CHAPTER 25

HOW DIESEL ENGINES CAN RUN ON ALCOHOL

Learning how to run diesel engines on alcohol gives us a peek at what alcohol engines of the future may be capable of doing. Diesel engines are used in heavy equipment, generators, cars, ships—almost anything requiring reliable, efficient, industrial power. They are noted for very high thermal efficiency, and the price of diesel fuel is often lower than gasoline. Diesel engines are increasingly being found in European cars, which get higher and higher mileage rates as improvements are made over the years.

Gasoline engines are spark-ignited, meaning they fire their fuel with spark plugs. Diesel engines

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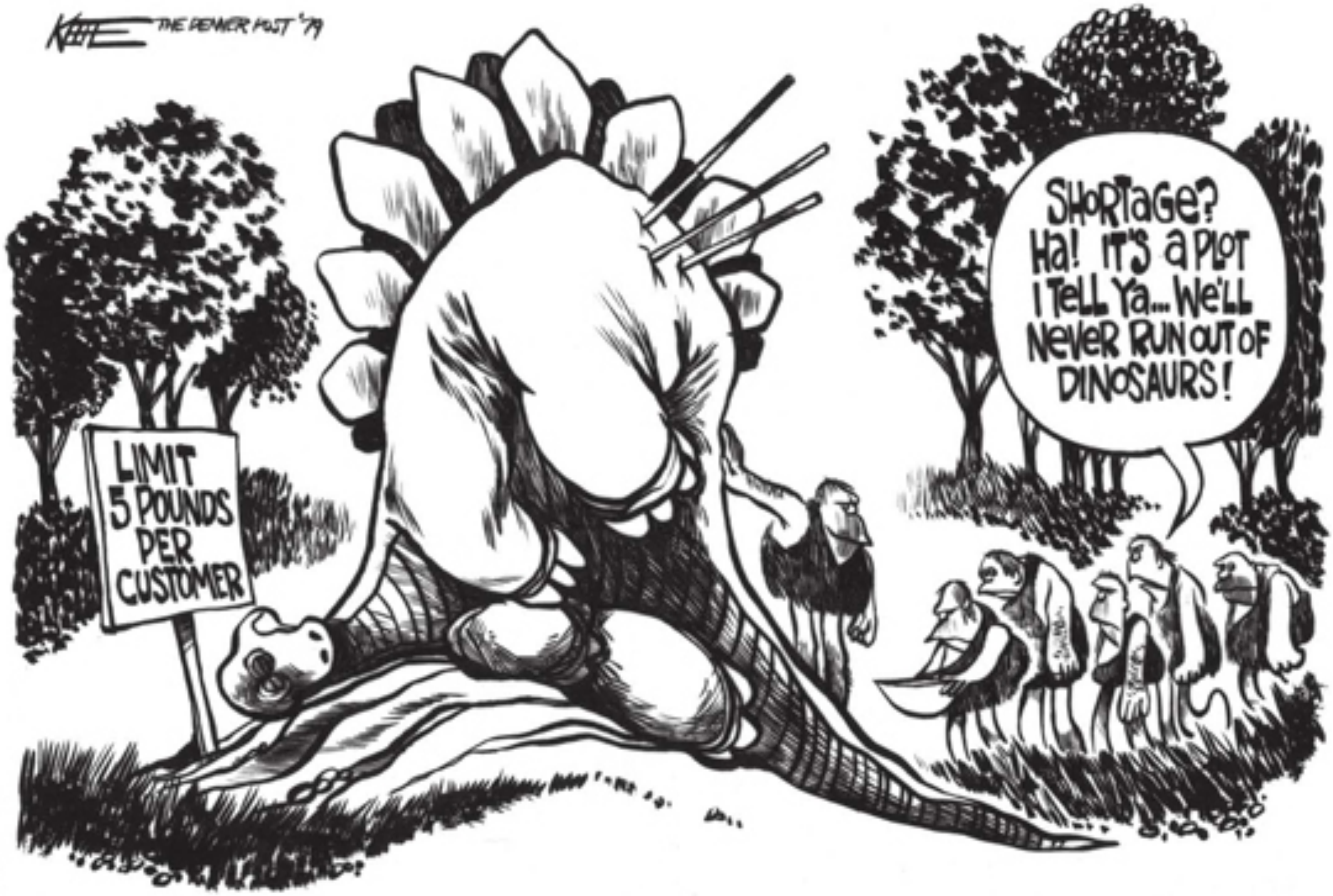

