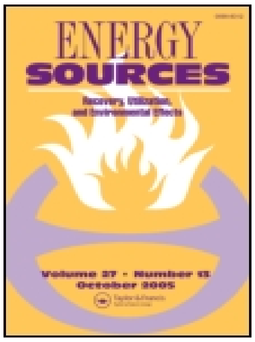

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An Investigation of the Use of Rapeseed Oil in Agricultural Tractors as Engine Oil

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An Investigation of the Use of Rapeseed Oil in Agricultural Tractors as Engine Oil

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In this study, as engine oil canola (rapeseed-00 oil), which is vegetable oil based and biodegradable, was used. This investigation was performed in Turk Motor Company (TÜMOSAN), 34 kW diesel engines with 3 cylinders as the motor was used. As a mineral oil, Turkish Petroleum Office (Petrol Ofisi) 20 W/50 and canola were tested for 50 h each, and the values of kinematics viscosity, viscosity index, flash point, and total base number about engine oils were determined in the laboratory. In addition, during the study engine performance values, oil temperature, and oil pressure were measured, and engine emission values were also measured when using different types of oil. Then the values measured were compared for each engine oil. At the end of the analysis in the laboratory, viscosity value of Petrol Ofisi 20 W50 mineral oil was 527.3 Redwood second, viscosity of rapeseed oil-00 was 140 Redwood second and the density of both oils was measured as orderly 0.856 and 0.857 g/cm^3.

Keywords canola (rapeseed–00 oil), engine oil, lubricants, farm machinery

Introduction

The main function of engine oil is to decrease the frictional force to a minimum level by forming a film between moving parts; therefore abrasion of the moving parts reduces and prevents power loss. In addition to this main function, it also carries out the functions of cooling, imperviousness, cleansing, and damping. Mineral oils were obtained by the distillation of crude petroleum and were then matured with the treatments of the dissipate with solvent, dissipate with acid, neutralization, wax separation, removal with clay, and filtering treatments. The most important feature of oil is accuracy and thickness. Thin oil facilitates the first start of the engine, causes less power loss, and affects thin parts of the engine easily. However, thinner oils leak out of the surfaces, and they can't form an oil layer in normal thickness. Whereas thick oils don't spoil in a very short time because

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they can't penetrate between the parts, the fuel consumption increases and the engine heats rapidly (Acaroğlu, 1996; Karaosmanoğlu, 1997; Anonymous, 1999a). As lubricating oil, the required features of the plant oils are viscosity, flow specialty, greaser specialty, thermal strength, toughness, solvent specialty, and biodegradability (Acaroğlu, 1996; Karaosmanoglu, 1997).

Vegetable oils are not toxic, they have easy and rapid biodegradability, high viscosity indexes, high flash point, their sources are renewable, and they don't cause high cost. All these are advantages for their use as lubricating oils (Anonymous, 1999b; Brenndörfer, 1990; Luther, 1998; Remmele and Widmann, 1998; Römer, 1994; Shütte, 1999; Synek, 1999; Weidmann, 1995).

Material and Method

Material

In this study, for the tractor engines produced by TÜMOSAN, Petrol Ofisi 20W/50 super diesel engine oil, widely used, and canola, permitted to be used as an engine oil at the end of laboratory studies, were used. The properties of the oils are given in Table 1. The oils were tested in 3D-29DT diesel engines with three cylinders. Technical specifications about the engine are given in Table 2. The hydraulic dynamometer in TÜMOSAN was used for motor test runs. The technical specifications of the dynamometer are given in Table 3 (Anonymous, 1997). In order to measure fuel consumption we used Seppeler brand, which can measure the volume of 50-100 milliliter (ml). In order to measure exhaust gas, which forms at the end of fuel burring, OVLT mark and gas analysis devices were used (Anonymous, 1994).

