NEW BIODEGRADABLE OILS USED IN AGRICULTURE

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Abstract. The use of biodegradable oils instead of conventional oils, lubricants in agriculture is an important step to protect the environment by reducing noxious emissions of greenhouse gases and soil pollution. To highlight the biodegradability experiments were conducted on the tribological parameters of three kinds of biodegradable oils (experimental models) and two conventional oils, resulting in the high quality of the tribological parameters of biodegradable oils as against the trade classical oils.

Keywords: biodegradable, environment, lubricating, oil, parameter, protection.

Introduction

Development of bio-lubricants is not a new appearance, in the late 70ies the vegetable oils appeared in the spotlight. Their lubricating effect was already known and other arguments have emerged: regeneration, biodegradability, non toxicity, no bioaccumulation, does not irritate the unique molecular structure, viscosity stability with changing temperature, low volatility, bimolecular layer on metal surfaces which should protect against corrosion and reduce friction [2].

The use of lubricants as environmentally responsible began to develop in Europe, North America and other regions, bio-lubricants made from vegetable and animal oils and fats being regarded as environment friendly.

Lubricants, as all “components” of any industrial, commercial or domestic activity, affect health and safety of persons who use them and also influence the environment. Although the problems of health, safety and environment facing lubricants industry is no different than those faced by other industries, they are important and present a number of technical and market dilemmas, some of them can not be bypassed [1; 2; 3].

Lubricants affect the health, safety and environment in all stages of their production, use and abandoning of them. They must not be toxic to human health by contact or inhalation during their manufacture and use thereof. Accidental or intentional spillage of them may have the potential to cause environmental disasters in the sensitive areas of the environment such as forestry, agriculture, mining, construction or groundwater areas [2].

It should be noted that “health and safety” were mainly associated with people, while the “environment” refers to the rest of the planet. Further, the distinction between the two topics has become blurred by dragging the conclusion that many of the things that affect or harm the environment are likely to harm the human health and vice versa.

In recent years, the concerning about the potential impact of oil-based lubricants on the environment has created the opportunity to promote acceptable alternatives in terms of environmental protection. Bio lubricants have been developed as some of environmentally friendly products.

The main features of environmental friendly lubricants, the so called bio lubricants or biodegradable lubricants are: conserve energy, long operating time - less waste, reduced consumption – throw less, are recyclable, biodegradable, have low ecotoxicity, and have low pollution risk for water, soil and air.

The term bio-lubricants include a wide range of lubricants, such as vegetable oils, hydrogenated vegetable oils, vegetable oils with high oleic acid, synthetic esters produced from vegetable oils.

Advantages and disadvantages of bio-lubricants: less pollution for air, soil and water, minimum health and safety risks, damage easier, due to their biodegradability.

More specifically, the benefits of bio-lubricants compared to mineral oil lubricants are: good lubricating characteristics, good corrosion inhibiting properties, low volatility leading to lower emissions, very low aquatic toxicity, intrinsic biodegradability, wide availability, and production from renewable resources.

For over 50 years and particularly in the last 20, the major manufacturers of lubricants (SHELL, TOTAL, BP, AGIP, etc.) began to develop, produce and commercialize lubricants (oils, greases, etc.) designed specifically for use on machines and agricultural equipment or food industry equipment [17].

This was mainly due to the fact that classical lubricants failed to ensure high performance and lasting protection to these types of equipment because the working conditions on uneven soil, oscillating forces, etc. led to some tougher operating conditions.

Moreover, some of the major manufacturers began to produce lubricants themselves dedicated to own machinery and equipment (John Deere) and beyond.

Materials and methods

To determine the lubricating properties in linear and point contacts of oils experiments were performed under INMA Bucharest - Department Tests on four types of oil, two biodegradable (BF and BIOR-S) and two commercial (HUS and T90 LS-EP2 S), for which determinations were made for: density, viscosity, refractive index and calorific value, using a *methodology for determining the parameters of the ecobiodegradabile tribological fluids*, before and after the endurance test by shear stress of oil, when passing through a pump 12V type gear CLAXCOR [17].

Checking the evolution of the physical parameters of oil due to wear was made on a test stand, which offered the possibility of testing four samples of endurance oil, in accelerated regime, the oil being passed through a gear pump which has conducted a shear operation on it, simulating the operation in normal regime. The oil drain section was reduced from the inlet section to create an additional resistance force, simulating the operation in load. The test duration of each type of oil was set at 25 hours, in cycles of 1'15" – in work, 1'15" – pause and an additional break of 30 minutes every 1 hour 30 min. work, the volume of the oil subjected to shear being of 75 ml.

The main characteristics of CLAXCOR pump used for tests are:

- pump speed: 0÷10.500 rot·min^{-1};
- pump flow: 1.714 l·min^{-1} (at speed of 5000 rpm);
- supply voltage: 10 Vcc.

