THE EFFECT OF SUNFLOWER OIL ON A DIESEL FUEL SYSTEM

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A typical farm tractor diesel fuel system (injection pump, fuel lines, filters and injectors) was tested on a test stand at various temperatures using sunflower oil, diesel fuel, and mixtures of the two as fuels. Measurements taken included fuel volume delivered by the injector line pressure at the injector, pressure drop across the filter, transfer pump pressure, and fuel injection timing.

A fuel injection calibrating test stand was used for the tests. A Roosa Master Pump was tested using all the fuel system components from an Allis Chalmers model 190-XT tractor. Commercial #2 diesel fuel and crude sunflower oil extracted at the Agricultural Engineering laboratories at North Dakota State University were used. Physical properties of fuels are listed in Table 1.

Table 1. Physical Properties of Fuels Used

Fuels	API Gravity	Specific Gravity	Viscosity* (Centistokes) @77°F	Cetane* Number
#2 Diesel	34.9	0.850	3.12	48.0
10% S.O.	33.3	0.859	—	—
25% S.O.	31.5	0.68	7.00	—
50% S.O.	27.8	0.888	13.72	38.2
75% S.O.	24.9	0.905	26.75	—
100% S.O.	21.7	0.942	54.77	28.7

*Hofman, 1981 S.O. = Sunflower Oil

Fuel was continuously recirculated in the test set up. The fuel flow pattern is shown in Fig. 1. Two starting temperatures were used: room temperature, 60°F, and cold start, 36°F. Fuel volume, injection pressure and filter restriction were taken at intervals until the fuel temperature stabilized at approximately 90°F. Transfer pump pressure was recorded at idle and rated speed. Transfer pump pressure was set to factory specifications and not adjusted throughout the tests. Injection timing was recorded at the beginning and end of each run.

RESULTS

Fuel Volume:

Fuel volume per 1000 strokes vs. temperature when starting at room temperature and recirculating until 90°F using various fuels is illustrated in Fig. 2.

Kucera is professor, Schunk is former graduate student and Pratt is professor and chairman, Department of Agricultural Engineering.

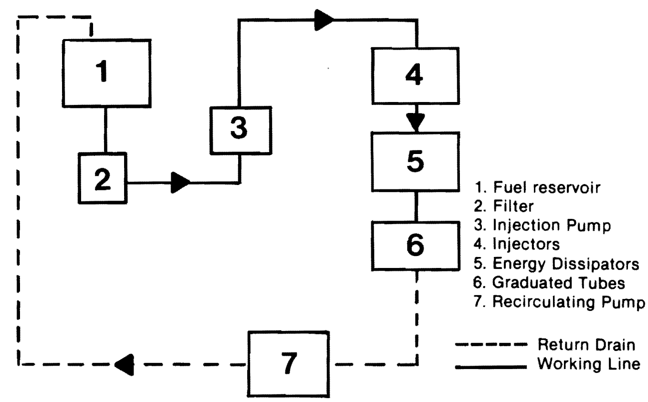


Fig. 1. Fuel Flow Pattern

Results from cold start runs using mixtures of the three highest percentages of sunflower oil are shown in Fig. 3. These were considered the most critical at low temperature starts because of the high viscosity of sunflower oil.

Seizure of the injection pump occurred on the final cold start run with 100 percent sunflower oil. The injection pump was disassembled and inspected. The seizure was similar to the Roosa Master manual description of failure due to a lack of lubrication between intake and

