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LUBRICATION OF MANURE SPREADERS AS AN ELEMENT OF PREVENTIVE MAINTENANCE

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Abstract: *Lubrication of agricultural equipment, i.e. is part of preventive maintenance, which has the goal to prevent clogging of friction elements. The operation of manure spreaders is limited to a certain period of time, which, apart from high productivity of manure spreaders also requires reduction of standstills as much as possible. Correct maintenance of manure spreaders enables more economical operation and completing the process of fertilization in relatively short agritechnical terms. This paper shows an example of manure spreader lubrication, and also a statistical analysis of the effect a "failure" has on the total capacity of the manure spreader.*

Keywords: *lubrication, maintenance, manure spreader.*

1. INTRODUCTION

The operating quality of a manure disperser depends on two independent systems, one for dispersing manure on the soil surface, which consists of dipersing cylinders, horizontally or vertically placed (*figure 1*), with adequate shovels, teeth, usually positioned spirally, and the other system that feeds the manure to the dispersing cylinders and also a pole position regulation system. Manure dispersing and the uniformuty of dispersing per unit of area, taking into account the cylinders as executive elements of dispersion, cannot be obtained without adequate feed of mass, with a certain flow, by the height of manure and its uniformity. Low movement speeds of a standing chain transporter, from 0,5-3 m/min usually are obtained by using a locking mechanism that got its driving power through a shaft attached to a tractor or through the wheel of a trailer. The efficiency of the manure primarily depends on the amount and uniformity of manure supply through cylinders. Mechanical transmission elements are frequently replaced by hydraulic systems with components that provide a variety-rich regulation, of primarily kinematic parameters, which causes non-uniformity of manure dispersion.

2. MANURE DISPERSERS

The characteristics of manure disperser use primarily refers to a large amount of manuring , up to 40 t/ha which requires the use of adequate mechanization. For the dispersion of manure on one hectare, it is necessary to supply from 5 to 10 trailers, depending on the capacity of trailers and the width of the dispersion. Taking into account that the storage location of the manure lies at a distance from the place of use within a range of a few kilometers and up to a few dozem kilometers, we can conclude that the transport costs are extremely high. Manuring is done in a relatively short period of time, with one trailer, which takes from a couple of minutes up to 10 minutes, depending again on the capacity of the trailer and the manure dispersion system.

The basic parameters of a trailer are its dimensions, the manure dispersion system (dimensions, characteristics, shape and kinematic parameters of cylinders), and the manure supply system to the dispersion cylinders. The regulation

of the amount of manure is primarily achieved through the movement speed of the standing chain transporter with a low speed. At a relatively low amount of manure in the trailer, the operating quality decreases and the amount of manure per square unit falls outside the given range.

By using hydraulical elements and adequate components of a hydro-system the supply of manure can be provided at a certain speed or a certain amount, which affects the operating quality of the manure disperser.

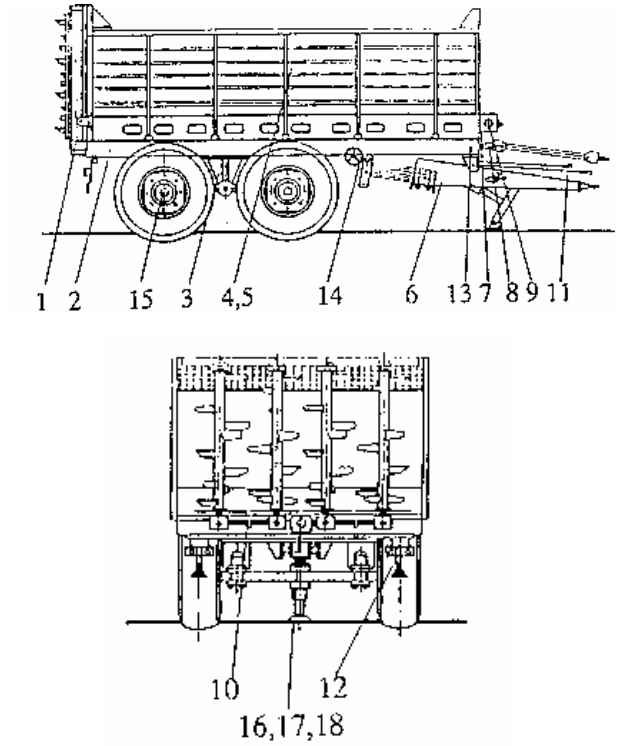

Figure 1. Manure disperser with vertically positioned rotors
(1-rotor device for dispersion; 2-frame; 3-spring; 4,5 i 7-left, right and front side; 6-pulling shaft; 8-drive shaft; 9-front shield; 10-drive mechanism of the standing transporter; 11-pneumatical assembly; 12-electric wiring; 13-hydraulic assembly; 14-manual brake; 15-wheel axis;16,17 i 18-drive device)

