THE NORTH DAKOTA "FLOWER POWER" PROJECT

Jon Walter, Paul Aakre, and John Derry

INTRODUCTION

Research has shown that a farmer growing oil-type sunflower could produce an adequate supply of fuel for farm production from 10 percent of his crop acres. The extension circulars "Sunflower for Power" and "Sunflower Oil as a Fuel Alternative" give details on this analysis. Prior to 1981, the long term effects of blends of sunflower oil and diesel fuel on engine components had not been thoroughly studied. Short term tests have indicated that diesel engines would run when sunflower oil was blended with diesel fuel.

Flower Power, Inc. evolved from two separate groups interested in field testing of sunflower oil as a fuel. These groups included Verendrye Electric at Velva, North Dakota and the Agricultural Committee of the Grand Forks Chamber of Commerce. Short term fuel storages and spiraling fuel costs in 1979 provided the incentive for field testing sunflower oil.

With financial backing from the U.S. Economic Development Administration, the North Dakota State Mill and Elevator, and the North Dakota Sunflower Council, along with commitments from three tractor manufacturers, the "Flower Power" tests were initiated in the spring of 1981.

ON FARM TESTING

Twelve cooperators using new unmodified farm tractors participated during the 1981 season. These cooperators maintained log sheets in which they recorded operating conditions for the tractors powered by sunflower oil-diesel fuel blends. Operating temperatures, hours, field conditions, loads, fuel consumption and oil change intervals were included in the records. Cooperators followed a routine program of oil sampling which was analyzed to provide some of the data needed to measure the effects of the sunflower oil fuel on the engines. A team of three representatives from North Dakota State University, Fargo and North Dakota State School of Science, Wahpeton, monitored the field testing program. Dynamometers were routinely used to test engine performance of the tractors throughout the season.

Walter is research associate and Aakre is graduate research assistant, Department of Agricultural Engineering. Derry is fuel injection instructor, North Dakota State School of Science.

SUNFLOWER OIL USED DURING THE TESTS

The sunflower oil used in the fuel blends was an alkali refined and winterized oil. This oil was selected to reduce potential problems with fuel filtration.

Sunflower oil was delivered to two cooperating fuel dealers and then added to equal volumes of #2 diesel fuel. The 25/75 percent blend was obtained by mixing the 50/50 mixture with equal volumes of #2 diesel fuel. Farmers stored their fuel in a 1000-gallon tank fitted with a pump, fuel meter and a 5-micron filler. A 5-miron filter is similar to that used on some tractor fuel systems.

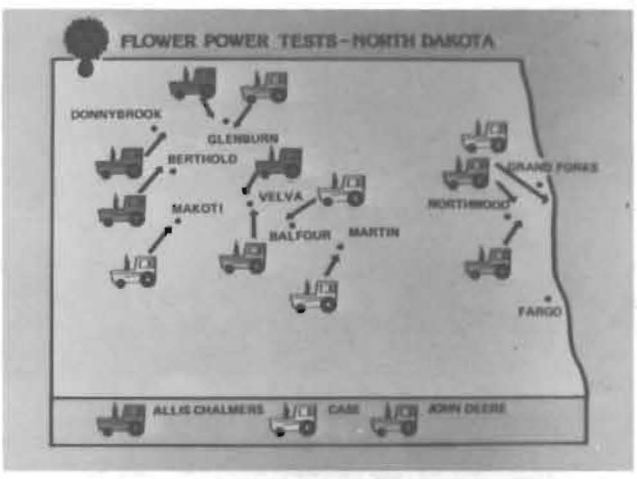

Figure 1. Three tractor manufacturers were represented. Nine cooperators were located in the Minot area and three were located near Grand Forks.

SUNFLOWER OIL PERFORMANCE ON THE FARM

Nearly 7000 running hours were accumulated on the 12 tractors during the 1981 crop season. Thirty-six thousand gallons of fuel was used of which 13,000 was sunflower oil. Between April 14 and November 20, cooperators started and operated their tractors at temperatures from 5°F to over 100°F. At these temperatures fuel filtration problems were not apparent and engine performance was satisfactory. Dynamometer tests indicated that engines performed in a satisfactory way throughout the test period.

Accumulations of varnish-like material built up around filter caps of tractors and service vehicles. These accumulations were difficult to remove if not cleaned up immediately.

Some abnormal coking (carbon buildup) of the injectors was noted during the season. Operating the tractors at conditions near maximum load appeared to reduce this problem and improve engine performance.