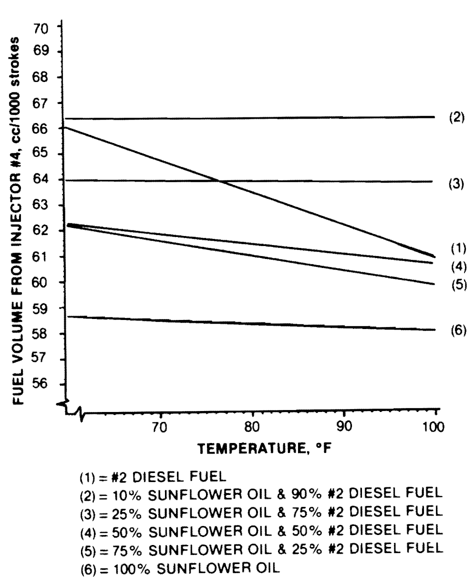


Fig. 2. Fuel Volume, cc/1000 Strokes, vs. Temperature, °F, from Injector #4 Starting at Room Temperature.

discharge ports on the rotor shaft (Fig. 4). The injection pump was rebuilt to factory specifications. During the second run with 100 percent sunflower oil, seizure occurred again. This time the pump was sent to the Roosa Master Company.The second failure appeared to be typical of a misalignment problem. In both cases, conclusions were based on previous experience of the manufacturer when using #2 diesel fuel.

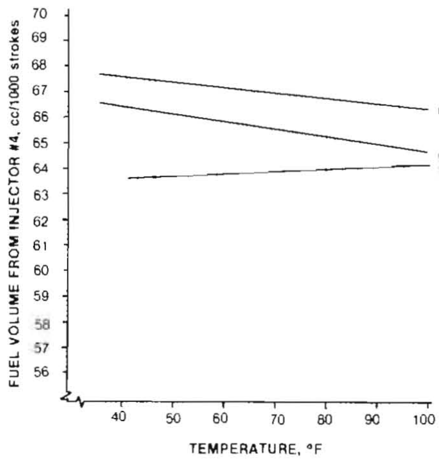


Fig. 3. Fuel Volume, cc/1000 Strokes, vs. Temperature, °F, from Injector #4 Starting at Room Temperatures.

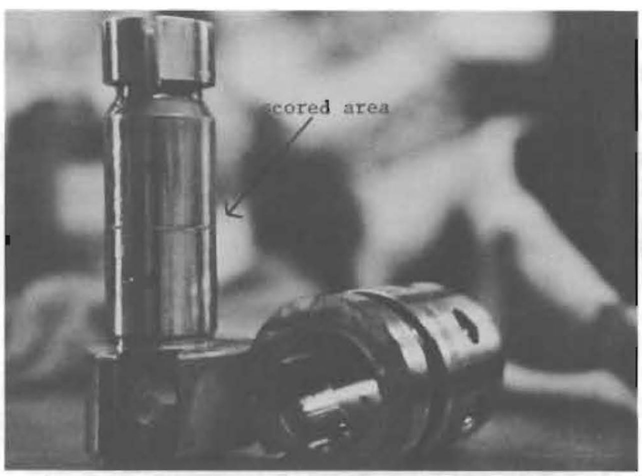


Fig. 4. Failed Injection Pump Parts

Test results show that the volume of fuel delivered by the injection system decreases as the fuel temperature increases, and decreases as the percentage of sunflower oil in the fuel increases. The degree of fuel atomization was not measured. Therefore, actual combustion efficiency in an engine cannot be predicted by this experiment.

Line Pressure at Injector:

Fig. 5 illustrates final results. The typical oscilloscope wave form of injection line pressure vs. time is shown in Fig. 6. For maximum pressure values, the average of the two peaks shown were used by varying the sweep time and superimposing the peaks.

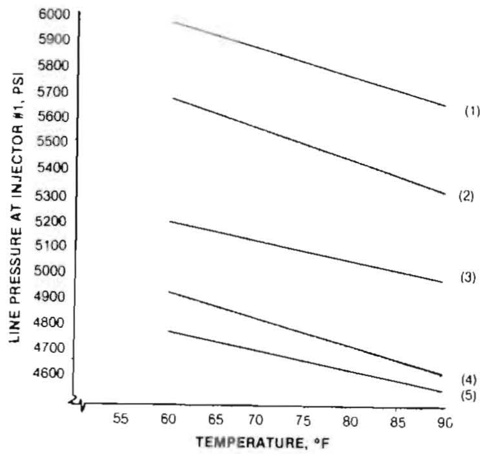


Fig. 5. Line Pressure, psi, vs. Temperature, °F, at Injector #1 (All Sunflower Oil Fuels)

