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Screening Test for Rapeseed Ethyl Ester Two Cycle Oils

by

Charles L. Peterson
Professor
Department of Biological and Agricultural Engineering
University of Idaho
Moscow, Idaho 83843

Daryl L. Reece
Instructor
Agricultural Machinery Technology
Utah State University
Logan, Utah 84322-2300

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Summary:
In this project, 50:1 rapeseed ethyl ester (REE), 50:1 Winterized REE (WREE), 25:1 WREE and 75:1 WREE were compared with two commercial biodegradable two cycle oils and the engine manufacturer's recommended two cycle oil in a side-by-side test. Engines used were Stihl two cycle power blowers (model BG-72) operated at full throttle for 10-12 hours per day. All of the engines using commercial two cycle oils were still operating when the REE lubricated engines had failed. Failure was characterized by polymerization in the piston ring area. The 75:1 WREE engine also experienced cylinder wall scuffing. The test should not be used to infer differences in the commercial oils used; the test was designed to screen REE as a potential lubricant for two cycle engines, no conclusions beyond that intent should be formed.

Keywords:
Biodiesel, energy, two cycle engines, rapeseed

Screening Test for Rape Ethyl Ester Two Cycle Oils

by

Charles L. Peterson and Daryl L. Reece[1]

Abstract

The University of Idaho, Department of Agricultural Engineering compared 50:1 ethyl ester (REE), 50:1 Winterized REE (WREE), 25:1 WREE and 75:1 WREE with two commercial biodegradable two cycle oils and the engine manufacturer's recommended two cycle oil in a side-by-side test. The REE had been given extra care to minimize the glyceride. Engines used were Stihl two cycle powered blowers (model BG-72.). The engines were operated side-by-side, at full throttle, for 10-12 hours per day. Each blower was connected to a 19 L (five gal) fuel supply tank and were started each morning and allowed to run until the crew left work at the end of each day.

The REE fueled engines all experienced premature failure. The 50:1 REE engine failed at 38.5 hours, the 75:1 WREE engine at 50 hours, the 50:1 WREE engine at 75 hours and the 25:1 engine at 97 hours. All of the engines using commercial two cycle oils were still operating when the REE lubricated engines had failed. Failure was characterized by polymerization in the piston ring area. The 75:1 WREE engine also experienced cylinder wall scuffing.

This test should not be used to infer differences in the commercial oils used. The test was designed to screen REE as a potential lubricant for two cycle engines no conclusions beyond that intent should be formed.

Introduction

Two cycle engines, of the type used in snowmobiles, small blowers, weed whips and small marine motors, operate on a blend of gasoline and lubricating oil. One part of the lubricating oil, added as a lubricant for friction surfaces in the engine, is generally mixed with 25-50 parts of gasoline. Because the oil enters the combustion chamber, the exhaust tends to emit more smoke and particulate than would be expected from a 4-cycle engine. Since these engines are small and are generally used for less time and in fewer numbers than are larger 4-cycle engines which power cars, trucks and buses, less attention has been given to their role in creating air pollution.

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[1]The authors are Professor, Department of Biological and Agricultural Engineering, University of Idaho, Moscow, Idaho 83844-2060 and Instructor, Department of Agricultural Machinery Technology, Utah State University, Logan Utah 84322-2300.

Each of the lube oils were used in a side-by-side test with Stihl[2] two cycle powered blowers (model BG-72). The blower engines are 23.9 cc (1.46 in^3) displacement and are rated at 0.7 kW (0.95 hp). They deliver 600 m^3/hr (353 cfm) of air. Each of the blowers were connected to 19 L (5-gal) fuel supply tanks and were operated for identical 10-12 hour full power cycles. It had been estimated, based a previous test, that each engine would use 0.76 L (1/5 gal) of fuel per hour. The plan was to operate the engines for 300 hours or until failure occurred sufficient to make it impossible to continue. The seven engines required approximately 1590 L (420 gal) of gasoline and 31.8 L (8.4 gal) of lube oil if they operated for the full 300 hours. At the completion of the tests all seven of the engines were disassembled for evaluation. The test procedure used was designed for this experiment as a screening test and did not follow any published two cycle lubricant procedures recommended for testing their lubricating oils.

Twenty three liters (six gal) of REE were produced for the test from Dwarf Essex industrial rapeseed. Extreme care was used in producing this fuel to get as high an esterification percentage as possible. The kinematic viscosity was 5.843 cSt at 40°C and the cloud and pour point were -2°C and -18°C respectively. Four gallons of the REE were winterized by cooling to -20°C and filtered through a denim bag. This winterized REE (WREE) had a kinematic viscosity of 5.83 cSt at 40°C and a cloud and pour point of -15°C and -21°C.

Ten liters (2.7 gal) of Planto Twin S were supplied by Metal Lubricants Co., Harvey, Illinois. This was a 2-cycle engine lubricant that was biodegradable and produces less smoke. Planto Twin S is manufactured by Fuchs Mineraloelwerke, Germany. The pour point was found to be -28°C.

Three and 8 tenths liters (1 gal) of Stihl 2-cycle engine lubricant was procured from Jones Service and Supply, Moscow, Idaho. The measured pour point for this product was -9°C.

Three and 8 tenths liters (1 gal) of Conoco Bio Synthetic 2-cycle lubricant was donated by Yellowstone Park. A pour point of -28°C was measured for this product.

Table 1 provides a partial list of specifications for each lubricant used in the test.

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[2]Use of trade names is for simplicity in description of products used, no endorsement by the University of Idaho is implied nor is discrimination toward similar products, not mentioned, intended.

