CIGR - International Conference of Agricultural Engineering
XXXVII Congresso Brasileiro de Engenharia Agrícola

Brazil, August 31 to September 4, 2008

METALLIC PARTICLES INTO MECHANICAL AND HYDRAULIC SYSTEMS IN AGRICULTURAL AND CONSTRUCTION MACHINES

JAIR ROSAS DA SILVA [(1)], MARCOS ROBERTO BORMIO [(2)], DEISE PAULA DA SILVA [(3)]

[(1)] Researcher, Agricultural Engineering Center, Agronomic Institute, Campinas, Brazil.
[(2)] Postgraduate Teacher, São Paulo State University, Faculty of Engineering, Bauru, Brazil.
[(3)] Agronomist Trainee, Agricultural Engineering Center, Agronomic Institute, Campinas, Brazil.

ABSTRACT: The lubricant oil analysis are an indicator of the conditions how the lubricant is, may to allow the prevision of damages that occurred into machine due to the internal abrasion of hydraulic and mechanical components of the machines. The present study had the objective to determine the kind and quantity of the metallic particles that occurred into the lubricant oil of the mechanical and hydraulic compartments of the energy transmission systems of three kinds of machines: a tracked-tractor, a sugarcane harvester and a group of power-shovels. The metallic particles presents into these compartments were determined under laboratory tests and concerning to the following elements: iron, copper, chromium, lead, nickel, aluminum, silex, tin and molybdenum. About to the tracked-tractor, the metallic contaminators into to the oil charges surpasses the tolerate levels, considering the technical standards adopted in this evaluation. In the sugarcane harvester only a metallic element in excess was identified and, in a power-shovel group it was showed the need to correct air false entrances in the hydraulic or mechanical systems due the high presence of silex element.

KEYWORDS: Lubricant oil, analysis, wear, machines.

INTRODUCTION

Studies in the agricultural and construction machines foresight maintenance by physical and chemical analysis of lubricant oil samples used in compartments of machines are an important tool in direction to the good performance of these machines.

It is habitual the occurrence of various kinds of failure observed by lubricant oil contaminates, where the more commons are abrasion, static friction, erosion and corrosion.

The contaminates engaged in these processes includes solid particles, water, air, chemical products and others outsider materials to these systems.

The abrasive wear that is due to the solid particles is the failure more common and vital in this case and is responsible to about 90% of the failures due to contaminations.

Some laboratories relates that the lubricant oil analysis are the indicator of the conditions like the lubricant are, allowing the improvement of the change interval oil charge and the period of time service machine and, on the other hand, these analysis contributes to the good performance of all the systems to the each machine.

The objective of this study was to characterize the actual state of the lubricant oil contained into the energy transmission system a high power tracked-tractor, into the hydraulic system of a sugarcane combine harvester and in a energy transmission system of a power-shovels group, all machines used in agricultural and engineering construction works, aiming to determine the compositions and quantity levels of the presence of metallic particles into the lubricant oil samples

in these compartments, intending to evaluate and to foresee the kinds of feasible failures would to occur in the tested machines in its habitual activities.

METHODOLOGY

The machines tested were:

a) a high power (104 kW) tracked-tractor D6N Caterpillar model, used in soil tillage, conservation and systematization during planting and management of sugarcane crop at a sugar-alcohol mill placed in the center of Sao Paulo State. The compartment of the energy transmission system analyzed was both sides of the final drive transmission;
b) a 298 kW tracked combine sugarcane harvester Claas, Ventor model, used in the same sugar-alcohol production unit. The machine compartment evaluated is the hydraulic system;
c) a group of sixteen Volvo power-shovels, various models, motor potency varying from 74 kW to 258 kW, used in engineering construction and agricultural works in Sao Paulo and Minas Gerais States. The power-shovels used in agriculture accomplishes soil tillage, systematization, earth moving, loading and moving bagasse and limestone, mainly in the sugarcane crop. The others machines are used in construction works, mineration, earth moving, various debris and residues moving, etc. The first thirteen machines mentioned in Table 2 are used in engineering construction activities and correlated services and the others, in agricultural operations.

In beginning the assay, for to obtain a good sampling, was necessary to adopt some cautions, to have in view the lubricant oil samples to be the most representative of the charge oil, as follows: cleaning the material in contact with the lubricant oil; to retire the sample when the oil charge is in service and in temperature operation; consecutive sampling in same point; do not take off samples after oil replenishment; always to agitate the oil samples before beginning the physical and chemical analysis.

The metallic chemical elements presents in variable quantities into lubricant oil charges, after some service hours, like iron, copper, chromium, lead, nickel, aluminum, silex, tin and molybdenum, were analyzed for atomically absorption spectrum-photometer, Varian 1275 model.

This laboratory procedures and the output values interpretation may to estimate the internal wear that occurred inside the compartments of the machine organs, like a gearbox, a wheel hub, a turbine, a final drive transmission and others, considering the increase of metallic elements particles evaluated during a certain time period, in such a manner to a combination of highly concentrated elements.

The maximum values of metallic contaminates that are used in mechanical and hydraulic systems of machines to a comparative references in this study, according Snowden Jr & Westerheid (1975) to a iron, lead, copper, silex and aluminum and other chemical elements, as for chromium, nickel, tin and molybdenum, how parameters levels adopted by Tracbel (2007), a Volvo dealer to a machines and vehicles of construction and agricultural usage. These indexes are presented in Table 1.

