Availability Of Hay Presses Within The System Of Maintenance

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Abstract: *This paper deals with the pressing of hay from the aspect of size, mass and form of the bales. Analysed are systems forming bales of the paralelepiped shape, and the possibility of rational maintenance. Operating availability of the presses for actual dataconcerning the number of failures and the failure repair time is also given through research results.*

Key words: *availability, effectiveness, maintenance, hay press*

1. Introduction

The economical justification of storaging hay and straw depends majorly on technological solutions related to presses. By packing hay into bales a density of pressed hay of 100 to 250 kg/m^3 is achieved and compared to storaging non-pressed hay the density (depending on type and moisturity of hay) of which is 30-60 kg m^3, the manipulation costs are reduced 3 to 5 times. When forming bales with piston presses, where the cross section of a bale is approximately 0,45 x 0,35m , and the length is 0,6 to 1,0 m, and the mass of bale is 15 to 35 kg, which are in most cases manipulated by hand (also used are systems for mechanized manipulation) a more and more important part also have presses for forming big size bales, where the mass of bale is from 300 to 600 kg. The advantage of presses for forming big size bales lies in shortening time and price of loading, instead of 10 to 25 bales, only one big size bale is loaded. The efficiency of use of transportation space and trailers is much higher , and so is the level of economical justification of unloading, storageing and use of such formed bales. Besides the economic effects of such conduct, which are obvious, it is important to provide bales of hay in a very short agrotechnical time interval. Standstills cause, besides higher costs, significant reduction of the nutitional value of hay due to being exposed longer on the field, especially in bad meteorological conditions. The quality of hay press maintenance should be observed through preventive and timely maintenance, which would help to avoid unnecessary standstills which affect the exploitation price significantly.

2. Hay press

Significant differences in shape, size, mass and method of forming bales, point to very significant specific properties and differences of technologies for storaging hay and the possibility of use of individual press solutions. Basically, the main differences relate to the methods of making bales by compressing hay, by impact and compression exerted by the piston or operating part of special shape, and to the way of making bales by compressing bales over the whole circumference of the bale in a press chamber. Based on existing press solutions, the method of making bales, the shape of bale etc., a classification of bales is given in picture l.

Besides the diversity in forming bales, big differences also exist in shape and dimension of the bale, figure 2. The volume of a conventional bale 0,45x0,35x0,9m is 18 times smaller than that of cylindrical bale with a diameter of 1.6m and width of 1.3m, and it is 200 times smaller than a stack of pressed hay measuring 2.4x3x4m. In case that the density of bales is approximately the same, around 150 kg/m^3, the mass of bales is between 22 kg for conventional dimensions, 390 kg for cylindrical bales and 4320 kg for stack-shaped bales.

The look of a classical press for making conventional bales, that has been considered in the part concerning maintenance, is shown in figure 3.

3. Maintenance of hay presses

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.

