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ANALYSIS OF THE HYDRAULIC OIL TO DRIVE BAND SAWMILL

Transport and material handling is a sum of technological processes in the wood-processing industry. Hydraulic drives are one of the drive options used as a basic part of the transport – handling machines. Contamination control involves preventing contaminants from entering a hydraulic system and placing filters in strategic locations throughout the system to trap any contaminants to find their way into the fluid. But for critical equipment, a successful contamination control program must also include regular assessment of the hydraulic fluid cleanliness. It must be often done every two to six months or after every 500 or 1,000 hours of operation, depending on the equipment duty cycle, operating environment, and how critical it is to overall operation. Pressure forces in hydraulic drives are transferred to hydraulically-operated devices which also serve to lubricate the elements, displace and remove heat from the system. To increase the service life of hydraulic drives, hydraulic oil must meet individual physical characteristics. To ensure reliability, timely diagnosis of hydraulic oil is required. Some experts also recommend that fluid to be tested immediately after any maintenance event that exposes the hydraulic system to the external environment. This could occur when a hose or other component is replaced or fluid is added to the reservoir. Fluid replenishment can be particularly troublesome because new fluid is notorious for being dirty – often from improper storage and handling practices. The article deals with the methodology of measuring the basic physical properties of hydraulic oil by the respective diagnostic devices directly on the hydraulic drive of the bend saw in the full operation of the machine. The methodology suggested enables making decisions for improvement of the hydraulic oil state.

Keywords: hydraulic oil; diagnostic; no-failure operation; band saw.

Introduction. Transportation and manipulation with material is an important part of almost every technological process in industry. Manufacturing process consists of multiple operations that follow one another, and connection between them secures transportation and manipulation technology. Transportation and manipulation with material is greatly affecting quality, economics and safety of work in individual branches of industry. Because of this, it is necessary to dedicate increased attention to this problem to ensure, that manufacturing process is most effective and safest as it could be. From the function perspective oil is used as lubricant most of the time (engines, gears) or as a element for transfer of energy, alternatively it has sealing, cooling or filtrating function (Hnilica & Dado, 2012; Antalov, 2017). Mineral oils are applied in almost every industry. They are substances of petroleum origin formed by mixture of higher hydrocarbons with the addition of special substances (Hybská et al., 2017, 2018). In all cases it is possible to make us of changing quality of oil. Contamination is causing most of the malfunctions in hydraulics. (Balog et al., 2002; Graça et al., 2011)

Experiences of designers and users of hydraulic and lubrication systems confirmed the facts, that more than 85 % of all malfunctions are a straight consequence of contamination (Štollmann, 2010).

Expenses caused by contamination are growing gradually and are causing:

- Losses in manufacturing (downtime)
- Expenses for changing damaged parts
- Frequent fluid change
- Expensive elimination of faults
- Raised expenses for maintenance
- Raised expenses for confusions (Krilek, & Dobrotová, 2016).

Material and methods. For prolonging the lifespan of hydraulic system for driving a bandsaw is required to check quality and amount of water contained in oil. Measurement was made on carriage made by Dinaco VEL – 970 bandsaw Dinaco FIL – 1600. On hydraulic drive of bandsaw carriage were with portable diagnostic device icountOS monitored parametres of purity of hydraulic oil and amounts of water. Capacity of oil reservoir of hydraulic unit driving the bandsaw carriage is 130 litres. System is filled with hydraulic oil Telus 46 Schell HLP ISO VG 46.

Parker Hannifin's icountOS (Figure 2) is an oil laser monitoring device. This mineral oil or aviation fuel contamination detector is designed for use in demanding environments and therefore its packaging is made of highly resistant resin HPX. This Vortex valve allows pressure relieving without draining water, and the soft handle of the icountOS is designed with a view to its high durability, functionality and future customization capabilities.