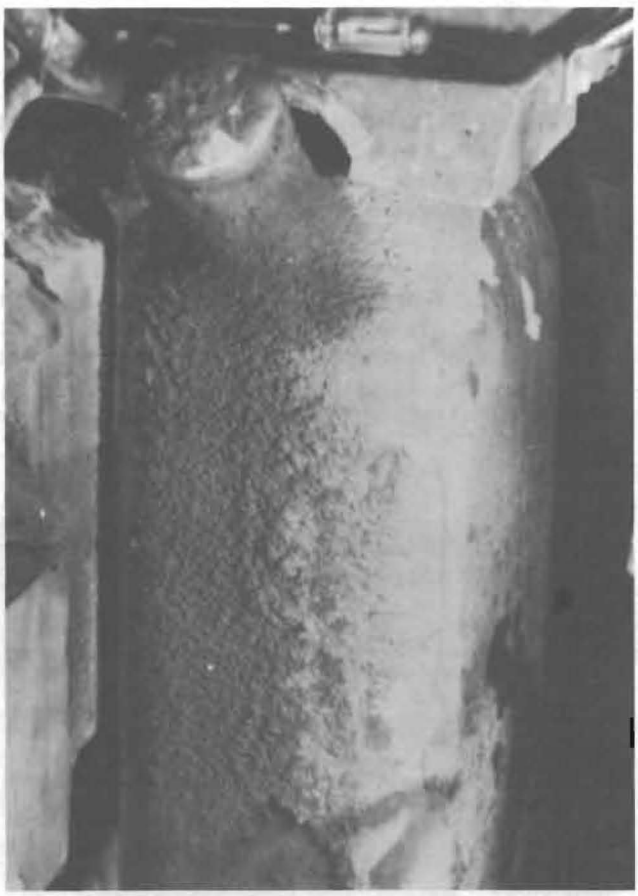

Figure 2. Partial oxidation occurs with sloppy fuel handling. Once dried this varnish-like material is difficult to remove.

FINAL ENGINE INSPECTION

Following the end of fall work, the tractor engines were disassembled to check for abnormal wear and engine deposits. Inspection revealed high carbon and varnish-like deposits on several engine components. Piston ring grooves and ring lands on all engines contained excess deposits. Use of pistons with a flat ring design running on the 50 percent blends led to ring sticking, a few broken oil rings, and scored cylinder sleeves. Engines with keystone (tapered) piston rings did not have stuck rings, but the level of excess carbon and varnish appeared greater than would normally be expected.

The underside of the engine head including the valve heads and injector tips appeared relatively free of excess carbon. The load characteristics of the tractor appeared to have as large an influence on engine deposits as the percentage of sunflower oil in the fuel blend. Light loads appeared to increase deposits. One tractor used as a loader tractor the last 20 hours revealed heavy carbon deposits around the injector tip. Heavy loading prior to disassembly may have reduced the carbon deposits. Nearly all tractors had excess carbon on intake valve stems and intake ports. These deposits could lead to valve sticking and burned valves.

Engine wear appeared normal except in the case where sticking piston rings led to scored sleeves. Engine bearing wear appeared normal in all engines.

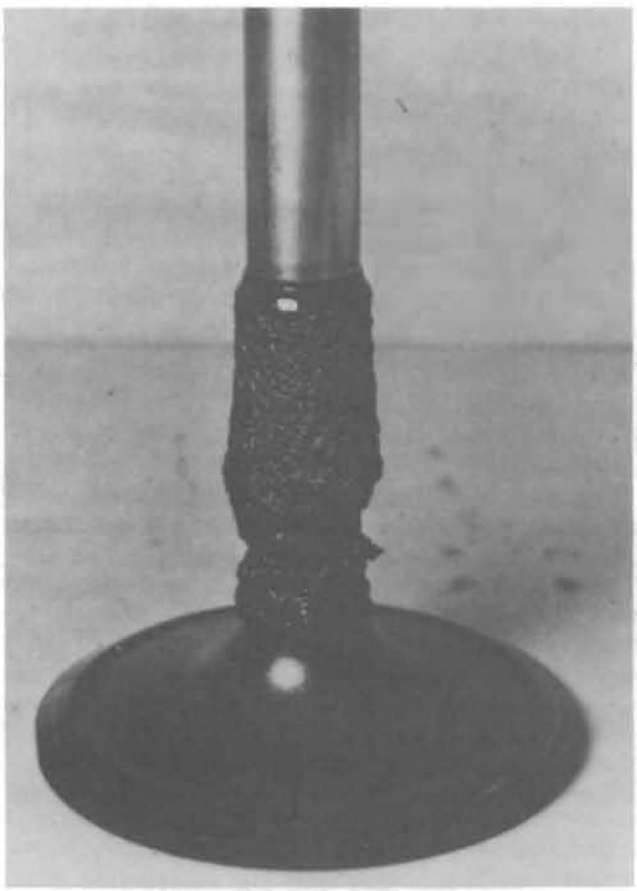

Figure 3. Excess carbon deposits were found on intake valve stems and ports.