Table 1
The properties of some oils used in the study

	Petrol Ofisi 20 W/50	Canola
Density (gr/m^3 at 15°C)	856	891
Viscosity (Redwood-S at 40°C)	527.3	140
Water content (mg/kg)	–	1000
Flash point °C	242	324

Table 2
Engine specifications

Cylinder Number	3
Fuel	Diesel
Nominal speed	2500 (rpm)
Power	34 kW
Torque (at 1400 rpm)	140 (Nm)
Injection pump	Lucas Cav DPA
Capacity of lubricating oil	7 (liter)

Method

The experiment mechanism was a hydraulic dynamometer, engine, smoke density measuring instrument, and control units which feed and control them. The test order is given in Figure 1.

They were of the connecting the engine with the experiment mechanism. During the engine experiments, Petrol Ofisi 20 W/50 oil was first added into the crankcase and the engine was tested in full load. The experiments were done according to DIN norm. The temperature of the engine cooling water was stable at the limit of $\pm 2°C$. The output of the exhaust gas was through the smokestack. In order to measure smoke density, the exhaust-connecting pipe was bored and the probe of the smoke density measuring device was fixed here. At the engine test, after heating the engine the connection mechanism was calibrated.

Then the measurements were started; engine revolution number was decreased 100 at a time by loading the engine step by step at complete gas. The number of

Table 3
Technical specification of hydraulic dynamometer

Mark	Zöllner
Model	3n19 A
Type	Hydraulic dynamometer
Production year	1983
Maximum power	120 kW
Maximum speed	3600 1/min
Maximum torque	53.7 kpm
Maximum balance value	75 kp
Speed measurement range	0–3000 1/min
Water quantity at max performance	2.4 m^3/h
Return direction	Single direction

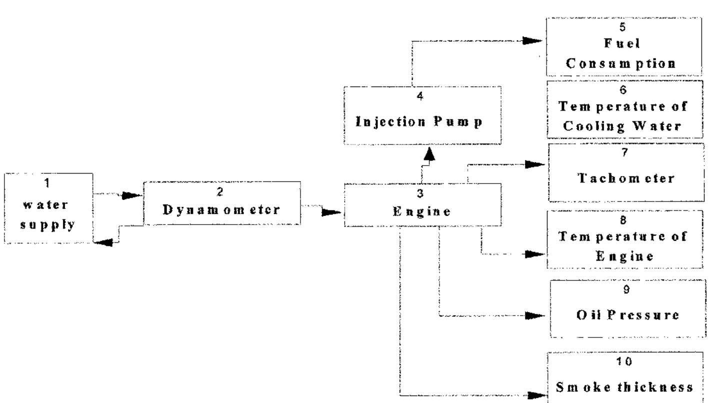

Figure 1. Schema of engine experiment.

revolutions was adjusted by loading the engine, and the balancing weight was registered from the indicator at each revolution stage. At the same revolution and loading, the time spent for the fuel consumption of 50 ml was measured with a fuel gauge and recorded.

At the beginning of the measurement, daily air pressure was measured as 670 mmHg and peripheral heat as 30°C. In addition, at each rotation stage, engine oil heat and pressure were read from the indicator. At the end of 50 h of work, the engine oil was changed and canola oil was used; the oil filter was also changed and the same treatments were repeated for canola oil.

Review of Viscosity Values of Oils

Viscosity values of the oils chosen as engine oil were measured. A number 1 redwood viscosity meter was used for determining viscosity (Kadayıfçılar and Acar, 1992). The measurements were started at 20°C and measured at an interval of 10°C until 90°C. The viscosity values of the oils are given in Table 4.

Investigation Results and Conclusions

Engine Test Results

Investigation of Power and Moment According to Engine Speed. During the engine tests, torque and fuel consumption per hour were measured at various engine speeds and full load. Engine power and specific fuel consumption values were calculated from measured values. By using these calculated values, engine performance curves were drawn. The engine performance curves are shown in Figure 2. When analyzing Figure 2, the engine torque is 138.5 and engine power is 36.3 kW with the use of Petrol Ofisi 20 W/50 as an engine oil. However, the engine torque is 145.3 Nm and engine power is 36.3 kW with the use of canola oil.

Table 4
The viscosity values of the oils

	Viscosity			
	Petrol Ofisi 20 W/50		Canola	
Temperature (°C)	(Redwood-s)	(cSt)	(Redwood-s)	(cSt)*
20			312.5	75
30			224.2	
40			140.0	
50	527.3		100.7	
60	289.2	70.5	73.1	16.3
70	192.3		61.3	
80	138.8		55.7	
90	114.2	27.8	50.2	9.1

*These values were turned from the tables.