Regardless of the manure disperser type (*figure 2*), or of the fact whether the disperser has horizontally or vertically positioned rotors, the main parts of a manure disperser are:

- ***Dispersion device*** for manure in the shape of a spiral shaft (or with teeth) which lies in self-adjusting bearings.
- ***Satnding transporter*** in the shape of a infinite chain (two or more) of great strength, connected by rods. The tension of the chain is done through tension chains on the front end of the trailer.
- ***Drive of the manure dispersion device*** is performed through a reductor, a clutch and a chain transmission from the drive shaft of the tractor.
- ***Drive of the standing unit*** is carried out from the reductor to the hydraulic pump and by pipes to the hydraulic motor which is connected to the reductor and which drives the transporter through a chain.
- ***Hydraulic system*** consists of a sub-system for driving the standing transporter and a hydraulic system for the shaft.
- ***Shaft*** with a spring on the rear part, which enables an elastic connection to the frame. Shafts of single axis manure dispersers have a built-in hydraulic stand on the middle section which is used for the trailer when it does not operate.
- ***Box*** which consists of two sides and a horizontal surface which are connected. The rear part of the box is designed so that it mount easily to the dispersion device.

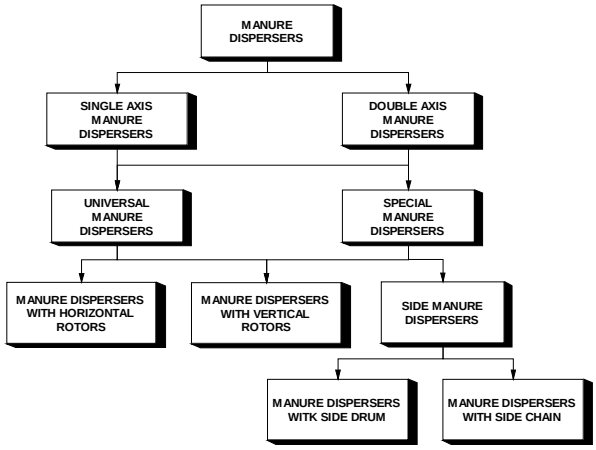

Figure 2. Manure disperser classification scheme

3. MAINTENANCE OF MANUR DISPERSERS

Maintenance may be defined as the need to undertake technical and other activities the primary objective of which is to provide the soundness of equipment in the production process, with minimum maintenance costs caused by standstills due to failure repair or because of costs related to maintenance, that are not directly caused by standstills.

Maintenance has the task to remove failures and prevent them from occurring, to provide reliable functioning of the production system during its work and to eliminate all standstills that could occur during the exploitation process.

Basic objectives of an organized maintenance process are:

- minimizing costs because of standstills in operation due to breakdowns that are not foreseeable,
- providing the necessary level of reliability of production equipment,
- achieving a better product quality,
- increasing the work productivity.

4. LUBRICATION AS PART OF PREVENTIVE MAINTENANCE

Lubrication is a procedure that has the goal to replace material wear due to friction of two elements with friction within the fluid, by using lubricants. That slows down the wearing process on often very expensive elements, and increases the working capability of the whole system. The lubrication procedure includes the following activities:

- Cleaning of: lubrication installations (pumps, filters, conducts etc.), contacting surfaces of elements of the machine under friction,
- Checking the type of lubricant and its quality,
- Checking the amount of lubricant in the system and add some, if necessary,
- Replacement of lubricant after a certain, given period of time.

Knowledge about the friction elements that are wearing out, and the wearing process itself enables creating conditions for slowing down these processes. To produce efficiency in the operation of equipment, it is necessary to perform lubrication within strictly determined time intervals. During lubrication one must be careful that each part is lubricated with a certain lubricant, in a certain amount and within a given time interval.