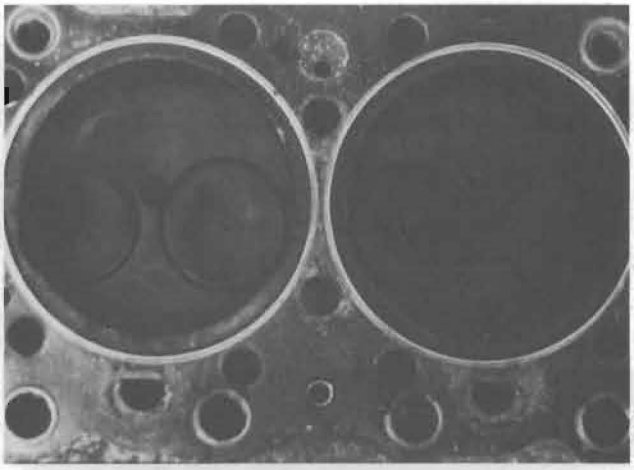

Figure 4. Cylinder head showed no abnormal deposits.

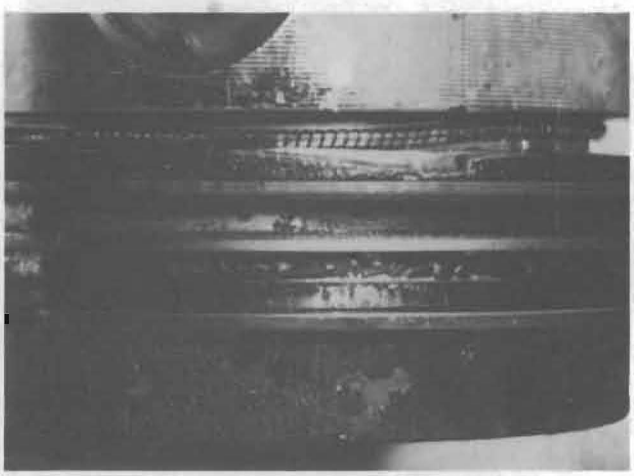

Figure 5. Excess carbon and varnish-like deposits were found on the piston sidewalls. This led to stuck piston rings and broken oil rings in some cases.

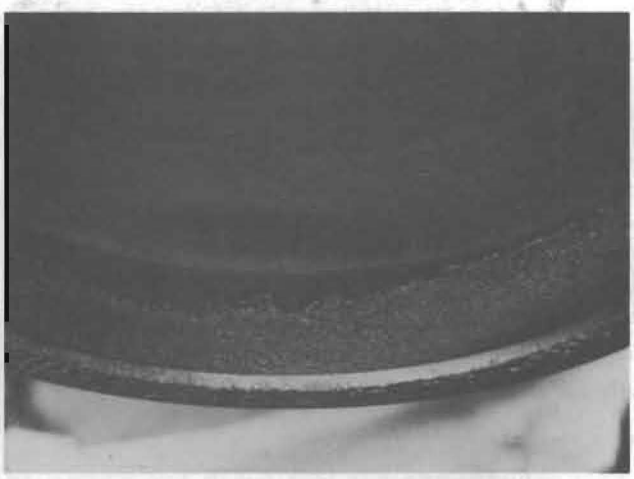

Figure 6. Heavy carbon deposits were found on the liner surface above the top ring land.

CONCLUSION

The "Flower Power" test indicated that farm diesel tractors can be operated on blends of up to 50 percent sunflower oil and diesel fuel. Its continued use would appear to cause premature engine problems.

Research has shown that engine deposits may result from poorly atomized fuel caused by the high viscosity of sunflower oil. Varnish-like deposits occur as a result of the chemical makeup of sunflower oil typically grown in North Dakota. Using quality lubricating oils and closely observing oil change intervals are especially critical when using the sunflower oil-diesel blends.

Engine conversions, fuel and lube oil additives, sunflower oil modifications, and genetic changes in the sunflower seeds are being investigated to improve the use of sunflower oil as a farm fuel. While results of the "Flower Power" tests are encouratging, use of sunflower oil as a fuel is not yet recommended. Continued long term testing is needed to evaluate the performance of sunflower oil-diesel blends.