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## RESEARCH ON ACTIVE ELEMENTS WEAR OF THE WORKING BODIES USED ON CEREALS MILING

BY

DĂNUȚĂ COZMA<sup>1</sup>, OANA ELIZA BĂETU<sup>1</sup> and  
DRAGOȘ CRISTIAN ACHIȚEI<sup>2\*</sup>

“Gheorghe Asachi” Technical University of Iași,

<sup>1</sup>Department of Mechanical and Automotive Engineering

<sup>2</sup>Department of Technologies and Equipment for Materials Processing

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**Abstract.** The paper presents the methodology, testing machine and some experimental results on the wear that occurs in friction between metal surfaces and grain seeds. The testing machine, designed and built especially for this purpose, allow changing the following parameters: the relative speed of the metal samples in relation to seeds; the contact pressure between samples and seeds mass; variety and grain humidity; geometric shape and metallic samples material. The research regard the type of wear that occurs and the factors that influence it. This study is done by microscopic analysis of the samples surfaces attacked by the seeds mass. This paper presents the results of wear testing of the metal samples, on the friction with corn. This is the case of wear working bodies of corn mills, pneumatic conveying installations, grain cleaning systems, plants of corn silage, etc.

**Key words:** wear, sample, machine, corn, seeds, riddle, roller.

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\*Corresponding author; *e-mail*: dcozma\_2000@yahoo.com

## 1. Introduction

In agriculture and food industry there are frequently met equipments whose operating parts contact directly with the agrarian material, producing a wear which modify the constructive and functional parameters. Thus it is influenced the quality of the working process and the processing capability of the mentioned equipments.

The working of the processing parts of the processing equipments (beating, press, cleaning-sorting, transport, etc.) is influenced by the composition and the abrasive attack of the seeds (Cozma *et al.*, 2007). This reality imposes that in designing the processing tribosystems it must be used the compatible materials with the contact product.

The progressive evolution of the active elements estate of the working parts which are stressed under tribologic conditions is recognized through the modification of the surface properties especially shape and roughness.

In the installations for grain cleaning, the conveyer pipe line but mostly riddle, are subjected on a wear process that can lead to local degradation by breaking or tearing of the riddle, due to reduced thickness of the material which was made (Fig. 1) (Cebotărescu & Cozma, 1993).



Fig. 1 – Used riddle from grain cleaning equipment.

In case of cereals milling in rolls with flute rollers or even with smooth roller, the contact pressure between seeds and the active surface of body work, have values much higher than in previous case, because grain crushing occurs.

In case of flute rollers, the constructive parameters of flute (Fig. 2) will be affected by the wear phenomenon and as a result milling quality is reduced.

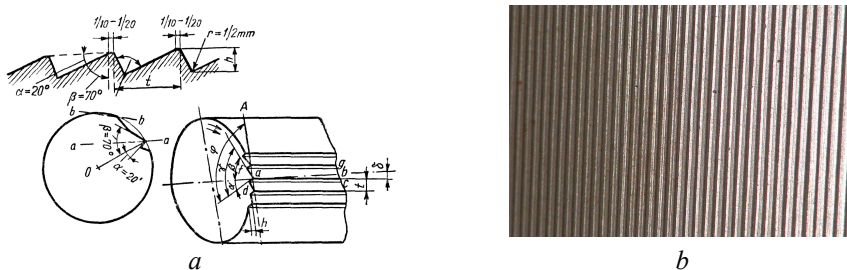


Fig. 2 – Constructive parameters of flute milling rollers.

## 2. Research Method

It is necessary for abrasive wear study a specific apparatus to determine the values of some mechanic and physic parameters which act on the friction process of the coupling elements. This apparatus must fulfil the following conditions:

- the correlation of the experimental friction coupling with the real phenomenon;
- the repeatability of the results for the imposed sensibility and precision, where is imposed the elimination of the vibrations in the charge applied system and the assurance of samples similarity (geometry, micro geometry, heat treatment, etc.);
- the constant maintaining of the friction-wear regime implies the selection of the test machines and equipments and the friction coupling type so that the kinematics and dynamic parameters do not modify during the tests.

The wear tests require the adjusting and the determination of the following elements, (Neculăiasa *et al.*, 1996; Luo *et al.*, 1993).

- the type of the coupling friction;
- the characteristics of the medium where the wear test take place;
- the measurement of the normal loading force;
- the calculus of the real contact pressure;
- the measurement of the relative speed of the friction coupling surfaces;
- the measurement of the friction force and the friction coefficient;
- the measurement of the temperature at the contact surface;
- the measurement of the way or of coupling the function time;
- the measurement of the contact surfaces wear.

## 3. Experimental Tests Wear Stand

In order to study the friction process between the seeds of the agrarian cultures and the metallic surfaces it was realized an experimental tests wear stand. On this stand it can be made tests concerning the friction between different metallic or non metallic materials and some seed types.