Results and discussion

Determination of density and viscosity of oils

The oil density (Fig. 1) tested was determined by two areometers having the scale values: 0.820÷0.880, respective: 0.880÷0.940 and a graduated cylinder and the viscosity (Fig. 2) with SV-10 viscometer (vibroviscometer), constantly monitoring the working temperature which is an essential parameter. The cinematic viscosity was determined based on the dynamic viscosity by using the formula:

$$\nu = \eta / \rho.$$

where η – dynamic viscosity of oils and ρ – density of oil.

Fig. 1. **Determination of oil density**

Fig. 2. **Determination of oil viscosity**

Determination of refractive index and calorific power of oils

The refractive index (Fig. 3) was determined by the refractometer ABBE AR6 and the calorific power (Fig. 4) with a calorimeter CAL 2k.

Fig. 3. **Determination of refractive index**

Fig. 4. **Determination of calorific power**

Testing the durability of the oil

The stand consists of the following elements: power supply 0-30 VDC; gear pump (auto type) – 2 pcs.; timer and an Erlenmeyer glass – 2 pcs., it offers the opportunity of testing in parallel of two samples of oil. To avoid the burning of pumps due to the continued operation a timer was introduced so that the pumps run 1 minute and 15 seconds and cool one minute and 15 seconds cyclically. The pump power supply was set at 10 VDC.

Before to begin testing the endurance viscosity, density, refractive index and calorific power were determined. After determining of these parameters, the 75 ml oil samples were placed in each container of the stand and turned on the power supply, starting actual testing of the four types of oil. After determining these parameters, each of the 75 ml of oil samples were placed in every container of the stand and the power supply was switched to the chassis and the power supply switched from actual testing of the four types of oil: BIORAL-S (Fig. 5), BF (Fig. 5), LS HUS (Fig. 6) and T90 EP2-S (Fig. 6) type. After 25 hours of testing (shear) of the oil, again the above parameters were determined.

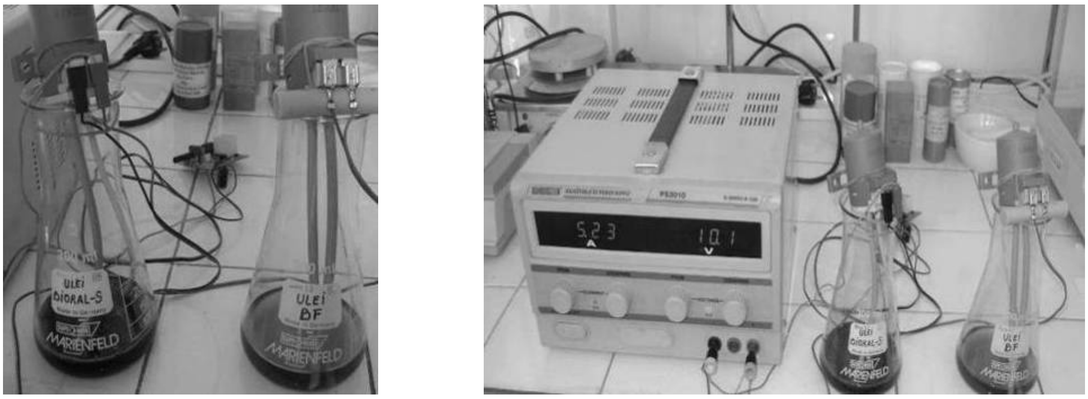

Fig. 5. **Shear testing of oils BIORAL-S and BF type**

Fig. 6. **Parallel testing of two types of oil: type LS HUS and T90 EP2-S**

Experiments on the effects of impurification with abrasive particles and other fuels on tribological performance and durability

In the experiments on the effects of impurification with abrasive particles on the tribological performances and durability of the experimental oils, in the Testing Department (INMA Bucharest) three samples of oil (BF, HUS and T90 LS EP2-S) were tested, Figure 7, which are contaminated with: *powdered sawdust, fine particles of soil and fine particles of leaves* (Fig. 8), after mixing and shaking, determinations of density, viscosity, refractive index and calorific power were made using a *methodology for determining the effects of impurification with abrasive particles on tribological performances and durability*.

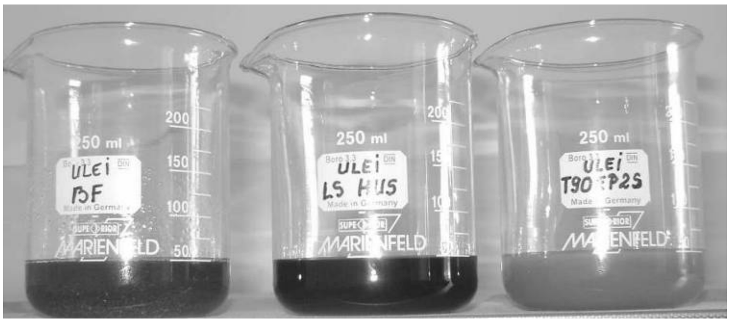

Fig. 7. **Three types of experimental oil before impurification**

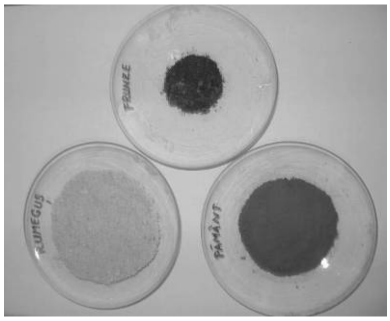

Fig. 8. **Infestation agents of oils**

For the experiments the effects of impurification by external agents for a chain saw (chainsaw guy) were taken into account, realizing impurification for each oil as follows:

- Step 1: *sawdust powder* was added, which is the most common impurification especially in the case of the moto saw where the chain saw comes in direct contact with the sawdust powder.
- Step 2: *fine particles of soil* were added in the sample vessel (already contaminated with sawdust powder), the chain saw blade having a contact and with the soil in certain situations;
- Step 3: into the sample vessel contaminated with sawdust and fine particles of soil were added and fine particles of leaves.

The amount of contaminant agents and the degree of impurification has been established according to the probability of impurification of the oil from the chain saw blade (in working) with one of the three agents: *sawdust powder*, *fine particles of soil* and *fine particles of leaves* and the contact time between the chain saw blade and the contaminant agent.

Thus, it was established that each experimental oil sample was contaminated with: 1 % *sawdust powder*, 0.5 % *fine particles of soil* and 0.25 % *fine particles of leaves* taking into account that the likelihood of impurification with *fine particles of leaves* is the rarest meet and the impurification with this agent is done in a smaller percentage especially thanks to the lack of adhesion of these particles to the blade.

After each impurification (Figure 9), it was determined again: the density, the viscosity the refractive index, and after the last impurification the calorific power.

Fig. 9. **Three types of experimental oil after impurification**

The results of the measurements concerning the effects of impurification with abrasive particles on tribological performance and durability of oil (type BF, LS and T 90 EP 2S HUS) are presented in Table 1:

Table 1

The results of measurements concerning effects of impurification with abrasive particles

Oil sample	Parameter measured					
	Density, $g \cdot cm^{-3}$	Viscozity		Refractive index	Caloric value, $Mj \cdot kg^{-1}$	Temp. at which the measurement was made, ˚C
		η, mPa·s	ν, $mm^2 \cdot s^{-1}$			
OIL TYPE BF						
Before impurification	0.921	169.0	183.5	1.4745	39.356	18.5
Oil + 1 % sawdust	0.920	161.0	175.0	1.4750	-	19.7
Oil + 1% sawdust + 0.5 % mould	0.921	163.0	177.0	1.4752	-	20.2
Oil + 1% sawdust + 0,5 % mould + 0.25% leafs	0.921	171.0	185.7	1.4754	38.775	20.4
OIL TYPE LS HUS						
Before impurification	0.863	101.0	117.0	1.4767	44.552	19.0
Oil + 1 % sawdust	0.864	101.0	116.9	1.4767	-	19.5
Oil + 1% sawdust + 0,5 % mould	0.865	107.0	123.7	1.4774	-	19.5
Oil + 1 % sawdust + 0.5 % soil + 0.25 % leafs	0.865	109.0	126.0	1.4777	44.655	19.7
OIL TYPE T 90 EP 2S						
Before impurification	0.893	226.0	253.0	1.4905	42.749	19.0
Oil + 1 % sawdust	0.893	242.0	271.0	1.4897	-	19.5
Oil + 1 % sawdust + 0.5 % mould	0.896	247.0	275.7	1.4899	-	19.7
Oil + 1 % sawdust + 0.5 % mould + 0.25 % leafs	0.900	259.0	287.8	1.4900	43.995	19.7

Observations: the contamination of the oil sample was made with:

- fine sawdust;
- chopped finely mould;
- leaves finely chopped.

Conclusions

Biodegradable oils are of particular interest lately with regard to environmental protection. The characteristics of biodegradable oils are comparable and in some cases are even better than of mineral oils used for the same applications.

In general, as base oils for biodegradable lubricants may be used: poly glycols, synthetic ester oils and vegetable oils.

In case of testing of the experimental biodegradable oils realized: type BIORAL-S and BF, compared to commercial oils: type LS HUS (oil used for LS HUSQVARNA chainsaws) and type T90 EP2-S (used in mechanical transmissions), the following was found:

- better wear behavior of biodegradable BIORAL-S and BF, compared with those from trade;
- density of the experimental oils (BIORAL-S and BF) had a slight decrease after the realization of the 25 testing hours at endurance (shear);
- dynamic and cinematic viscosity of the experimental oils (BIORAL-S and BF) declined after the realization of the 25 testing hours at endurance;
- due to contamination with powder sawdust, fine particles of dust and fine particles of leaves, there was observed an increase of density, viscosity and refractive index, as a contamination agent was added;

- caloric power showed no relevant changes as a result of endurance tests, or the contamination by external agents.

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