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THE HYDRAULIC OIL ANALYSIS OF FOR DETERMINATION OF THE NUMBER OF MECHANICAL DIRT AND WATER CONTENT IN HYDRAULIC CRANES

INTRODUCTION

Machine oil of different types have a large variety of usage in the operation of machines and regarding to periodical and varying quality after every exchange they are a significant factor of diagnostic signals. The signals show the state of oil and its necessity of exchange, or level of machine components wearing, especially those which they are in touch with and these particles are then a part of oil. From functional point of view, oil is lubricant (engine, gears) or it transfers energy (hydraulic systems) and it also has a function of sealing, cooling and filtration [8]. In all cases it is possible to use the quality of this liquid. Dirt can cause failures in the hydraulics [1, 7]. The goal of this analysis is to obtain as many oil and machine parameters as possible to decrease operation costs and get the best view of oil quality.

MATERIALS AND METHODS

The goal of oil analysis is to obtain as many oil and machine parameters as possible to decrease operation costs and get the best information about the quality of oil and a machine. To increase hydraulic system lifetime in the case of hydraulic crane it is necessary to check the pureness and volume of water in oil. For the given parameters there was used a diagnostic unit called icountOS (Fig. 1) in the hydraulic cranes called ESSEL 180Z and Palfinger Epsilon 250 Z, which are used for wood mass transport in VšLP in Zvolen.

The unit of icountOS by Parker Hannifin is a laser monitoring device for oil. This detector of fluid contaminations is based on mineral oils or aviation fuel.

Figure 1 – Icount oil sempler by Parker Hannifin [11]

Measurement is held at the operational temperature of hydraulic oil in hydraulic cranes where oil was shook enough. Then low pressure hoses are put into the oil tank of the hydraulic crane to hold a measurement by a diagnostic device called icountOS. The time of measurement is not limited. After the end of measurement there are displayed levels of dirt, unit and level of oil moisture according to ISO 4406: 1999 or NAS1638.

The first measurement was held on new hydraulic oil OTHP 32 and then there were measurements held on oils in hydraulic cranes. After the evaluation of dirt in hydraulic oil, the results were compared.

Table 1. Technical parameters in hydraulic crene ESSEL 180 Z and Epsilon Palfinger E250Z [4,5]

Technical data	**180Z**	**E 250Z**
Max. turning moment (kNm)	183,6	210
Max. horizontal impact (m)	9,0	9,5
Carrying capacity (m/kg)	9,0 / 1950 6,0 / 2950	9,0 / 2200 4,0 / 5150
Turning angle (°)	380	395
Krútiaci moment otoče (kNm)	37,1	36
Obsah olejovej nádrže (l)	195	195
Pracovný tlak (MPa)	25	26
Max. prietok oleja (l/min)	2 x 62	2 x 90
Hmotnosť (kg)	2630	2980

Hydraulic cranes ESSEL 180Z and Epsilon 250 Z belong to forest cranes type Z (according to the shape of the hydraulic crane). Their construction is used for wooden mass manipulation in the long lengths in forests and wooden stocks (Tab. 1).

In the hydraulic cranes there is used hydraulic oil called OTHP 32. Hydraulic crane OTHP 32 is especially used for heavy loadings for force transfer and hydraulic controlling i.e. hydraulic gears with heavy working conditions (pressure up to 25 MPa in gear pumps and pressure up to 35 MPa in piston pumps) and elsewhere is higher temperature and moisture of environment.

RESULTS

New standard for cleanness level ISO 11171 substitutes standard ISO 4406 and it brings ISO MTD (middle value of tested - artificial) dust as substitution for used dust ACFDT in the old standard. The most often there is spread the volume of dirt bigger than 4, 6 and 14 micrometres in one millimetre of a fluid. Number of particles 4+ and 6+ micrometres is used as a reference point for particles creating „dust-mud“. Size 14+ shows the number of bigger particles which can cause serious damages of parts. Code number is given to every size individually and final code of clearance means the worst code of individual particle sizes [3].

In the first step there was evaluated new hydraulic oil by diagnostic unit icountOS and measured values were **ISO 19 / 17 / 14**. From the result it is clear that new oil shows higher level of dirt. The volume of water in new hydraulic oil is 65% representing **195 ppm**. In this case the concentration limit for water is 200 ppm. The results confirm that new fluid taken from an original package is not suitable for hydraulic or lubricating systems [16].