The stand (Fig. 3) has a drum were the seeds fill in with a certain intensity and contact with the metallic samples which are in relative movement.

From the feeding basket 1 the feeds are taken over by the feeding worm 2 situated in case 3 and spilled-over in drum 4. The edge of the worm is maintained in axial position by the bearing situated on the holder 5. In the frontal part of the drum is the disk 6 where the samples 7 are situated. The disk is rotated by the belts bearings 10 and 11 which receive the move from the electric engine 9. The rotation of the worm 2 is realized through belt bearing 13 the movement come from the second electric engine 12.

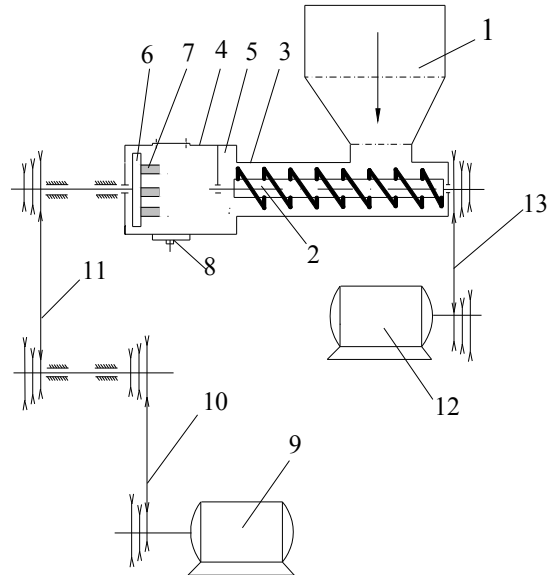


Fig. 3 – Experimental test stand of the seeds influence on wear (Cozma *et al.*, 2008).

The samples are put on the frontal part of the disk 6 and can be disposed in different diameters (Fig. 4), where they could have distinct friction conditions regarding to the seed mass way.

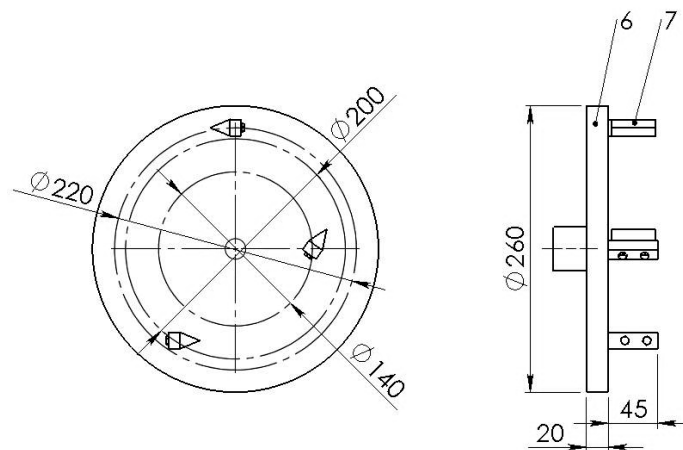


Fig. 4 – The disk with samples.

The shape of the samples is key type whose constructive characteristics are given in Fig. 5 (Cozma *et al.*, 2007).

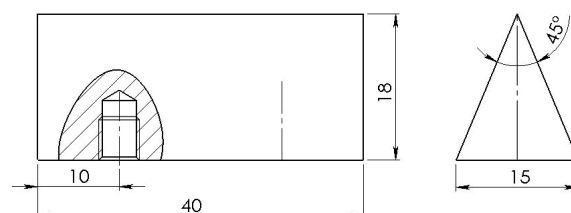


Fig. 5 – The test samples.

The wear of the samples resulted from the friction with the seeds mass will be influenced by some parameters whose values can be modified in some limits of the stand.

These parameters are:

- the contact pressure between seeds and the sample;
- the movement speed of the samples in the seed mass;
- the material of the metallic samples;
- the seed type or the class of a certain sort;
- the attack angle in the seed mass.

Some characteristics of the seed tried on the stand are given in Table 1.

**Table 1**  
*The Geometric Dimensions and the Mass of the Cereals (Banu et al., 2002)*

The seeds type	Dimensions, [mm]			Weight		
	Length $l$	Width $b$	Thickness $h$	Absolute weight at 1000 beans [g]	Specific weight [kg/dm <sup>3</sup> ]	Volumetric weight [kg/dm <sup>3</sup> ]
Autumn-wheat	4.8-8.0	1.8-4.0	1.6-3.6	22-40	1.2-1.5	0.70-0.83
Spring-wheat	4.0-8.6	1.6-3.6	1.4-3.8	22-42	1.2-1.5	0.67-0.79
Rye	5.0-9.8	1.4-3.4	1.0-3.4	13-32	1.2-1.5	0.65-0.79
Corn	5.5-13.5	5.0-11.5	2.5-8.0	286	1.3-1.4	0.73
Barley	7.0-14.6	2.0-5.0	1.2-4.5	31-51	1.2-1.4	0.55-0.75
Oats	8.0-18.6	1.4-4.0	1.0-4.0	20-42	1.2-1.4	0.40-0.51
Sunflower	6.0	3.5-4.2	1.7-2.8	53-69	–	–

#### 4. Experimental Results

Experimental tests were performed with wear-testing machine built for this purpose. Have been using corn seeds with 15% humidity, which is a low percentage of humidity from the 17% standard humidity. The metal samples are made of cast steel OLC 45, with shape and dimensions like in Fig. 5.

