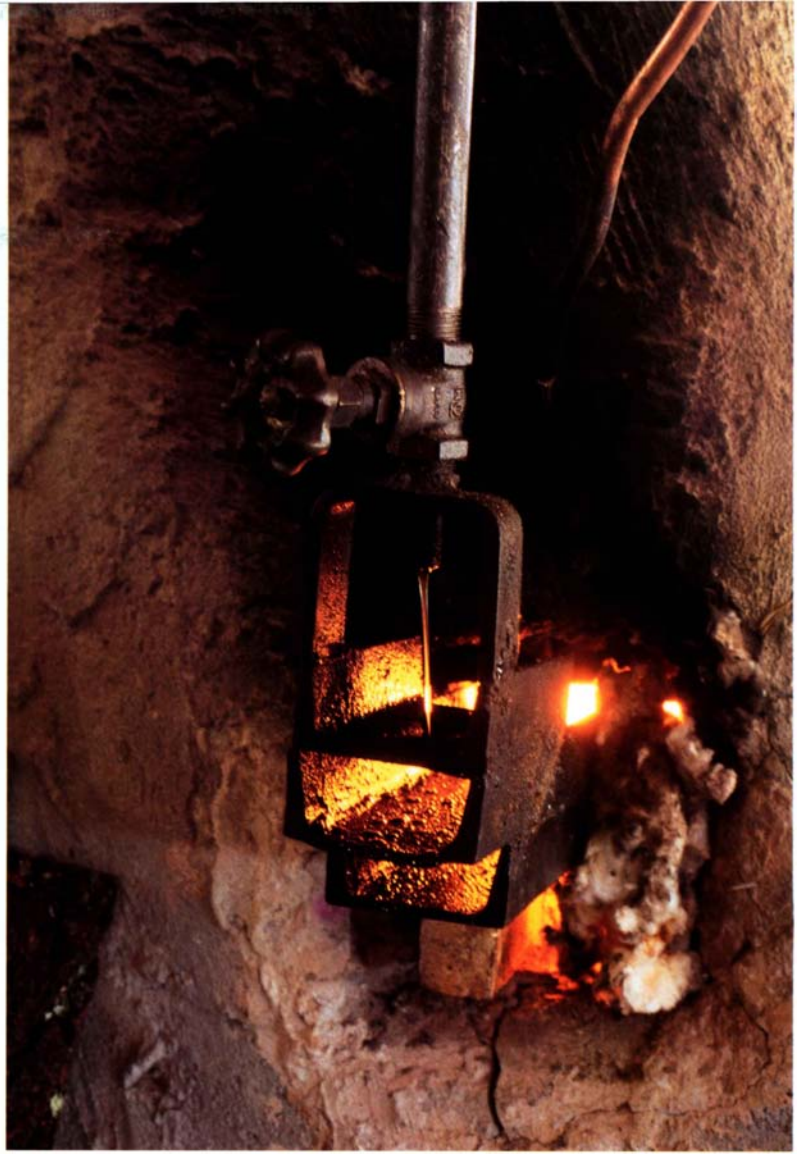
Firing with Vegetable Oil

by John Britt



The oil-drip burner is made of channel iron welded together to form three steps. The oil temperature increases as it drops onto each step, until it vaporizes and ignites inside the kiln.

Many potters consider themselves environmentalists, yet they fail to consider the effects of their craft on the environment. As we take part in the demand for electricity, minerals and petroleum, we also share the responsibility for their environmental effects. One of the most common rationalizations is that we are only using the scraps of industry and are therefore not the primary cause. For Sam Clarkson, this rationalization was unsatisfactory, and he decided to take some positive action to reconcile his love of pottery with his concern for the environment.

As a production potter, Clarkson wanted to minimize both the cost and the detrimental effects of burning hydrocarbons while pursuing his passion for high-fire pottery. For a time, he experimented with wood firing, using scrap wood from a molding factory. He reasoned that the wood was waste and would have been burned in an incinerator anyway. This solution worked well for a while, but wood firing is extremely labor intensive and can produce large amounts of soot emissions.