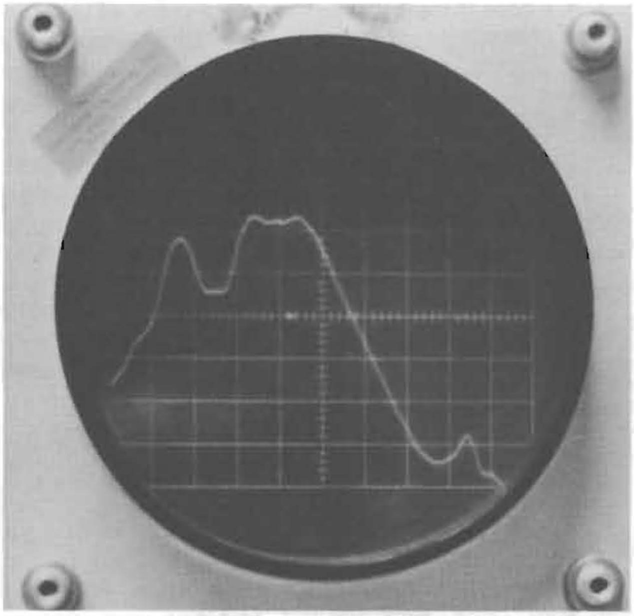


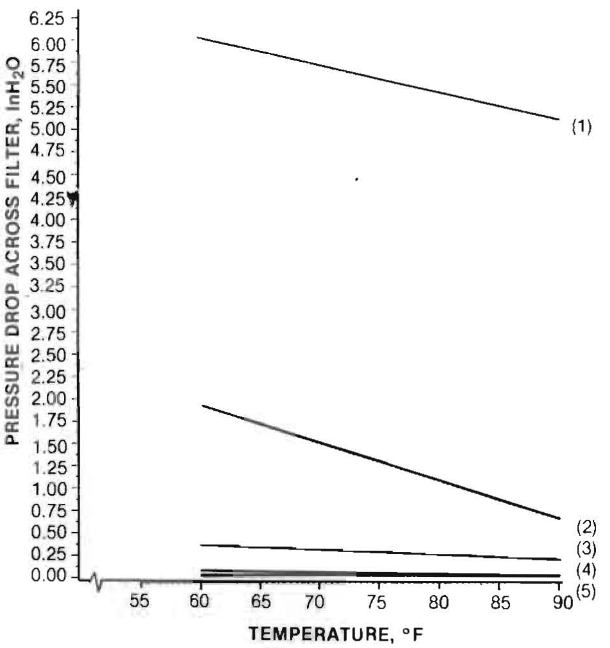
Fig. 6. Oscilloscope Wave Form of Injection Line Pressure vs. Time.

Injector line pressure increased as the fuel temperature decreased, and increased as the percentage of sunflower oil in the fuel mixture increased. Increases in injection line pressure may exceed the design pressure of the injection pump and shorten its life. It could also affect the combustion efficiency, fuel consumption and horsepower output for a given engine.

Pressure Drop Across Filter:

The results are shown in Fig. 7. The pressure drop for low percentage sunflower oil mixtures shown is small when viewed on a practical basis.

High viscosity of sunflower oil and colder temperatures resulted in a lowered pressure on the inlet side of the transfer pump. The use of a booster pump to larger lines from the reservoir may be necesary to reduce the pressure loss.



(1) = 100% SUNFLOWER OIL
(2) = 75% SUNFLOWER OIL & 25% #2 DIESEL FUEL
(3) = 50% SUNFLOWER OIL & 50% #2 DIESEL FUEL
(4) = 75% SUNFLOWER OIL & 25% #2 DIESEL FUEL
(5) = 100% SUNFLOWER OIL

Fig. 7. Pressure Drop Across Filter, InH_20, vs. Temperature, °F (All Sunflower Oil Fuels.)