Their arrangement on the disc machine was at different radiuses, as Fig. 4, because during driving the samples in the grain mass to be attacked by different

layers. Samples were prepared before the test, both in dimensional point of view and attack surface quality. They were polished and prepared on buffing machine. The loading system of the machine which allows adjustment of contact pressure has not been turned on at this set of tests. In this way, samples have run free in grain mass for a period of 8 h. The attempt are preliminary to an extensive study on wear of working bodies in contact with the seeds of grain crops, and besides corn will be analyzed wheat, rye, barley, oats. This paper begin the study and is informative on the process of wear of metallic materials in contact with the seeds of grain crops.

From the analysis of the microscopic appearance of metallic samples which are free moving in the corn mass with a certain speed, shows the following:

1. The samples surface show a plastic deformation of the metal with the look of occurrence of microporosity which have dug deep channels. The directions of spreading of these channels are almost identical, but there are single tracks with completely different directions, even perpendicular.

2. Small channels beam and protuberance projecting oriented on the same direction, is the result of repeated samples impact with corn and due to high metal plasticity and low hardness.

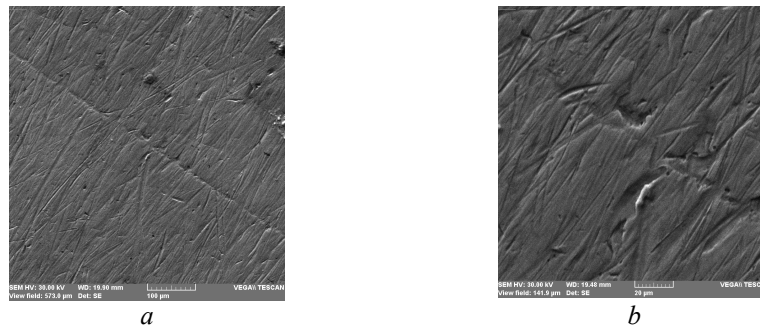


Fig. 6 – Channels beam and protuberance.

3. On certain sections of the samples surface, can meet small exfoliation areas. This occurs due to repeated impact and deformation that leads to the fatigue phenomenon.

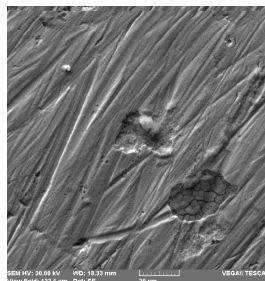


Fig. 7 – Exfoliation areas.

## 5. Conclusions

The analysis of obtained results allows drawing the following conclusions:

1. Was designed, built and tested a wear testing machine produced by seed crops;
2. Developed a method to study the wear caused by crop seeds;
3. Corn in friction on metal surfaces produce abrasion wear and fatigue wear.

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### CERCETĂRI PRIVIND UZURA ELEMENTELOR ACTIVE A ORGANELOR DE LUCRU FOLOSITE LA MĂCINAREA CEREALELOR

(Rezumat)

Lucrarea prezintă metodică, mașina de încercări și unele rezultate experimentale privind uzura ce apare la frecarea dintre semințele de cereale și suprafețe metalice. Mașina pentru încercări, proiectată și construită special acestui scop, permite modificarea următorilor parametri de analiză: viteza relativă a probelor metalice în raport cu semințele; presiunea de contact dintre probe și masa de semințe; soiul și umiditatea cerealelor; forma geometrică și materialul probelor metalice. Cercetările vizează tipul de uzură care apare și factorii care o influențează.

Probele metalice fixate pe partea laterală a unui disc antrenat în mișcare de rotație în jurul propriei axe, au forma unei prisme triunghiulare. Ele pătrund și ies din masa de boabe de porumb aflate în camera de lucru, cu o viteză care este în funcție de turația discului suport.

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Uzura suprafețelor probelor aflate în frecare cu semințele, a fost analizată la microscop după un ciclu de funcționare a mașinii de 8 ore. S-a constatat că pe suprafețele probelor a apărut un fascicul de mici canale și proeminente orientate în aproximativ aceeași direcție ca urmare a deformării plastice a metalului din care sunt executate probele. Totodată, în anumite zone au apărut și mici exfolieri a stratului superficial ca urmare a impactului repetat și care a condus la apariția fenomenului de oboseală.

Cercetările vor continua prin înlocuirea materialului probelor metalice precum și prin folosirea altor soiuri de semințe cum sunt cele de grâu, secară, orz, ovăz.