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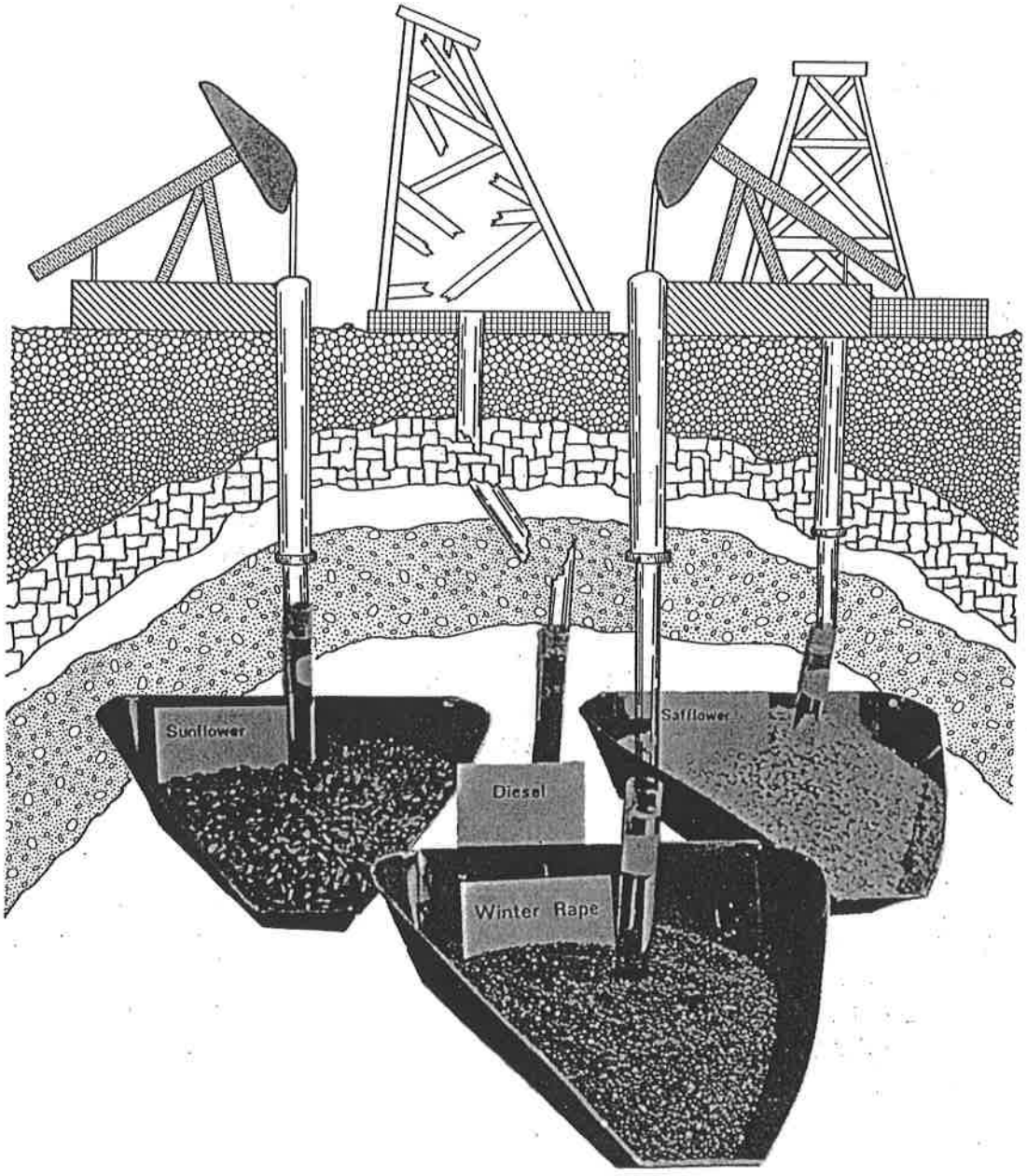
Use of Vegetable Oil as a Fuel in Time of Emergency



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Use of Vegetable Oil as a Fuel in Time of Emergency

Timing of field operations such as planting, cultivating, spraying and harvesting is critical. A delay of only a few days can result in reduced yields or even loss of a crop. Therefore, agricultural production is vulnerable to short-term shortages of fuels.