The following two issues affect lubrication:

- Type of lubricant or the characteristics of the lubricant as are: temperature i viscosity.
- Type of element that is lubricated, the material that it is made of and its geometrical shape.

A maximum of ten spots for individual, i.e. manual lubrication, is allowed on one machine. All other lubrication systems should be:

- With own drive mechanism or machine drive and
- With an automatic system, which in the case of failure turns off the machine. The machine operator gets the information about the failure spot on the lubrication system through visual or audio signal.

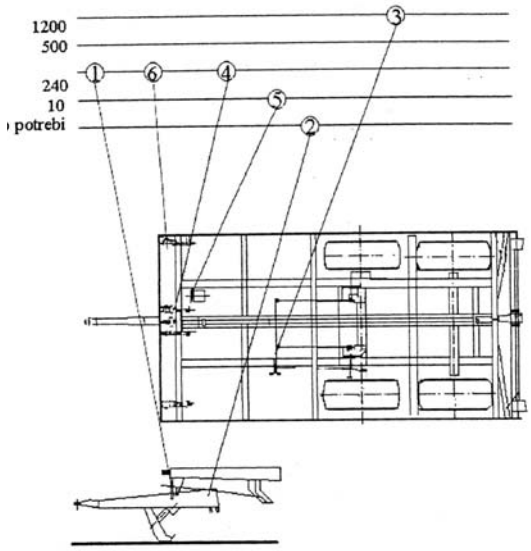

Figure 3. Lubrication manure spreader

Table 1. Manure spreader lubrication

No.	Part description	Time cycle (h)	Lubricant	Amo unt (l)
1	Spring supports	240/1200	MoS2+N LGI-1	0.05
2	Spring	60000	MoS2+N LGI-1	0,05
3	Manual brake	1200	NLGI-2	0,05
4	Upper chain wheel bearing (inner)	240/1200	MoS2+N LGI-1	0,05
5	Cylinder pump chain	10	Oil for open chain wheels	0,5
6	Upper chain wheel bearing (outer)	240/1200	MoS2+N LGI-1	0,05

5. CRITERIA FOR EVALUATING MAINTENANCE

One of the most interesting questions is the evaluation of the maintenance quality on technical systems in time, i.e. measuring the maintenance quality.

Measuring means comparing a known value to an unknown value that is examined. Measuring maintenance quality is not always an easy task. To be able to measure maintenance quality, certain criteria have to be defined in advance, based on which it will be possible to assess the maintenance quality. The most important criteria for evaluating quality are the following:

- reliability of a technical system,
- intesity of failure occurence,
- availability of equipment,
- level of documentation etc.

6. AVAILABILITY OF MANURE DISPERSERS

We differ between the following types of availability:

- operating availability,
- own availability,
- achieved availability

Operating availability of a system is the probability that the system considered will function in the way predicted, in any moment of the time interval considered. Operating availability includes the time of use and the standstill time of the system. We can describe the operating availability as follows:

$$Pro = tk / (tk + tz) \quad (1)$$

where:

Pro - is the operating availability,

tk - time of use,

tz - standstill time

Own availability of a system is the probability that the system considered will function in the way predicted, in any moment of the time interval considered. Own availability includes the time of use and the time of active repair. We can describe the own availability:

$$Prs = tk / (tk + tap) \quad (2)$$

where:

Prs - is the operating availability,

tk - time of use,

tap - time of active repair.

Own availability is always greater or at least equal to the operating availability of the system, because it does not take into account time losses due to logistic need (waiting for the spare part to be purchased and similar.)

$$Prs \geq Pro \quad (3)$$

Achieved availability takes into account all types of maintenance that are performed on a system, i.e. planned (preventive) and unplanned (corrective) maintenance.

7. RESEARCH RESULTS

Research was conducted on the agricultural facility «Jedinstvo» near Kikinda, which has 2860 ha of farming land. This farm delivers 25.000 pigs and 150 steers per year. The agricultural facility has manure dispersers: M-535-Oluja 7 units.

The corresponding procedures contain preventive maintenance activities and preservation activities at the end of the season.

The analysis of time needed for preventive maintenance is given in table 2.