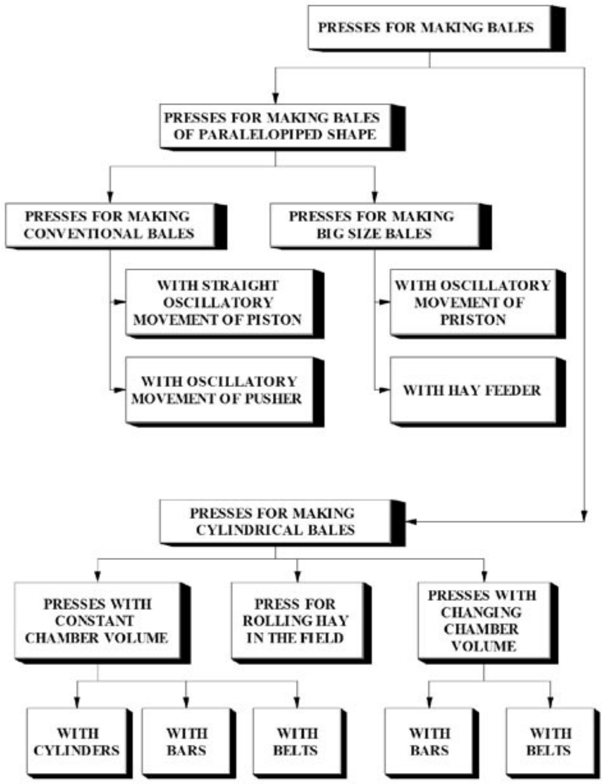

Figure 1. Scheme of classification of presses for hay

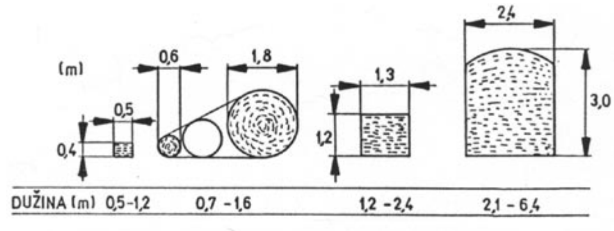

Figure 2. Geometric parameters of bales

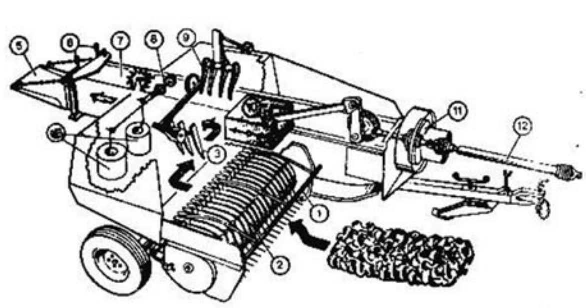

Figure 3 : Scheme of a hay press
(1- shield, 2- collector, 3- pusher, 4-linking means, 5-output channel, 6-device for setting level of compression for bales, 7- chamber, 8-device for binding bales, 9 – compressing device, 10 – piston, 11- fly wheel, 12- cardan shaft)

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. Effectiveness of hay presses

Effectiveness of equipment, i.e. the technical system may be considered through three following different concepts:

1. readiness, reliability and functional suitability (*figure* 4),
2. availability, durability and capability,
3. performance, availability and use.

If the effectiveness of equipment, i.e. the technical system is observed through performance, availability and use (concept no. 3) and is written down as a mathematical relation, it yields:

$E_S(t)=W(t)\,P_p(t)\;\;FP$

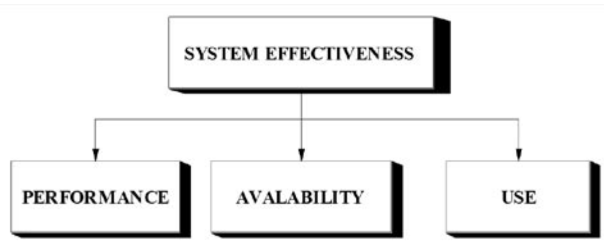

Figure 4. Three components of system effectiveness [7]

where:

Es (t) – is the effectiveness of the system (equipment)
W(t) – performance of equipment. The performance of equipment, i.e. the equipment performance index shows the capability of the system in actual operation, assuming hundred percent availability and use.
R (t) – availability of equipment.
K (t) – use of equipment. Use of equipment, i.e. the numerical index describing the level up to which the capability of the given system is used during the task.

The value of the effectiveness function is in the following interval:

$0 \le E_S \le 1$

If we represent that graphically, we get the diagram (*figure 5*):

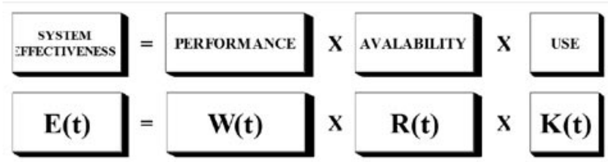

Figure 5. Graphical presentation of effectiveness as a function of performance, availability and usefulness

5. Availability of hay presses

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) (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) (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 ≥ Pro (3)

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

6. Research results

The farm ″Ečka″, being part of the Agricultural school and has clover on a area of 150ha. Packing clover in bales is performed on 2 presses of the ″Poljostroj″ type. Relevant procedures exactly include preventive maintenance activities and in the end of the season conservation activities.