Transfer Pump Pressure:

Transfer pump pressure was recorded once for each mixture since it did not vary with any of the other parameters being evaluated. Transfer pump pressure was initially set to factory specifications and was not adjusted throughout the tests. Transfer pump pressure vs. fuels is shown in Fig. 8.

Transfer pump pressures were higher when using high percentage sunflower oil fuels, especially at low temperatures. This pressure change may require modifications of factory specifications when using sunflower oil as a fuel.

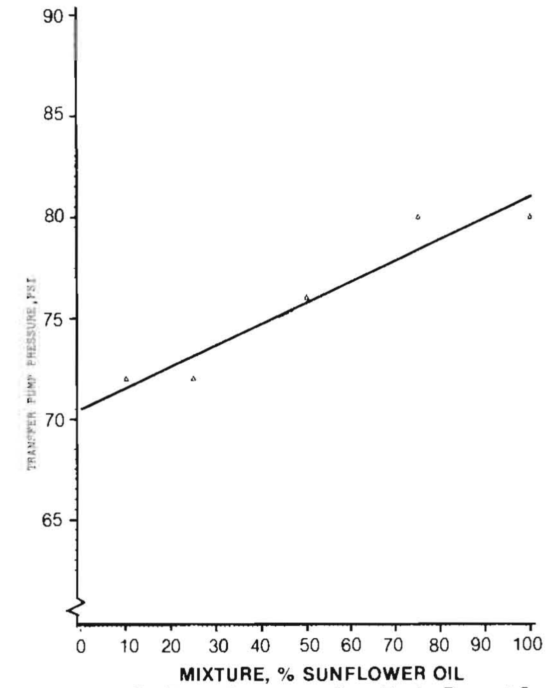


Fig. 8. Transfer Pump Pressure, psi vs. Fuels, Percent Sunflower Oil Fuel.

Fuel Injection Timing:

No changes were noted with the various fuels, so no changes in the diesel injection system timing would be necessary if sunflower oil fuels are used unless engine performance tests show a greater efficiency at other settings.

Summary:

Results from a test stand evaluation of a typical diesel fuel system show changes in performance of the system as the sunflower oil content of the fuel increases and the temperature decreases. It appears low percentages of sunflower oil may be used successfully in the system under "summer" conditions. Design changes to the system may be necessary for higher percentages of sunflower oil and cold conditions.

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off, but not enough to give the U.S. the energy security it needs. Concerns over petroleum arise from the fact that fossil fuels are the largest source of energy used in this country. Presently the three fossil fuels (oil, natural gas, and coal) account for about 92 percent of the energy used in the U.S.

The dependence on fossil fuels has dictated that innovative Americans start looking for alternative fuels. Gasohol started showing up at service station pumps in the 1970's. This fuel, a blend of nine parts gasoline and one part alcohol, was supposed to help reduce America's dependence on foreign oil. It's symbol was the corncob since the alcohol for use in gasohol was primarily distilled from corn. However, attention has shifted toward the development of vegetable oils for use as an alternative fuel source, especially for agricultural production. One major reason is that while alcohol is readily adaptable for use in gasoline engines it should not be used in diesel engines which power most of the farm machinery. Methanol has been used exclusively in many racing automobiles for years, but alcohol has not been proven practical in diesel engines. In recent years, there has been a solid shift toward diesel farm tractors and other engines used on self-propelled farm equipment. A recent estimate is that 95 percent of farm motive power is supplied by diesel engines. Diesel engine manufacturers know conceptually how to use alcohol fuels, but their use results in decreased engine life or even catastrophic failure. The major manufacturers of diesel engines for farm and industrial equipment do not recommend alcohol fuel use in diesel engines at the present time.

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