Change of Fuel Consumption and Specific Fuel Consumption Depending on Engine Speed. Depending on the engine speed, fuel consumption per hour was increased when both Petrol Ofisi 20 W/50 and canola were used. The fuel consumption per hour and specific fuel consumption are given in Figure 3.

The Results of Oil Pressure

The change of oil pressure values during the use of both oils as engine lubricant, which changed depending on the engine rotation, are given in Figure 4.

The oil pressure values of the engine oil were changed between 18 bar and 3.4 bar depending on engine load. Therefore the limit values weren't exceeded for both types of oil. Therefore no problems occur, as canola oil ensured the system pressure limits.

Investigation of Oil Temperature

The viscosity of the oils changed with temperature. The main feature, which is important for the oil, is viscosity index. Depending on engine load, engine oil

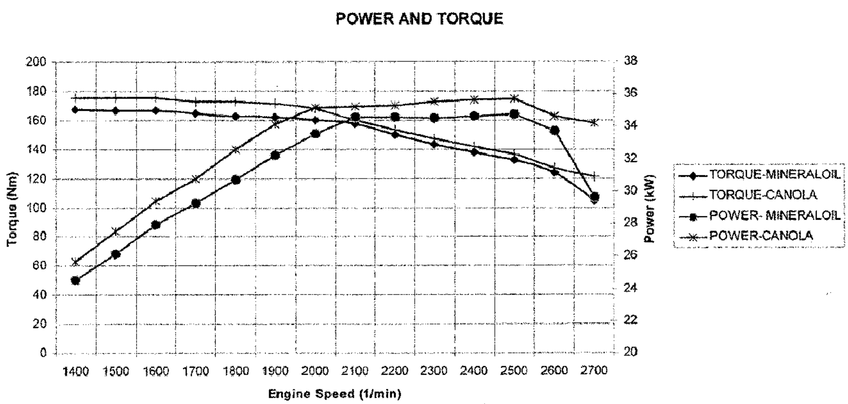

Figure 2. Diesel engine performance using canola oil and mineral oil as a lubricant.

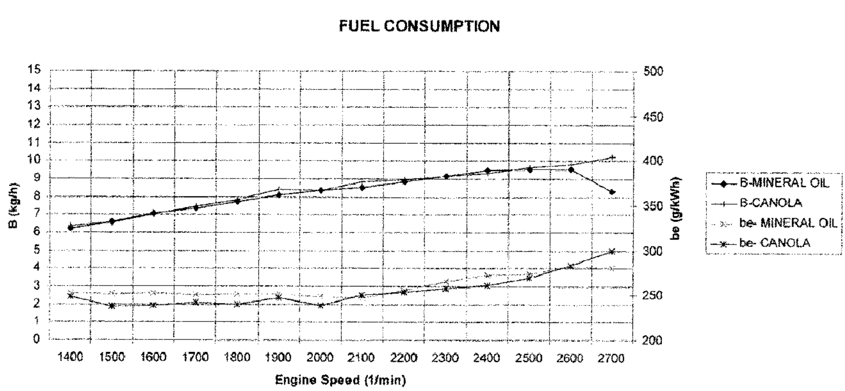

Figure 3. Fuel consumptions using canola oil and mineral oil as a lubricant.

temperature increased as linear, but the limit values were not exceeded with the use of both oils.

In Figure 5, the oil temperature of both oils were given as a function of engine speed.

Changing of Lubricant Properties Depending on Operating Time

Samples were taken at 30 and 50 h. Then the samples' FFA, sop value, saponification number, iodine number, and color determination results were investigated. These results are given in Table 5.