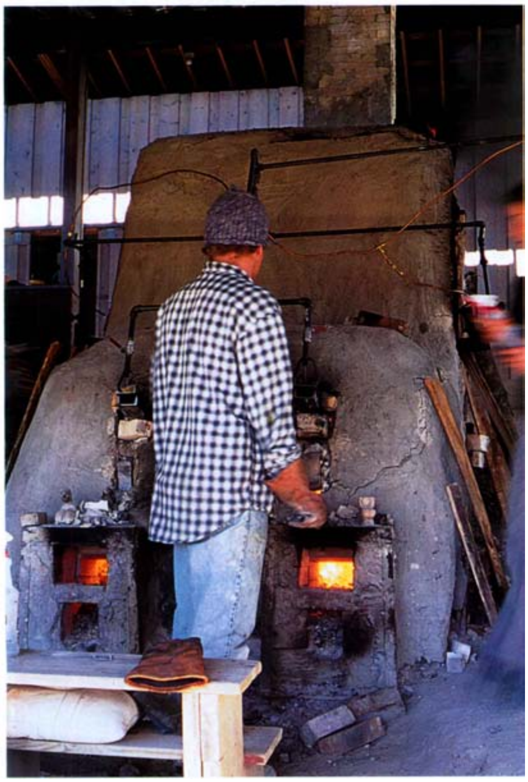
While searching for another solution, Clarkson heard a story on NPR (National Public Radio) about a car that runs on biodiesel, a mixture of 80-90% vegetable oil and 10-20% ethanol alcohol. It is produced from a chemical reaction that is catalyzed by the introduction of lye into the vegetable oil. He thought that if it was possible to run a car on vegetable oil, surely it would work as fuel for a small kiln. So, while in graduate school at Penn State, he experimented with vegetable-oil fuel in a 7-cubic-foot kiln. After some initial success, he longed to experiment with a larger kiln to test the viability of this method in a production setting.

His chance came in the fall of 2001 while team-teaching an eight-week concentration at Penland School of Crafts in North Carolina. Although the focus of the course was functional dinnerware, he and fellow teacher Alleghany Meadows persuaded the 20 students to take on the experimental project of firing Penland's noborigama with used vegetable oil.

Other people who fire such kilns use wood to reach Cone 8, then finish off with diesel fuel. Switching fuels allows them to quickly and easily reach the final temperature, while eliminating fly ash at the upper end of the firing. Clarkson and Meadows decided to adapt this method of a wood/fuellsalt firing, but substitute vegetable oil for the diesel fuel. The plan was to start the kiln with wood until it reached approximately Cone 1, thus allowing enough time for some early ash deposits while establishing enough heat to ignite the oil.

One advantage of burning used vegetable oil is that it is a waste product of the massive fast-food industry. Some major restaurants and fast-food chains have contracts with companies that process their waste oil for use in cosmetics, livestock feed, pet food, heating, etc. Yet there are thousands of smaller restaurants across the country that simply dispose of their waste oil. This means there are millions of gallons of vegetable oil that could potentially be available as fuel.

Aside from being readily available and free, the most important reason for using vegetable oil is that the hydrocarbon, soot and nitrogen emissions are very low. Tests show that biodiesel emissions are substantially lower in carbon dioxide, carbon mon-



Far left: Plumbing for the water and oil was installed to conform to the shape of the kiln, out of the way of the stokers.

Left: Oil is gravity fed from a 50-gallcn drum on an elevated platform.

oxide, sulfur dioxide, nitrogen dioxide and a host of other emissions than petroleum diesel emissions. In fact, the amount of carbon dioxide emitted is about the same, theoretically, that is absorbed from the atmosphere by growing the next crop of soybeans or corn.

Canola and corn oil are probably the most popular vegetable oils used in fryers across America. Canola oil has one of the highest yields of any of the oil crop, around 200 gallons per acre. The Penland kiln consumed approximately 20 gallons per firing.

