

Analysis of New Biodegradable Fluid During of the Operating Test

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Abstract: *The aim of present article is the analysis of new biodegradable fluid MOL Farm UTTO Synt, which is made by MOL Group Company. This fluid was tested under operational condition by Tractor Zetor Forterra 114 41. During the test were measured the main parameters. In group of these main parameters include monitoring of contamination (wear) particles and physical and chemical properties of used biodegradable fluid (water content, total acid number and kinematic viscosity). The contamination particles was measured by magnetic analyser and on the basis of results we found that the Tractor Forterra after 900 engine hours is in the running-in process. Regarding the physical and chemical properties it can be see, that the properties did not exceed the limit value, therefore the fluid maintained good properties.*

Keywords: *biodegradable fluid, ferrography, physical and chemical properties*

INTRODUCTION

At the present time, hydrostatic systems are widely dispersed in the industry. It provides the various types of motions. The power transmission is realized by hydraulic fluid. Hydraulic fluid needs service and observation of operating parameters [12].

Fast development and increasing level of technology currently allow wider to deal the question of environmental protection. One answer to this question may be the development of new hydraulic fluids that are environmentally friendly. These fluids have to be before first use thoroughly tested [5].

In point of view environmental, it is important to change mineral fluids with vegetable oil-based fluids or synthetic oil based fluids [10]. Understandably, biodegradable fluids have slightly different properties compared with petroleum-based fluids [11]. Therefore we are dealing with the evaluation of properties of a newly developing synthetic-based fluid as a potentially possible substitute for mineral-based fluids.

From utilization of hydraulic fluid in a machine point of view there is the most important to know the running properties of fluid i.e. to know the influence of fluid on technical state of parts in the hydraulic system [4, 5]. Into the fluid during the device operation entrance metal particles through which is possible to evaluate a wear process and predict the next operation of the device. Particle contamination in hydraulic fluid accelerates wear of system components [1,4]. Therefore is very important to pay attention to purity of hydraulic fluid which is used [6].

The fluid should be replaced if the value exceeds the limits, which are specified by manufacturer. The most common hydraulic fluid contaminants are water and air, along with particles of metal, rubber or dirt [9].

MATERIALS AND METHODS

The ecological fluid, which was used, is a newly developed ecological fluid, which is made with synthetic base fluid based on poly-alpha-olefins. We choose this fluid, because it has high chemical stability and miscibility with mineral fluids, which are currently used in tractors in Slovakia. During the test we used a new ecological fluid MOL Farm UTTO Synt, which is produced by MOL Group, Hungary. This fluid belongs to the group of universal transmission hydraulic fluid designed for tractors. The main specifications of fluid are in Table 1.

Table1. Specifications of the fluid MOL Farm UTTO Synt.

Properties	Base value	Amount
Kinematic viscosity at 40°C	mm ² .s ⁻¹	58.14
Kinematic viscosity at 100°C	mm ² .s ⁻¹	10.22
Viscosity index		165
Pour point	°C	-42

FERROGRAPHY ANALYSIS

The aim of ferrography study is to identify the quantity and size of wear particles in the oil samples. Were studied samples of the new oil, samples of oil after completing 450 engine hours and after completing 900 engine hours. Wear particles have a significant effect on the abrasive wear of friction pairs in the tractors gear-hydraulic circuits. These contaminants degrade the used hydraulic oil.

Particle of pollution, despite located of oil filters in the tractor gear-hydraulic circuit should be during operating tests continued to grow. Particle of pollution during the test have tendencies agglutination and aggregation into larger particles. Technological progress of ferrography analysis in the laboratory of the Department of Transport and Handling, Faculty of Engineering, University of Agriculture in Nitra was carried out.

Magnetic analyser T2FM (Fig. 1) and KAPA 6000 Microscope for the ferrography analysis of samples oil was used. MOL Farm UTTO Synt was diluted before ferrography analysis in proportion 2:1 with tetrachlorethylene to better highlight of pollution particles in the oil.



Fig. 1 Ferrographic analyser T2FM

PHYSICAL AND CHEMICAL PROPERTIES OF BIODEGRADABLE FLUID

For measuring of the total acid number (TAN), we used the test by which we neutralized the acids in the fluid by adding potassium hydroxide KOH. Amount of alkaline reagent, which is needs to achievement of neutralization point is a function of acid concentration in fluid.

