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Analysis OF CORN GRAIN DAMAGE ON THE SILO "BAFI" IN FUTOG

ANALIZA OŠTEĆENJA ZRNA KUKURUZA NA SILOSU "BAFI" U FUTOGU

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Abstract: *In this paper will show the procedure of the examination which consists of total and comparative analyses of corn grain damaging between single elements of artificial drying system and grain storage. The examination of driers, built in transportation elements and equipment showed significant mechanical grain damaging (fractures and breaks). Long transportation way of grains, inadequate means, as well as, technical faults additionally dynamically burden grains and by that grains are less resistant and more susceptible to breaking which brings to the increase of breakage portion in total amount of mass. Well as established places and estimate the damage and breaking of corn grains on the silo "Bafi" in Futog.*

Rezime: *U ovom radu predstavljen je postupak ispitivanja koji se sastoji u sveukupnoj i komparativnoj analizi oštećenja zrna kukuruza između pojedinih elemenata sistema veštačkog sušenja i skladištenja zrna. Ispitivanjem uređaja za sušenje, ugrađenih transportnih elemenata i opreme uočeno je da dolazi do značajnih mehaničkih oštećenja zrna (napukline i lomovi zrna). Dugi transportni putevi zrna, neodgovarajuća primena i izbor transportnih sredstava, pa i tehnički nedostaci dodatno dinamički opterećuju zrno i samim tim je manje otporno zrno podložno lomu, što dovodi do povećanja udela loma u ukupnoj količini mase. Utvrđena su mesta i procenti oštećenja i loma zrna kukuruza na silosu "Bafi" u Futogu.*

Key words: *corn, grain damage, transportational elements, drier, silo*
Ključne reči: *kukuruz, oštećenje zrna, transportni elementi, sušara, silos*

INTRODUCTION

The crop with grain as a primary product is sowed on the 70% of cultivated land in Serbia (Statistic yearbooks, 2001-2006). On that land, 10 million tons of grain is produced, in average, every year. 15% of that grain is stored in floor storages and silos (Janjic et al., 2002).

During the process of harvesting of grain products there are mechanical damages, which are especially seen in badly adjusted combines. Corn, as the most extended crop in our country, is a typical example. It is harvested in the phase of physiological maturity, when the content of humidity is 30-35%. The harvesting of grain with this level of humidity by combine brings to visual mechanical damages (breaks and fractures). Combines damage this kind of grains, and differences in damages are insignificant and depend on the level of humidity in grains and the time of harvesting.

The examination of driers in several places in Vojvodina showed that built in transport elements, all together or separated, do not satisfy projected capacities of driers. It is seen that in transport elements and equipment significant mechanical damages are made, which are said to be technical - technological failure of driers. Incandescence after the drying zone grains goes to the zone of cooling, where it is momentarily cooled, especially during winter period. That kind of grain becomes glassy and fragile. Introduction of the cooled grains into the elements of transport device can induce great mechanical grain damage. That is why it is necessary to choose the optimal technology of receiving and drying grains, especially to pay attention on choosing the suitable equipment for grain transport.

An elevator is a device for vertical transport of grains. The height of grain elevating can be different, and usually the elevators on silo 45m high are used.

Breaks and fractures of grains in elevators usually come from low level of utilization of cannikins. To increase the capacity of elevators, in practice, the tape speed is being increased (over 2,5m/s), which brings to grain fractures, especially in the head of elevators, because the centrifugal forces are the strongest at that point. These fractures later become the grain breaks. The damage of the grain in elevators are 4,6 - 10,2% of whole grain damage (Alimpic M. and Brkic M., 1974).

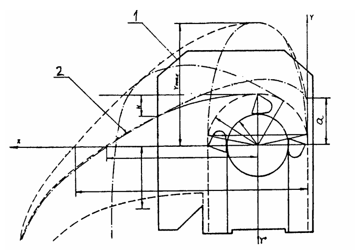

Figure 1. Existing and ideal shape of outlining ofexit pipe on the upper head of elevator (1-existing shape; 2-ideal shape)

The speed of elevator tape can not be too low, because during spilling of grains some of it goes back and brings to more grain damage.

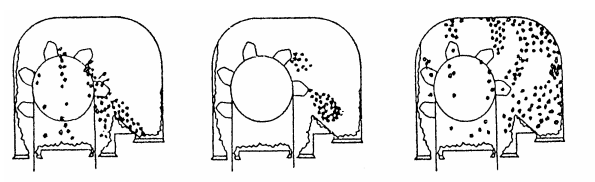

Figure 2. Impact of tape speed on grain unload from cannikin (a-low speed; b-recommended speed; c-too high speed)

MATERIAL AND METHODS

Corn as a crop primarily is cultivated for grain production. In the corn grain there are almost all important nutritive matters (carbohydrates, proteins etc.) in easy adoptable shape. They make 95% of a grain.