TABLE 1. Maximum values of metallic particles considered in lubricants oil charges, parts for million.

Maximum values of metallic particles, parts for million (*)								
iron	copper	chromium	lead	nickel	aluminum	silex	tin	molybdenum
120	40	20	15	10	27.4	15.5	20	15

(*) According Snowden Jr & Westerheid (1975) and Tracbel Company (2007).

RESULTS ANS DISCUSSION

The analysis results of the lubricants oil samples used in transmission system boxes are presented in Tables 2 and 4 and in hydraulic system, Table 3.

TABLE 2. Metallic particles values into the lubricant oil charges in energy transmission boxes of the tracked-tractor, parts for million.

Service hours	Values of metallic particles, parts for million								
	iron	copper	chromium	lead	nickel	aluminum	silex	tin	molybdenum
3,444	171	5	22	56	15	9	14	2	2
4,138	74	5	17	85	23	5	13	13	3
4,792	142	69	24	54	14	31	47	13	6
5,241	148	64	17	52	16	22	49	13	4
5,366	147	77	18	61	16	31	59	3	6
5,491	138	54	22	63	16	30	45	5	6
5,830	389	52	10	22	6	20	58	13	-

Considering the lubricant oil analysis of the energy transmission system of the tracked-tractor, made by atomic absorption spectrum-photometer, the obtained results (Table 2) showed that metallic particles of the majority of the chemical elements presents more quantities than tolerate taxes, according the mentioned authors, excepting tin and molybdenum. Several abrasions of various natures would be occurring into the organs of the energy transmission system in the evaluated tractor, even so considering the little usage in service.

TABLE 3. Metallic particles values into the lubricant oil charges into the hydraulic system of the sugarcane combine harvester, parts for million.

Service hours	Values of metallic particles, parts for million (*)								
	iron	copper	chromium	lead	nickel	aluminum	silex	tin	molybdenum
15,060	0	44	0	0	0	0	0	0	-
16,103	-	19	0	5	1	2	0	0	-
16,904	2	17	1	0	2	0	0	1	-
17,398	3	47	0	0	0	0	0	0	-
17,978	0	41	0	0	1	2	4	0	-
18,340	0	25	0	8	0	2	7	4	-

The metallic particles analysis results into hydraulic system of the Claas sugarcane combine harvester (Table 3) showed that only the copper chemical element presents excess values considering admitted quantities in the compartment evaluated.
This result was observed in four different analysis replicates and indicates an anomaly due an irregular wear of machine bearings. All the wear remainder elements showed compatibles values according the peculiar feature of these specifications.

Among the metallic particles evaluated in some boxes of the energy transmission system of power-shovels group, the results are presented in Table 4.

TABLE 4. Metallic particles values into the lubricant oil charges into the energy transmission system of the power shovels sixteen group, parts for million.

Power-shovel	Service hours	Values of metallic particles, parts for million (*)					
		iron	copper	chromium	lead	aluminum	silex
a	1,567	41.2	3.4	0.9	0.1	0.6	4.0
b	1,216	19.2	2.6	1.5	0.1	0.3	2.2

c	410	7.7	0.9	2.7	16.1	1.2	5.3
d	7,000	0.1	1.5	13.7	4.5	0.1	14,7
e	6,750	0.1	1.0	2.5	2.9	0.1	19.2
f	6,500	0.1	2.1	20.1	4.4	0.1	1.6
g	1,005	2.9	2.0	4.9	31.5	0.3	8.3
h	1,025	0.1	1.5	3.7	39.3	0.1	18.3
i	490	0.1	2.4	3.2	20.8	0.1	7.4
j	501	4.6	2.0	2.8	18.3	0.1	2.7
k	489	5.4	1.5	3.6	17.1	0.1	0.1
l	1,680	5.4	1.15	2.0	8.4	0.1	0.1
m	2,076	4.7	1.5	2.8	27.5	1.5	1.4
n	1,512	0.1	1.1	4.5	45.7	0.5	2.3
o	1,094	2.6	0.1	2.3	14.9	0.8	0.1
p	1,074	0.5	0.1	2.2	14.2	0.1	0.1

About all the analysis realized in the group of sixteen power-shovels (Table 4), only two machines indicates anomalies regarding silex metallic particles into lubricant oil charges of the energy transmission systems, even so did not effectuate analysis to some chemical elements, such as nickel, tin and molybdenum.

These results indicates the necessity of correction of air false entrance in to energy transmission in these machines, through observations in box breathes, damaged air filters, dirty mouthpieces, loose bracers, holes in rubber hoses, etc.

CONCLUSIONS

The energy transmission system of the tracked-tractor showed wear elements to metallic particles in the majority of the chemical elements researched.

The excess of copper chemical element was diagnosed into the hydraulic system of the sugarcane combine harvester, supposed that is occurring anomalies in bearings in this machine.

High silex contents identified into the energy transmission system of two power shovels indicate necessity to correct air false entrances in these systems.

REFERENCES

SNOWDEN JR., J.E.; WESTERHEID, J.P. Oil analysis as a significant factor in oil equipment maintenance. Lubrication Engineering, v. 8, n. 32, 1975.

TRACBEL. Volvo Partner. Lubricant oil analysis results of the energy transmission and hydraulic systems. Sumare, 2007. 18 p. (No published).