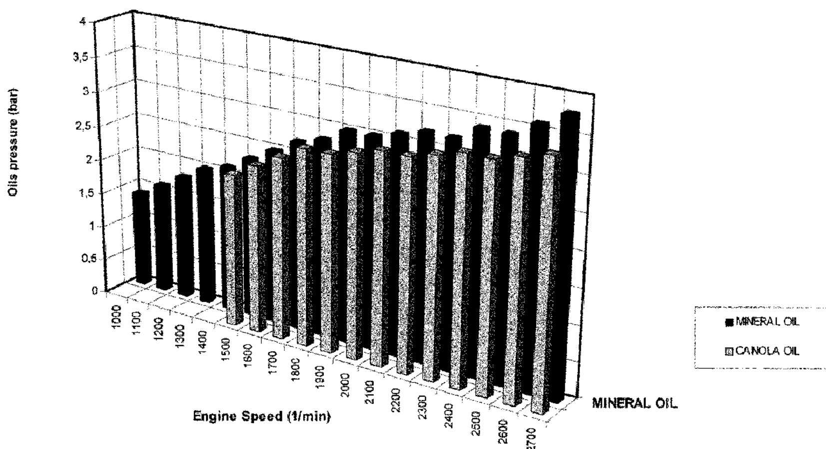

Figure 4. Variation of oil pressures depending on engine speed.

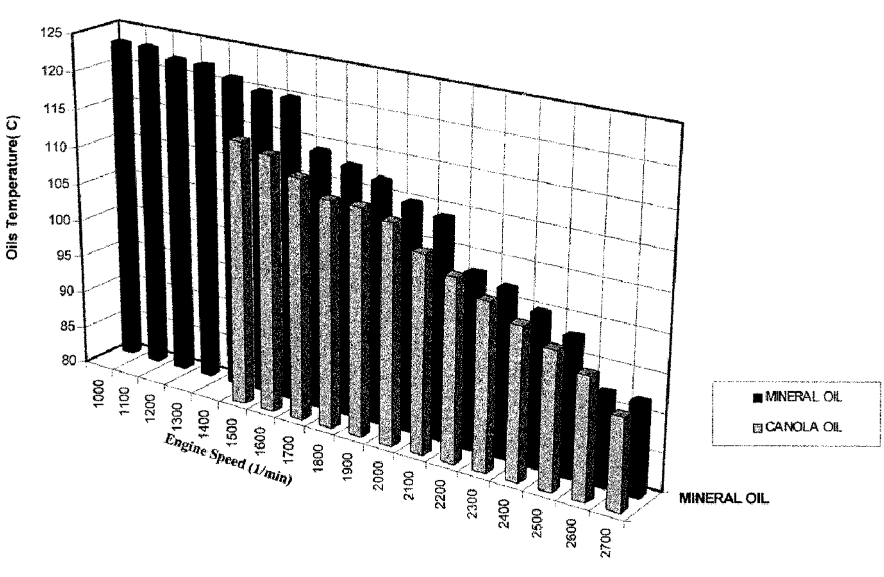

Figure 5. Variation of oil temperatures depending on engine speed.

Table 5
Change of lubricant properties depending on operating time

Properties	Canola	Canola (30 h)	Canola (50 h)
FFA	0.07	2.96	3.60
Soap	0.0	335	360
Saponification number	154	153	148
Iodine number	129	121	123
Color#	1–9	10.4–20–18.5	9.4–20–18.3

#Colors were tested by 10,00 OG bath. Color wasn't seen when other baths were used.

As Table 5 shows FFA was increased depending on operating time. Exhaust emission values didn't exceed the limit value of $2.5\,m^{-1}$ for both types of oil (Anonymous, 1994). The measured average emission value for mineral oil is $1.25\,m^{-1}$ and for canola oil is $1.34\,m^{-1}$. Canola's biodegradability was investigated and it was seen that 95% of canola oil biodegraded in 23 days (Anonymous, 1999b; Brenndörfer, 1990; Römer, 1994; Shütte, 1999).

Results

Use of environmently friendly oil is an advantage in farm machinery and forestry areas. Also, They can be obtained from renewable sources. Vegetable oils can be used not only for lubrication but also for hydraulic systems. At the same time, vegetable oils are suitable for engines. In this study, canola oil was tested as an engine lubricant in tractors, which are an important power supply for the farm sector, and its effect on engine performance was determined. As a result, additives must be improved for vegetable oils.

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