Sample taking of corn grain for examination of breakage and inner fractures of the grains was done on November 5^{th} 2008 on 22 measurement places in silo (fig.3): receiving basket (pos.1), on the transition from chain separator under the receiving basket into the chain transporter (pos.2), at the exit of chain transporter into the elevator basket E2 (pos.3), at the exit of elevator E2 into the gravitational pipe for coarse rotary filter (pos.4), at the entering of chain transporter M1 (pos.5), at the entering of drier S (pos.6), at the exit of chain transporter M1 and entering the first buffer cell beside the drier (pos.70, at the exit of buffer cell (pos.8), at the entering of elevator basket E2 (pos.9), at the ending of screw separator drier S (pos. 10), at the entering of elevator basket E3 (pos.11), at the exit of elevator E3 to gravitational pipe for rotary scale (pos. 12), at the exit of basket of rotary scale (pos. 13/1), at the entering of elevator basket E6 (pos.13), at the exit of elevator E6 into gravitational pipe for entering into cross chain transporter M11 (pos.14), at the transition from chain transporter M11 into vertical chain transporter above silo cells M13 (pos.15), at the exit of chain transporter M13 and at the entering the silo cell S14 (pos.16), at the transition from vertical chain transporter M59 under silo cells into cross chain transporter M58 (pos.18), at the transition from vertical chain transporter M53 under silo cell into cross chain transporter M58 (pos.19), at the entering the elevator basket E4 (pos.20), at the exit of elevator E6 into gravitational pipe for R1 (pos.21), at the exit buffer cell R1 into truck trailer (pos.22).

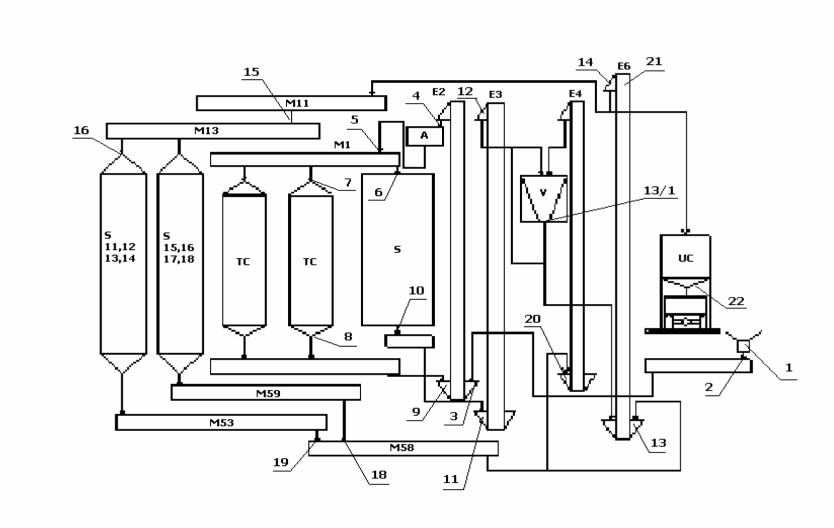

Figure 3. Technology scheme silo "Bafi" in Futog (reviewal measurement places)

Taking of samples from transport line were done by hard plastic boxes where it was possible, and by hand where it was difficult. From the truck trailer the samples were taken by silo telescopic sound from five different places. The samples were packed in hermetically closed plastic bags. With the samples in the bags was also a paper with data of the sample. The size of the samples was 800 to 1000g, sometimes 1300g.

The drier before drying was filled with corn grain. Measurement of drier parameters, as well as reading from rotational scale display was done in command - control room of machine house of silo every hour. The parameters were taken from computer acquisitioned system.

Temperature measurement of grains on exit from the drier was done by taking samples in a plastic vessel with a cover and by measuring grain temperature with a thermometer placed through narrow opening on the cover of the vessel. The temperature of environment air was measured with the same thermometer.

Measurement of grain humidity on characteristically measurement spots was done in the drier with a national standard procedure, on 105°C in duration of 24 hours.

Measurement of inner fractures of corn grain on typical spots was done by taking three times 100 grains from taken sample on determined places. Every group of grains was examined by magnifying glass with a strong light. The number of grains with inner fractures was marked as the percentage of fractures.