The measured hydraulic oil results in hydraulic crane Palfinger **Epsilon 250 Z** built in Iveco Trakker ZV-104 BX are **21 / 20 / 18** (ISO number code).

From the number code above it is visible that particles at the size of 4 micrometres and more are present at the volume of 10000 - 20000 particles in 1 millilitre of oil. Particles 6+ micrometres are present at the volume of 5 000 - 10 000 particles in 1 millilitre of oil. Particles 14+ micrometres are present at the volume of 1 300 - 2 500 particles in 1 millilitre of oil.

Volume of water was measured by icountOS and it was 50% what represents **150 ppm** or 0,015 % of relative volume of water in oil regarding to the level of saturation at the given temperature.

The measured hydraulic oil results in hydraulic crane Palfinger **Epsilon 250 Z** built in Iveco Trakker ZV-364 BG are **22 / 21 / 20** (ISO number code).

From the number code above it is visible that particles at the size of 4 micrometres and more are present at the volume of 20000 - 40000 particles in 1 millilitre of oil. Particles 6+ micrometres are present at the volume of 10 000 - 20 000 particles in 1 millilitre of oil. Particles 14+ micrometres are present at the volume of 5 000 - 10 000 particles in 1 millilitre of oil.

Volume of water was measured by icountOS and it was 48 % what represents **144 ppm** or 0,0144 % of relative volume of water in oil regarding to the level of saturation at the given temperature.

DISCUSSION

Tribotechnical diagnostics is a part of non-destructive technology dealing with diagnostics of the state of friction joints on the basis of taken samples of lubricants or fats used for friction of these joints [13,14]. Its role is to release the state of the machine in the laboratory, then to evaluate and define the number of dirt and water in the observed lubricant or fat. On the basis of these results there are changed fillings. Tribotechnical diagnostics enables rational and economical usage of lubricants and fats, early identification of defects in the operation of machines and devices [10, 8].

This method of evaluation a definition of mechanical dirt belongs to the most common used ones in the operation because it is economical, little time demanding and precise enough [7].

To get the best decision regarding to oil changing and the state of a machine, it is necessary to have real results about used oil filling. There is a question of parameters used in the analysis because there are many parameters which we can focus on. The authors Hnilicová & Kučera, 2013 offer wide view of methods which are used for analysis of hydraulic oil.

The similar task was observed by Ilčík et al., 2011 where diagnostics respectively operational analysis of the oil sample was held in hydraulic crane ESSEL 180Z by mobile oil laboratory called KLEENTEK. On the basis of the diagnostics of real state of oil sample dirt there was found out that there was very hard dirt. On the basis of the diagnostics, the sample was considered according to the gauge NAS 12 as ISO 23/21/18 [12].

Hydraulic oil belongs to the group of industrial oil where the limit for volume of water is 500 ppm (0,05 %). Recommended maximum limit of water level is around 200 ppm (0,02%) [15, 16]. From the measured water level in oil there is one hydraulic oil sample on the level of 200 ppm.

In the mentioned devices it is necessary to hold the regular diagnostics and filtration of oil fillings. It is also confirmed by research of authors Ilčík et al. 2011, Hnilicová 2015, Fitch a Troyer 2011, where 85% of defects in hydraulic systems are caused by dirt of hydraulic oil [17].

CONCLUSION

Particles are taken away at the wearing of frictional kinetic parts of the machines in the size of microscopical particles. On average loaded oil systems there are from 70% to 80% of solid particles at the size of 1 to 5 μm and 10% of solid particles 10+ μm. Critical solid particles responsible for higher wearing are 5+ μm. The purpose of this paper is to realize the practical measurement for establishment of volume of mechanical dirt and volume of water in hydraulic oil in hydraulic cranes. There were realized faults of observed hydraulic cranes and new fluid as well. The faults were connected to higher level of dirt which can cause damages of mobile parts of the hydraulic system as well as leaking decreasing lifetime of the hydraulic cranes. On the basis of results it would be suitable to clean hydraulic oil from bigger dirt and change filters in hydraulic cranes. After oil filtration it is necessary to check oil dirt again. It is important to consider also the state of new fluid, because there is certain level of dirt too [16]. The recommended levels for new fluids are according to ISO 18/16/13. In general, new fluid is taken from the original package is not suitable for hydraulic or lubricating systems. Level of water is within the limit up to 200 ppm. To decrease risky level of water in oil is the most suitable to buy hydraulic oil directly at the supplier and it is not recommended to stock big volumes of new oil in the oil stock.

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