Agriculture needs a backup supply of fuel for diesel equipment, and on the farm as a backup supply is where vegetable oil has the best chance of making an impact. A dual technology strategy could provide a valuable oil cash crop and allow that crop to be turned into a liquid fuel that would enable the production cycle to continue during an emergency.

Summary

Routine use of vegetable oil as a replacement for diesel fuel is not yet recommended, but in an emergency, vegetable oil could be used as a substitute for diesel fuel. However, the engine operator should be aware that engine damage may result — filter plugging, cold starting problems, injector coking, formation of carbon deposits in the combustion chamber and contamination of the lubricating oil.

Recommendations

If you are considering using vegetable oil as a replacement for diesel fuel, you should consider the following:

1. Use vegetable oil for as short a time as possible and only when good quality diesel fuel is not available. The vegetable oil esters are preferable to the unmodified oils.
2. Blend the vegetable oil with diesel fuel to reduce viscosity.
3. Use the more saturated vegetable oils such as high oleic safflower or peanut oil or high erucic acid rape oil rather than the more unsaturated oils such as high linoleic safflower or soybean oil.
4. Clean the injectors if engine performance appears to degrade.
5. Check engine oil viscosity at least once during every 8 hours of operation. If necessary, change oil more frequently than the normal oil change cycle — 50 to 75 hours may be desirable.

6. Filter plugging is a common problem. You may need to add an additional in-line oil filter. A dispersant fuel additive such as DuPont FOA-2 has been found to be effective in reducing filter plugging.
7. Do not idle the engine for long periods and do not lug the engine any more than necessary. Both practices allow raw vegetable oil to accumulate in the ring belt area causing ring sticking and contamination of the lubricating oil. Operate the engine in the 50 to 90 percent power range as much as possible.
8. If practical, add an additional tank to hold diesel fuel so the engine can be started and stopped in diesel fuel. Switch to diesel fuel about 5 minutes before shutdown to purge the vegetable oil blend from the fuel system and from the combustion chamber. Allow the engine to warm-up on diesel before switching to the vegetable oil blend.
9. Avoid cold weather operation with vegetable oils or install tank and fuel line heaters to extend cold weather operation. Vegetable oils solidify at much higher temperatures than diesel.
10. The vegetable oil molecule can be altered in a chemical reaction to form an ester that has been found to be nearly equivalent to diesel fuel. Production of esters may also add considerable cost to the vegetable oil fuel, however, unless a market for the by-products can be found. The esters are a desirable emergency fuel substitute for diesel when they are available.

Selecting a Vegetable Oil Type

The best vegetable oil types for use as a substitute for diesel* are sunflower, safflower, soybean, cotton, winter rape, canola and peanut. All of these vegetable oils have energy contents similar to diesel fuel, but vegetable oils are 11 to 17 times more viscous, which could result in injector pattern problems and is thought to be at least in part responsible for difficulties experienced with engine deposits. The vegetable oils have nearly the same specific gravity, but all are 7 to 9 percent heavier than diesel fuel. Table 1 compares some properties of a few vegetable oils with diesel fuel.

*Use of the word "diesel" in this paper refers to the commercial grade No. 2 diesel fuel commonly used to power agricultural tractors and equipment.

Most vegetable oils contain small amounts of phosphatides called "gums" and free fatty acids that are removed by hydrating with steam or hot water. After hydration, the water will settle to the bottom, and the oil is siphoned off. A simple filtration system can be easily constructed from readily available components. One such system used a roller pump of the type used on farm sprayers to pump the oil through a series of throw away filters and a final fuel filter from a diesel engine.

