed the entire economy of our nation? Do we want to be faced with having to use force to acquire producing oil fields around the world or see a depression and misery as we have never known as a country? My vote is "no" to that scenario and "yes" to the coal-to-liquid process. How say you? ■

Nuclear energy in use: The Nuclear Regulatory Commission does not regulate naval reactors, and the United States has built a total of 200 nuclear-powered ships, of which 60 are still in service — 10 aircraft carriers and 50 submarines. The Navy now has an impressive 5,500 reactor years of service without a single on-board nuclear power plant fatality. The new generation of nuclear reactors for civilian power plants will be even safer than those either powering naval vessels or currently used in civilian power plants.

† On February 29, 2008, the West Texas grid that has the largest percentage of wind turbine power in the United States suddenly dropped from 1,700 MW to 300 MW. Grid operators brought on available "spinning reserves" only to find they were insufficient to compensate for the sudden loss. Similarly, electrical feeds from other sources could not provide sufficient energy. To avoid "brownouts" or rolling blackouts, major electrical users were forced to discontinue operation.