When oxidizes the fluid, are produced organic acid which are collected in fluid and cause increase TAN. Like the kinematic viscosity and too total acid number reveals degraded fluid in which an occurred degradation processes and were more or less exhausted antioxidant additives. Of course, if the parameters were not changed by another way e.g. admixture of foreign acid character substances with a lower or higher viscosity than the tested fluid [6].

Kinematic viscosity is one of the parameters of fluids and the value can go up during operation, but also decrease. In some case, during fluid aging fluid, the viscosity decrease and whereupon and as increase the oxidation products can begin grow. During the evaluation of kinematic viscosity therefore we assume from lower and upper limits that are not exceeded during operation. Limit values are determined percentage depending on the fluid type. For example, if the kinematic viscosity of hydraulic fluid changed more than 20% compared with value of new fluid have to be replaced [7].

Fluid viscosity varies with temperature. Rate of viscosity change with temperature is referred to viscosity index (VI). Viscosity index is an empirical value that is used to quantify changes in viscosity in respect of temperature. Viscosity of fluid with high VI does not change quickly with temperature as fluid with low viscosity index [2].

Water content was determined by coulometric method, which is one of the most advanced and accurate measurement of water since 5ppm. Water in fluid is undesirable it can enter into only as an external substance, for example leakage through the cooling circuits, improper seal on fluid systems, poor storage (rain), but also by the condensation of a longer shutdown device [3].

Water can be characterized as a catalyst for degradation – fluid aging, it can wash from fluid some additives, increases the acid number and thus increases the possibility of corrosion in the device. When it is found that the amount of water exceeded the limit values can be taken order – e.g. remove the water by filtration [8].

RESULTS AND DISCUSSION

In the samples of unused MOL Farm UTTO Synt synthetic oil practically not be found particle of pollution (Fig.2). After completing 450 engine hours in samples of oil are wear particles, which do not exceed size of 10 μm (Fig. 3). At the same time in these samples clusters of small wear particles that have not a negative impact on activity of gear-hydraulic circuit of Zetor Forterra 114 41 tractor. In the samples of oil after completing 900 engine hours are found large clusters of small wear particles and were found also large wear particles (Fig. 4).

The ferrography images of synthetic oil were compared with a catalogue wear particles. In comparison with the images in the catalogue of wear particles we found that these are particles of adhesive wear.



Fig. 2 Wear particles in a new fluid



Fig. 3 Wear particles in fluid after 450 engine hours

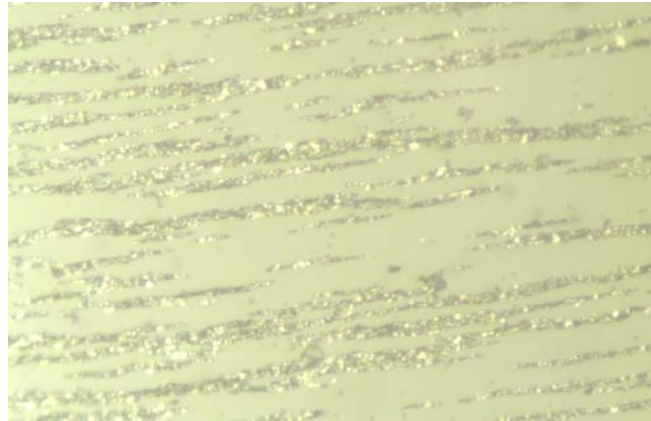


Fig. 4 Wear particles in fluid after 900 engine hours

During the test were evaluated the main physic-chemical properties of organic fluid which was tested. Samples were evaluated at an accredited laboratory WEARCHECK Almásfüzitő.