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Figure 1. Bandsaw with carriage [own photo]

Figure 2. Parker Hannifin's icountOS monitoring device (icount Oil Sampler, 2011)

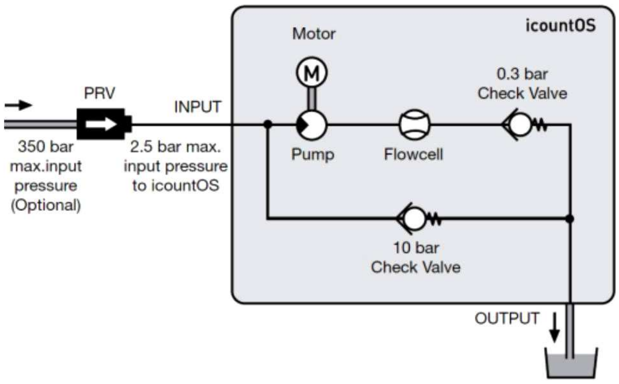

Figure 3. Hydraulic circuit icountOS (Icount Oil Sampler, 2011)

The measurement is carried out at the hydraulic oil operating temperature of the hydraulic saw blade carriage (Figure 1) in order to mix the oil sufficiently. Subsequently, the low pressure hoses of the diagnostic tool are placed in the oil tank of the carriage and measured using the icountOS diagnostic device (Figure 3).

Results and discussion. The monitored parameters influence the lifetime of individual parts of the hydraulic system (distributor, pump, hydromotor,…). For this research, the unit was set according to ISO 4406: 1999 (Figure 4).

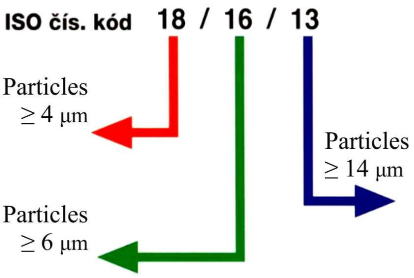

Figure 4. Description ISO 4406 of number code (Příručka filtrační techniky, 2015)

In order to determine the state and its improvement (correction), the relative degree of pollution is used. Reading particle pollutants is the most common method for deriving a standard of purity. Very sensitive optical instruments are used to determine the number of particles of impurities in variable ranges associated with particle size. These values are then referred to as a number (count) of particles larger than a certain (determined) size that has been found in a given volume of liquid. The code number is assigned separately for each size category, and the resulting purity code corresponds to the worst code mark from each particle size (Dálik, 2011).

After 200 hours of operation, the measured values were ISO 17/15/13 (Table 2) and % relative humidity 40 %, which is 120 ppm. It follows from the code number that particles of 4 µm are found in 1 ml of oil 640–1300. The 6 µm particles are in 160 ml of oil in 1 ml of oil, and 14 µm in 1 ml of oil is 40–80.

After 400 operating hours, ISO 18/16/13 and % relative humidity of water were measured at 45 % (Table 2), which is 135 ppm. The particle sizes of 4 µm are in the 1 ml of oil 1300–2500, 6 µm particles are in 320 ml of oil in 1 ml of oil, and 14 µm particles are in 40 ml of 1 ml of oil (Table 1).

After 600 operating hours, ISO 19/17/14 and % relative humidity 46 % (Table 2) were measured, i.e. 138 ppm. A particle size of 4 µm is present in 1 ml of oil in the range of 2500–5000, 6 µm particles in 6 ml of oil are 640–1300, and 14 µm particles in 1 ml of oil are 80–160 (Table 1).

After 800 operating hours, ISO 21/20/20 and % relative water humidity 47 % (Table 2) were measured, ie 141 ppm. A particle size of 4 µm is present in 1 ml of oil in the range of 10000–20000, 6 µm particles in 5 ml of oil are 5000–10000, and particles of 14 µm in 1 ml of oil are 5000–10000 (Table 1).

Table 1. Table of measurements ISO 4406:1999 (Příručka filtrační techniky, 2015)

ISO 4406:1999 table of measurements		
Code number	Particle count per ml	
	More than	Up to, including
24	80,000	160,000
23	40,000	80,000
22	20,000	40,000
21	10,000	20,000
20	5,000	10,000
19	2,500	5,000
18	1,300	2,500
17	640	1,300
16	320	640
15	160	320
14	80	160
13	40	80
12	20	40
11	10	20
10	5	10
9	2,5	5
8	1,3	2,5
7	0,64	1,3
6	0,32	0,64

Table 2. Table of measurements

n.	ISO code	% relative humidity water
1	17/15/13	40
2	18/16/13	45
3	19/17/14	46
4	21/20/20	47

Tribotechnical diagnostics is part of a non-disassemble technique for detecting the technical state of friction nodes based on a sample of the lubricant that they are lubricated (Kučera, 2000, 2003). Its task is to determine the status, evaluate and report the presence of foreign substances in the lubricant and its change, in quantitative and qualitative terms. Tribotechnical diagnostics enables us to rationally and economically use lubricants, early identification of emerging failures in the operation of machinery and equipment (Hnilicova & Kučera, 2013, Hnilica & Dado, 2012).