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Fig. 25-1

are compression-ignition engines. This means that they compress the air/fuel mixture until it gets hot enough to explode by itself (auto-ignition) without the need for a spark. They work by intentional pinging (kind of). But since diesel engines are made to withstand the stresses of auto-ignition, it isn't dangerous.

Compression ratios in diesel engines are as high as 18:1 in tractor-trailers, and 23:1 in cars like the Volkswagen TDI. Very high compression gets more of the easily extractable energy from a fuel.

The very thing that makes alcohol an ideal fuel for a spark-ignited engine—its high resistance to pinging, due to its high octane rating—works against its easy use in diesel engines. Diesel fuel is given a cetane rating, which measures how easily it will "ping." It's a rating system that's the opposite of octane rating. Diesel fuel itself has a cetane rating of about 45, while ethanol has only 8 (and methanol a pitiful 3). This rating expresses itself as the auto-ignition temperatures of each fuel. Ethanol will self-ignite at 395°C; diesel at 245°C. So, diesel wants to explode more easily at a lower temperature. When pure alcohol finally does ignite, it does so at the wrong time in a diesel engine and causes damage.

Using alcohol in a diesel engine presents immediate general problems. Presently, very high-pressure diesel injection pumps and injectors require lubrication, which diesel fuel normally supplies. (Diesel fuel does not lubricate the engine, contrary to what many people think.) Alcohol doesn't provide enough lubrication by itself. Also, if water in the system gets past the fuel line water trap, it will damage the fuel pump. The most significant obstacle is the low cetane rating. But depending on which approach you use, anywhere from 50 to 85 to 100% of diesel fuel can be replaced with alcohol and/or a combination of biofuels.

Sulfur, heavy metals, HC, NOx, CO, dangerous chemicals, and carbon dioxide could all be reduced drastically under alcohol's influence. Research done at the Institute for Technological Research in Brazil has shown that even a 3% addition of ethanol mixed into diesel will significantly lower particulate (HC) emissions. In fact, CO emissions from diesel engines run on E-95 alcohol can even be slightly less than from gasoline engines running on alcohol.[1] New European demands for cleaner diesels are leading the way for better versions of these noxious polluters.

BLENDING ALCOHOL AND DIESEL

Researchers are interested in finding ways to make alcohol and petroleum diesel mix. So far, most petroleum-based emulsifiers that have been proposed are too expensive to be worthwhile; these permit blending of 10% alcohol with petroleum diesel. Even this small addition dramatically drops some of diesel's emissions, but more can be done.

South Dakota farmers have discovered that biodiesel makes blending of dry alcohol and normal diesel possible in almost any proportion. Biodiesel mixes well with alcohol and, in theory, should provide the same versatility as castor oil (discussed below), at a lower price. What's more, biodiesel has the fuel pump lubrication that alcohol lacks. As mentioned above, even a 1% addition of biodiesel mixed with alcohol provides effective lubrication.

Most of the farmers' tests used 50% alcohol, and 25% each of normal diesel and biodiesel. Petroleum diesel was added primarily because it was cheaper than biodiesel at that time—clearly 50/50 alcohol and biodiesel should work equally well. The basic idea is that the biodiesel acts as the cetane improver and causes ignition at the right time, and the alcohol then goes right along with it.

More testing needs to be done to determine just how little biodiesel needs to be mixed with

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RIGHT: Fig. 25-2 Al Kasperson, renewable fuel pioneer, blending fuel. *Al has just shaken three layers—diesel, biodiesel, and alcohol—which have blended into a homogeneous mixture.*