Most researchers have reported fuel filter plugging to be a problem when using vegetable oil, and appropriate precautions should be considered. The addition of a dispersant type diesel fuel additive reduced filter plugging four-fold.

Vegetable Oil Storage

Vegetable oils can be stored for a long time if reasonable care is taken during storage. If the oil is to be stored for more than 6 months, the containers should be sealed with airtight caps, purged with nitrogen gas and stored in a cool, shaded location. Because vegetable oils solidify at higher temperatures than diesel fuel, heated storage may be required in cold climates. Storage in plastic or coated steel drums is preferred.

Short Term Engine Performance

Nearly every study performed to date has shown that vegetable oil can be used as a direct substitute for diesel in short term tests limited only by the viscosity of the fuel. Short term tests show that power output, torque and brake thermal efficiency when engines are fueled with vegetable oil were equal or were close to test results from when the engine was fueled on diesel. Fuel consumption is generally slightly higher, reflecting the reduced energy content of the vegetable oil.

In a summary of 22 short term engine tests conducted at 12 locations worldwide in which vegetable oil was compared to diesel fuel, peak engine power on the vegetable oil fuels ranged from 91 to 109 percent of that on diesel fuel; in 16 of the 22 tests, peak power was equal to or exceeded test results from when the engines were operated on diesel fuel. The vegetable oils included in the tests were rapeseed, soybean, sunflower, peanut, palm kernel, jojoba, coconut, linseed and canola.

Long Term Engine Performance

While short term tests results are almost always positive, longer term tests almost always lead to severe engine deposits, ring sticking, injector coking and thickening of the lubricating oil.

Injector coking is a problem reported in most long term engine tests with vegetable oils. A second major problem associated with vegetable oil use in direct injection engines is polymerization of the vegetable oil in the ring belt area causing the rings to seize. This is often associated with an increase in blow-by, a corresponding increase in the viscosity of the lubricating oil and resulting catastrophic failure of the engine. If vegetable oil is to be used without modification in direct injection diesel engines, it would need to be blended with diesel. The blend should not contain more than 25 to 50 percent vegetable oil. Whereas, if the vegetable oil is transesterified, it may completely replace diesel. However, reduced engine life may occur in both cases.

One factor that can reduce the engine deposit problem and somewhat extend engine life is the choice of vegetable oil. Those oils with fewer double and triple bonds in their fatty acids, that is, those less unsaturated vegetable oils, have less tendency to polymerize. In a study in which oleic safflower and high linoleic safflower were compared in long term tests, the engines operated on oleic oils did have somewhat less engine deposits at the conclusion of the tests than did engines operated on the more unsaturated linoleic safflower, but both were high in deposits when compared to those operated on diesel.

In a North Dakota study, tractors were operated on farms over a 3-year period with alkali-refined, winterized sunflower oil/No. 2 diesel blends. The engines operated a total of 7,617 hours and burned a total of 38,540 gallons of fuel. Three tractors were fueled with 25 percent sunflower oil/75 percent diesel and three with 50 percent sunflower oil/50 percent diesel. All engines were turbocharged, direct injection diesel engines. Two were intercooled, and one used a fuel and a lubricating additive. One engine experienced a camshaft/valve train failure. Most deposits were found on engines fueled with the 50 percent sunflower oil; a significantly lower level of deposits were found on pistons from engines fueled with 25 percent sunflower oil. The lowest average amount of deposits were found on pistons from engines fueled with only No. 2 diesel. No injector coking problems or ring sticking problems were encountered. Bearing wear was normal.

North Dakota researchers concluded that based on this study, use of 25 percent sunflower oil/75 percent No. 2 diesel blend or a 50 percent sunflower oil/50 percent diesel blend as a substitute diesel could not be recommended. However, under emergency conditions, a 25/75 blend of alkali-refined winter-

Disclaimer Statement

This report contains a summary of research results. This report is not to be construed as a recommendation for the use of any alternative fuel mixture mentioned. The engine operator is responsible for all decisions concerning use of alternate fuels.

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