By analyzing the number of failures that occur on a straw press, we got the following values of failure intensities for individual elements. They are listed in *table 1*.

Table 1: Results of analyzing the number and type of failure on hay presses

Number	Part description	Number of failures per year λ	Time of failure repair (min)	Type of failure	Failure repair method
1	Knife	1	30	Knife is blunt	Sharpen knife
2	Binder hook spring	1	40	Spring is weak	Replace spring
3	Hook	1	40	Hook damaged	Replace hook
4	Rope holder	1	10	Rope holder is loose	Fasten or replace
5	Binder plate	1	15	Plate is dislocated	Align binder plate
6	Light bulb	2	5	Bulb is defect	Replace bulb
		1	10	Bad earthing	Clean contacts
7	Signaling light	1	5	Bulb is defect	Replace bulb
		3	5	Contact is loose	Fasten contact
		1	10	Relay is defect	Replace relay
		2	5	Fuse has blown	Replace fuse
8	Flywheel lock	9	10	Fuse is torn	Replace fuse
9	Chain	2	15	Chain is loose	Fasten chain
10	Binder	4	10	Space between teeth of binder is dirty	Clean space between teeth
11	Feeding device	2	20	Device beats	Replace safety bolt
12	Pin	2	15	Pin falls back	Fasten element
13	Clamping device	3	10	Rope clamp is loose	Fasten bolts of channel clamping device
14	Feeding device	1	20	Feeding device has fallen out	Place feeding device properly
15	Bearing	2	60	Bearing worn out	Replace bearing

From the results shown in the table 1 we see that the number of failures on elements is not negligible. If we add the fact that the actual time of failure removal is a few hours (outside exploitation it is usually one day: the straw press has to be carried to the workshop, repaired and brought back to the field) and is significantly longer than the time of the repair itself, and the fact that the operation of the straw press is limited by weather (atmospheric) conditions, as well as the time of year (work less than a month during the year), then the intensity (number) of failures shown in the table is very indicative for the maintenance team. Besides the maintenance quality, the results shown in the table above are also a very good guidance for undertaking relevant activities of preventive maintenance, in order to reduce the intensity of failures on elements of the straw press. From the research results it is obvious that failures are most frequent on the fly wheel lock (λ=9), light bulbs, clamping device and others. Due to failure of these elements during a season an average of up to thirty failures occur, which can be reduced by better preventive maintenance.

Analyzing the data shown in *table 1*, it is obvious that average standstills due to failure, i.e. the duration of intervention maintenance is 9,916≈10 hours per year. As the press works around 30 days (an operating cycle is 10 h/day) the capacity of the press is reduced by 3,3 %, which is a significant percentage that can be reduced by better and more organized maintenance, and by that the production process costs can be reduced also.

Operating availability includes the time of use and the standstill time of the system. Average operating availability may be determined using the formulae:

Pro = tk / (tk +tz)
Pro =290 /(290+10)=0,966

where:

Pro – operating availability,
tk = 300 (h/yr)- time of use,
tz = 10 (h/yr)- time of standstill.

7. Conclusion

The intensity, i.e. the number of failures of agricultural equipment, especially hay presses is one of many, not the only one and not the most optimal criterion for evaluating the quality of maintenance. Evaluating the quality of maintenance provides a possibility to evaluate the performance, the maintenance team and to assess mistakes and naturally take appropriate actions for their removal. The research results show that the most frequent failures on hay presses occur on the fly wheel lock, the signaling system and clamping device. The intensity of failures on elements of a hay press is also an indication for the direction in which preventive maintenance should be engaged.

8. Reference

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