The method of detecting and determining the number of mechanical impurities is one of the most frequently used in operation, as it is economically and temporally least demanding and sufficiently precise (Graça et al., 2011).

The question remains what needs to be analyzed, because the parameters for the evaluation are fairly good. Authors Hnilic & Kučera, 2013 provide a broader view of the methods used for hydraulic oil analysis.

Hydraulic oils are included in the group of industrial oils in which the water content should not exceed 500 ppm (0.05 %). The recommended maximum water content limit should be 200 ppm (0.02 %) (Nováček, 2011; Příručka filtrační techniky, 2015). From the measured values it follows that relative to the % relative humidity of water is oil usable for hydraulic systems. This is bound water, which can be up to 300 ppm in the hydraulic oil under consideration, and more than 300 ppm already forms free water which forms an emulsion with the oil. For hydraulic systems, the permitted water content is up to 200 ppm. Above this value, oil may damage the hydraulic system such as corrosion.

It is necessary to perform regular diagnostics and filtration of oil fillings, as confirmed by the research of the authors Ilčík et al. (2011), Fitch and Troyer (2011), where 85 % of hydraulic system failures arise due to contamination of hydraulic oil (Štollmann, 2010; Krilek et al., 2016; Day & Bauer, 2007; Antalov, 2017).

Conclusion. From the measured ISO clarity values, an increasing tendency for impurities can be observed. This can be influenced by several factors. One of them is that the machine works in the dusty environment of the woodworking industry. Here, it is important to ensure that the elements are sufficiently sealed and that they do not get into the system through the leakage of dirt from the outside environment. Impurities from the outside can generate additional impurities in the system. They can cause single channel drainage in the valves, valve faults, failure of individual elements, poor system function, high failure, frequent machine downtime. This prevents predictive machine maintenance by monitoring oil contamination. First of all, filling the system with hydraulic oil by means of filtering devices, since hydraulic oil from drums is not of sufficient purity. Choice of appropriate filtering built into the system, and regular replacement of filter inserts. Clogged filter inserts cause great pressure losses in the system, as the hydraulic oil flows through them worse. Use filters with filter pointers to keep the machine maintenance when changing the filter cartridge.

In the case of woodworking machines, and not only, neglect of oil care leads to significant economic loss caused by long delays due to failure in hydraulic equipment. Therefore there is no need to make inexpensive compromises that will ultimately cost us, but we need to invest in quality filtration. This investment will later reflect on reducing the cost of spare parts, service, time consumption, breakdowns due to failures. Use fine air filters to filter aeration tanks of aggregates. Carefully select pressure or return filters, filters on separate filter branches. Take care of filter maintenance, replace filter inserts regularly and especially in time. Fill the hydraulic systems only with a filtering device, which can also be used as off-line filtering. By such measures we extend the life of not only hydraulic oil but also the hydraulic system itself.

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АНАЛІЗ ГІДРАВЛІЧНОЇ РІДИНИ ПРИВОДУ СТРІЧКОВОЇ ПИЛКИ

Транспортування та перероблення матеріалів – це частина технологічних процесів деревообробної промисловості, у яких часто використовують гідропривід. Контроль забруднення полягає у запобіганні потраплянню забруднювальних речовин у гідравлічну систему, розміщення фільтрів у стратегічних місцях гідросистеми так, щоб захопити всі частки бруду, які потрапляють у рідину. Для сучасних пристроїв успішна програма контролю забруднення повинна також включати регулярну оцінку чистоти гідравлічної рідини. Часто це потрібно робити кожні два-шість місяців, або кожні 500 або 1000 год роботи залежно від робочого циклу пристрою, робочого середовища тощо. Для збільшення терміну служби гідравлічних приводів, гідравлічні рідини повинні відповідати індивідуальним фізичним характеристикам. Для забезпечення надійності необхідна своєчасна діагностика таких рідин. Фахівці рекомендують тестувати оливу відразу після кожного випадку контакту гідросистеми із зовнішнім середовищем: поповнення гідрорідини, присадок й ін. Розглянуто методологію вимірювання основних фізичних властивостей гідравлічних олив діагностичним устаткованням безпосередньо на гідравлічному приводі стрічкової пилки під час її експлуатації. Така методологія дає змогу приймати рішення для поліпшення стану гідравлічної рідини.

Ключові слова: гідравлічна олива; діагностика; безвідмовна робота; стрічкова пилка.