Table 2. Preventive maintenance of manure spreaders

Maintenance time cycle	Maintenance operation	Operating time (min)
Daily lubrication or every 10 hours	chains for driving the cylinders of manure spreaders	8
	chain couplings	2
	transporter drive gear wheel	3
weekly or every 100 hours of work	cardan joint	5
monthly or every 200 hours of work	spring supports	5
	parking brake shaft	1
yearly or every 2400 hours of work	reducing device	2
	cylinder bearings of manure spreader	16
	transmission axle bearing on the front axle	8
	bearing of the rear transmission axle	2
	bearings in wheel hubs	8

Observed were failures on the manure dispersers and the results are shown in table 1.

From the aspect of maintenance, during its operation lasting around 10 days during manure dispersion, the dispersers have to be operational. Within the manure deadlines, optimum time is lost if the disperser is broken. Prolongation of optimum time caused by failure, leads to excess of the given deadline and the sowing that follows after manure dispersion looses quality.

Operating availability of the system is the probability that the system observed will function in a predicted way, in any moment of time. Operating availability Ro includes the time of use and the standstill time of the system:

$$R_O = \frac{t_r}{(t_r + t_o)} = \frac{193{,}05}{200} = 0{,}965$$

where:

$t_r = t_G - t_Z = 200 - 6{,}95 = 193{,}3$ h -is the time of use,

$t_G = 200$ h (20 work days of 10h)- number of working hours per year of manure dispersers,

$t_O = 6{,}95$ h-standstill time (*table 1*),

R_O - operating availability.

Tabela 3. An overview of the most frequent causes and numbers of failures with manure dispersers

Part description	No. of fail. per yr.	Failure repair time (min)	Failure type	Repair description
Chassis and sides	0,1	60	cracking and bending due to overload	straightening and welding
pulling shaft: • lug, • spring	 0,1 0,1	 30 60	breaking of lug and spring due to overload	Replace
underchassis: pneumatics	0,1	90	punching of pneumatics	vulcanization or replacement
wheel frame: • brake pads • wheel bearing	 0,1 0,1	 120 30	wear of brake pads, bearing breakdown	Replace
drive shaft bearings	0,1	30	bearing breakdown	Replace
drive shaft chain	0,1	10	tearing, elongation	Replace
cardanic shaft	0,06	60	Junction deterioration	Replace
standing mechanism chain	0,1	90	failure of drive chains	Replace
standing mechanism rods	0,1	10	bending and tearing of rods	Replace
standing mechanism chains	0,05	60	wearing or breaking	Replace
cylinder with shovels	0,1	90	deformation	Replace
rotor bearings	0,1	30	bearing breakdown	Replace
rotor shovels	0,1	10	shovel breaking	Replace
hydraulica assembly	0,1	60	Failure of gaskets, hoses and similar elements	Replace
pneumatic and mechanical braking assembly	0,1	60	failures on central pneumatic valve	repair in special service facility
electrical assembly	0,1	60		Replace

8. CONCLUSION

Lubrication takes an important place in the process of preventive maintenance of agricultural machines, especially manure dispersers. A correct procedure of lubricating the manure dispersers in given time intervals and with given type and amount of lubricant, enables reducing the wear and tear of elements which are in dynamical contact. Reducing the wear of operating elements of the manure dispersers, their life is extended, their capacity and efficiency are increased and the number of standstills and the operating costs are reduced.

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PODMAZIVANJE RASTURAČA STAJNJAKA KAO ELEMENAT PREVENTIVNOG ODRŽAVANJA

***Rezime**: Podmazivanje poljoprivredne opreme, odnosno rasturača stajnjaka je sastavni deo preventivnog održavanja, koji ima zadatak da spreči da ne dođe do pojave zaribavanja tarućih elemenata. Rad rasturača stajnjaka je ograničen u vremenskom periodu što zahteva osim visoke proizvodnosti rasturača stajnjaka i smanjenje zastoja u što većoj meri. Pravilnim održavanjem rasturača stajnjaka, omogućava se ekonomski opravdaniji rad i obavljanje operacije đubrenja u relativno kratkim agrotehničkim rokovima. U radu je prikazan primer podmazivanja rasturača stajnjaka, kao i statistička analiza značaja "otkaza" na ukupan kapacitet rasturača stajnjaka.*

***Ključne reči**: podmazivanje, održavanje, rasturač stajnjaka*.