Most of the oil used for the first two firings was new, as it seemed unwise to collect and store a lot of used oil until it was established that it would work. For the next firing, 25 gallons of used canola oil were acquired from the Penland kitchen fryer, thanks to the generosity of the head chef, "Big John" Renick. After the oil was screened, it worked just as well as the new oil, although it did have the familiar smell of french fries.

A reconditioned 50-gallon drum barrel was then purchased to store the used vegetable oil. It should always be stored in dark containers in a cool, dry location. It is also a good idea to keep the container as full as possible to minimize contact with air and moisture. This is important, as the oil may become very smelly from the growth of microorganisms.

With the help of the studio assistants, Steve Schaeffer and John Arsenault, I set out to construct a burner and oil-delivery system that was efficient enough to fire the kiln to Cone 10. The 50-gallon drum was elevated to approximately 6 feet by a stand made of 2x4s. The drum had both a 4-inch and a 2-inch female-threaded opening, which were placed at the bottom. This allowed us to easily attach threaded pipe for the delivery system. It also allowed the oil to be fed by gravity and kept our delivery pipes overhead, out of the path of workers. With an acetylene torch, we cut a 6-inch hole in the top of the drum where we poured in the vegetable oil. This hole remained open.

The burners were constructed from 5-inch-wide I-beam metal that had been cut into 12-inch lengths, then welded together in a stepped configuration. The three "steps" extended about 15 inches into the firebox, so that the heat of the firebox would be conducted to the metal burner. As the oil drips down the burner steps, it becomes successively hotter and hotter, until it vaporizes and ignites. A shut-off valve is used to control the flow of oil.

Another supply line feeds water onto the burner. This serves two purposes: it causes the oil to dissipate and flow down the metal burner channel, and it creates hydrogen reduction in the chamber. Hydrogen is far more reactive as a reducing agent than is carbon. When water combines with red-hot carbon, it produces carbon dioxide and hydrogen. This carbon hydrogen is also known as "water gas."

The Chinese have used hydrogen reduction since the Han dynasty in the production of gray bricks. It is still used today in some wood-fired kilns in Jingdezhen. The water is either dripped down the interior walls of the kiln or introduced through channels in the kiln as it reaches peak temperature. The kiln is then shut off and sealed.

Our water delivery system was constructed from a standard water hose that was reduced in diameter with a fitting and connected to ¾-inch copper tubing. We controlled the water with a shut-off valve at the hose and a needle valve at each burner. This had to be adjusted often because the water pressure fluctuated frequently. During the firing, it sounded a lot like water dripping into a hot frying pan—with the accompanying smell of cooking pancakes.

After several attempts, we determined that we needed four oil-drip burners. In order to have more control of the flame, we placed two oil burners in the front of the main firebox and two burners in the stoke holes of the main ware chamber. Each had separate feed lines to maintain equal pressure. Through patience and perseverance, Clarkson and the students were able to find a good blend of fuel, water and air. The kiln reached temperature and was well reduced throughout.

Firing kilns with used vegetable oil has great potential as an alternative energy source. It requires only a small investment in burners, supply lines and storage drums. The oil is easy to obtain, inexpensive (or free) and produces sufficient heat to fire to Cone 10. However, more research and experimentation is needed to perfect this method. One area to explore would be a stainless-steel injection burner system that would spray in the vegetable oil with compressed air.

The use of waste vegetable oil and other alternative fuel sources could help potters address the impending shortfalls of petroleum fuel, as well as its associated pollutants.

Salt-glazed cup, *Vk* inches (9 centimeters) in height, wheel-thrown porcelain, with black slip and celadon glaze, fired to Cone 10 with wood and vegetable oil, by Alleghany Meadows, Carbondale, Colorado.

Salt-glazed teapot, approximately 6 inches (15 centimeters) in height, thrown, stamped and altered porcelain, with celadon glaze, fired to Cone 10 with wood and vegetable oil, by Sam Clarkson, Sewanee, Tennessee.