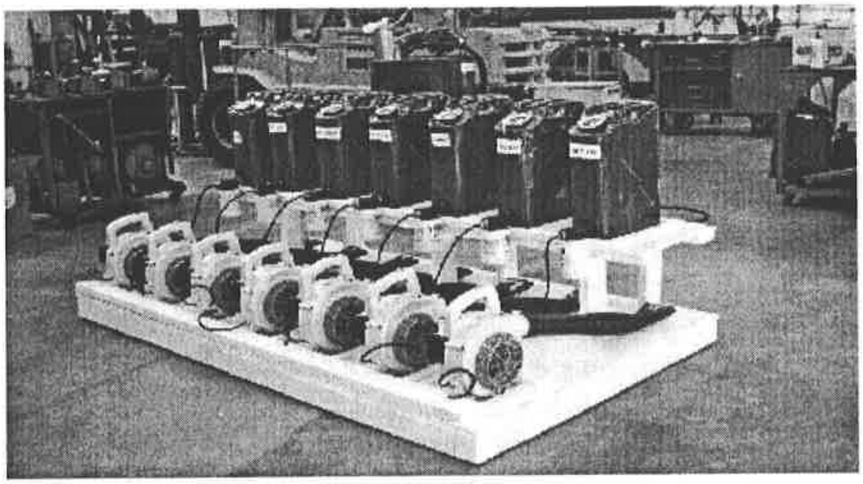

Figure 1. The seven stihl blowers and fuel containers mounted on the test stand.

October 28 --The blowers were started the blowers at 8:30 am. All started easily and each had good compression. Each blower was checked a couple of times during the day and each blower was operating. When they were shut down for the day at 9:20 pm the Planto Twin S engine was running as it had the night before (13 hours operating time.)

October 30 -- The muffler was removed from the Planto Twin S lubricated engine and the screen was plugged again. The screen and muffler were cleaned and installed onto the engine. Representatives of Metal Lubricants were consulted about the problem with the Planto Twin S. They suggested switching to the Sno Pro lubricant as it is available and used in the US. The fuel was drained from the fuel can and refilled with a 50:1 mixture of gasoline and Sno Pro lubricating oil. The blowers were started at 8:30 am. Each blower started easily and with good compression. Two and one half gallons of fuel mixture were added to each of the 5 gallon cans. The blowers were shut down at 9:00 pm (12.5 hours operating time.)
Total Hours - 37

October 31 -- The blowers were started at 7:30 am. At 9:00 am the 50:1 REE blower was running erratic and would not operate above 5200 RPM. The muffler was removed and it was found that the piston was tarnished. The piston was removed and it was found that the rings were stuck in the piston ring grooves and the exhaust side of the piston was tarnished. This engine operated 38.5 hours before failure. The blowers were shut down at 7:30 pm.
Total Hours - 49

November 1 -- The fuel leaked out of the fuel hose overnight from the Conoco engine and a small amount from the 25:1 WREE. Two and one half gallons of fuel were added to the Conoco, 50:1 WREE, Sno Pro, and Stihl fueled engines. The Sno Pro engine would not start. The

Table 2
Hours to Failure and Failure mode for REE and WREE used as 2-Cycle Lubricants

Fuel Type	Hours of Operation	Reason for Failure
50:1 REE	38.5	Piston Skirt Tarnished
75:1 WREE	50	Piston Seized
50:1 WREE	75	Piston Skirt Tarnished
25:1 WREE	96.75	Piston Skirt Tarnished

Engine Inspection Prior to Disassembly:

The Stihl oil lubricated blower had carbon build-up in 1/4 of the exhaust port. The muffler screen was clean, as was the cylinder wall. The piston skirt had a small amount of discoloration on the lower section.

The Sno Pro lubricated blower needed the muffler screen cleaned every other day except at the end of the test where it had ran for 21 hours without plugging. The piston skirt and cylinder wall looked clean. There was more carbon build-up in the muffler than the Conoco and Stihl lubricated blowers with a small amount of build-up in the port.

The Conoco lubricated blower had the least amount of carbon build-up in the muffler and exhaust port of the three remaining blowers. The piston skirt was clean as was the cylinder wall.

Observations Following Engine Inspection:

50:1 REE fueled engine -- The spark plug was black in color with minor carbon build-up. The piston top ring was stuck in the piston and the second ring was free. The exhaust side of the piston skirt was tarnished and intake side was clean. The crankcase had some discoloration. The cylinder wall was clean and free from scratches. The muffler was black and the screen had no carbon build-up. The exhaust port was clean.

75:1 WREE fueled engine -- The spark plug was brown in color with minor carbon deposits. The piston rings were stuck in the piston, as the engine had seized. The piston skirt was tarnished except for a small area on the intake side. The crankcase had some discoloration. The cylinder wall was scratched. The muffler was brownish and the screen had no carbon build-up. The exhaust port was clean.

50:1 WREE fueled engine-- This engine had considerable carbon build-up (the most of all the engines tested) on the piston as the wrist pin was not easily removed. The spark plug was brown in color with only a small amount of carbon build-up. The piston rings were stuck in the piston. The

Additional Testing

Two additional Stihl BG-72 blowers were purchased to test a 50:1 blend of rapeseed methyl ester (RME) and a 50:1 blend of raw rapeseed oil (RAW). The RAW lubricated blower operated for 16 hours before failure and the RME lubricated blower operated 38 hours before failure. Each of these engines showed polymerization on the piston skirts. Also, the piston rings were frozen in the piston ring grooves.

Acknowledgments

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