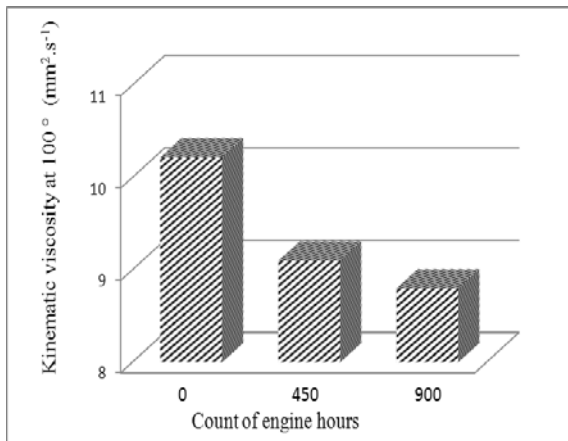


Fig. 5 Kinematic viscosity at 100 °C

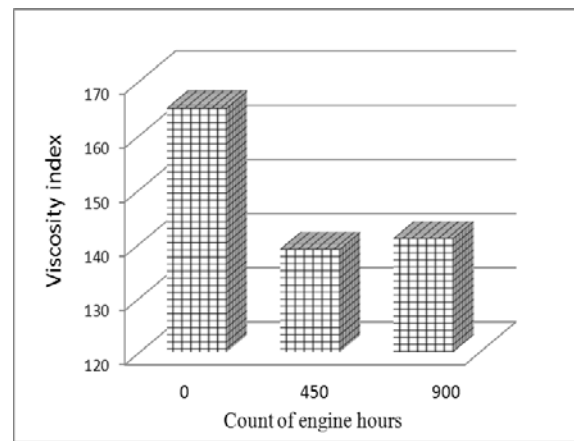


Fig. 6 Viscosity index

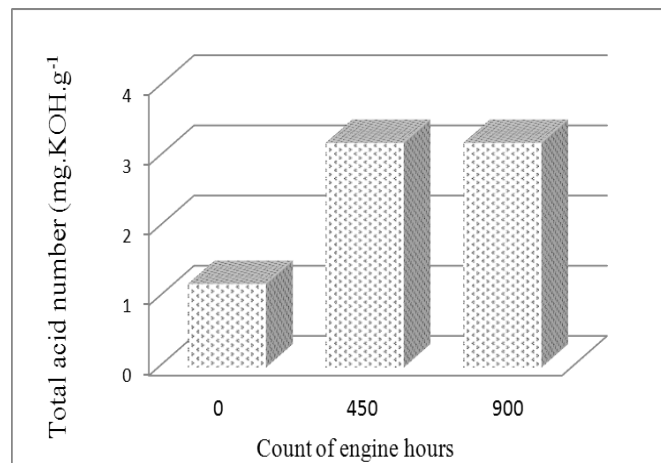


Fig. 7 Total acid number

The evaluation of kinematic viscosity is on the basis of manufacturers requirements, the value of kinematic viscosity have to not exceed the tolerance of $\pm 10\%$. The values obtained during the test of ecological fluid are in required a tolerance, which means that the fluid is in terms of viscosity in good condition (Fig. 5). Evaluation of TAN of fluid is important because

the increases of acid amount is characteristic for the fluid aging process, thus directly determines the degree of fluid degradation. Measured values of TAN (Fig. 6) had a slightly increasing trend up to 450 engine hour and then the TAN has not changed. Values are not exceeded the limits $3.5 \text{ mg.KOH.g}^{-1}$ which is specified by manufacturer, the fluid thus meets. Water content in ecological synthetic fluid was so low that it can not be measured by device. The values of VI (Fig. 7) during the test held the manufactures specified limits and also does not reason for the replacement of ecological fluid.

CONCLUSION

This article is focused on the analysis of new biodegradable fluid MOL Farm UTTO Synt which is made by MOL Group Company, Hungary. The fluid was applied into tractor Zetor Forterra 114 41 and during operation were collected the samples of biodegradable fluid and then were evaluated in terms of contamination and physical and chemical properties.

The evaluation of physico-chemical properties during the operational test, it is possible to see that not exceeding the limits specified by manufacturer and the fluid contains immeasurable water content. On the basis of obtained results from physico-chemical measurement of fluid properties it can be seen that the biodegradable synthetic fluid has good physical and chemical properties after 900 engine hours.

Based on the contamination analysis were the found particles compared with a catalogue of wear particles. According the results of ferrography it can be argue that the tractor Zetor Forterra 114 41 is in the running-in process, because there have been found a lot of particles less than $10 \mu\text{m}$. In term of ferrography, we recommended the fluid for filtration due to extends its technical life, because big cluster may adversely affect on parts of hydraulic circuit of tractor and the metallic wear particles act as catalyst of degradation processes. A large amount of wear particles was caused by mixing of test fluid with fluid in the additional equipment. On the basis of results, fluid shows good operational properties and can serve as good substitute for conventional made fluids.

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