Determination of grain brakes was done by measuring the mass of fraction of the samples on electric scale, with accuracy of 0,1 together with the plastic bag. The sample was spilled from plastic bags into sieves with openings of 5mm (upper) and 3mm (lower). The mass of the plastic bags was also measured. If the sample was too big (over 1kg) it was mixed in a bucket, and then spilled on the table. After that the sample was flattened and divided into four parts. Two diagonal quarters were taken. The sample was then sieved on a black paper, so that the broken parts could be seen. The mass of break fracture under 3mm and between 3 and 5mm was measured. After that the break under the 5mm was set apart by hand and measured on the scale. At the end, the mass of all fractions were sum up and compared with total mass of the sample (minus mass of the plastic bags). Deviations were 1 to 2g, because of dust and chaff. Collected data were taken into prepared table: the number of the sample, measurement place, time of measurement, date of measurement, mass of the sample, mass of the plastic bags, mass of the fractions, and eventual remarks. The percentage of brakeage was calculated for the fraction till 5mm and total brakeage, since it was necessary to process great number of samples (127 samples).

RESULTS AND DISCUSSION

The middle temperature of air was 23,6°C. The middle temperature of drier agents was 73,1°C. The middle temperature of corn grain in the drier was 40,9°C. The middle temperature of corn grains at the exit of the drier was 27,7°C. The humidity content of the grain at the exit of the drier was 14,1%, and the optimum humidity content was 14%.

The humidity content of the moist grain on the entering basket varied from 20 to 21%. The humidity content of dried corn grain was 12-14%, which means that the grains were overdried.

Grain breakage till 5mm on the entering basket was too high (3,04%), and the total breakage was even higher (11,27%). The inner fractures were significant and amounted 6,67%. This data shows that the combines did not worked well and that the starting raw material made the great part of the damaged grains. As admixture of corn grain we found soy grains.

On the measurement place 4 we could not take the adequate sample, because the opening for taking samples was too narrow and the line for rough cleaning of corn grains worked too short. After cleaning of corn grains the percentage of breakage was less than before.

On the measurement place 6 (entering of the drier) inner fractures of the grains were high (20%). After the process of drying the fractures were over four times higher (87,33%). The reason for this was hard to determine when it was known that the drying regime was not too rough - the temperature of the drying agents were under the 75°C, temperature of the air was not low (23°C), as it is normal for autumn period.

The drier does not increase the grain breakage significantly (1-2%).

The grain breakage till 5mm which is transported from drier to elevator basket E6 is not high (1,96%), and the total breakage is more significant (8,08%). The afterward grain breakage is especially high, when the grains comes out from silo cells and is transported by elevator (0,9 - 6,4% breakage till 5mm, 7,43 - 17,54% total breakage). The higher the entering breakage in elevator E6 the more it is crumbled.

It can be said the breakage from silo cells is not significantly higher (0,64 - 2,26% breakage till 5mm, 8,39 - 12,39 total breakage). Transport of grains from one cell to other does not induce so much breakage, as transport from cell to truck trailer. It can be concluded that, with the exception of grains from silo cells, it was not too much broken.

The most breakage is at the exit of the elevator E6, when it comes to silo cells (11% breakage till 5mm, 22% total breakage). The breakage is increased on gravitational pipe and buffer cell R1 for loading to transport vehicles (11% breakage till 5mm, 24,5% total breakage). At the end of grain transport the quarter of the grain mass is crumbled.

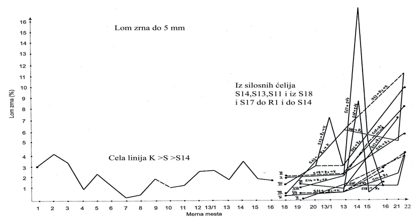

Figure 4. Grain breakage up to 5 mm

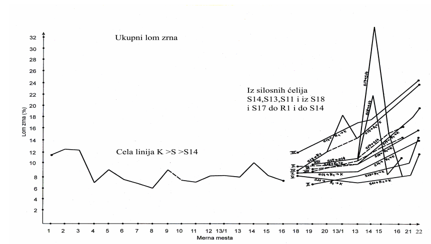

Figure 5. Total grain breakage

CONCLUSION

The grain breakage is high on the entering basket which brings to the conclusion that combines are not well adjusted.

Inner fractures of the grains are too high before the entering in the drier (20%), and more than four times higher at the exit of the drier (87,33%). Since the parameters for the drying of corn grains were optimal, it is supposed that the reason for this is an impact of transport equipment on the grain. On the drier the breakage was not high (1-2%).

The breakage is significant in the whole silo transport system, when grain only once goes through it (0,5 - 4% breakage till 5mm, 6 - 12,2% total breakage). In the cases when grains go through it several times, elevator E6 crumbles the grains (0,9 - 6,4% breakage till 5mm, 7,43 - 17,54% total breakage). The great breakage on elevators comes from too high speed of elevator tapes (3m/s). Cannikins knock fast at grains and break grains in the lower head of elevators. In the upper head of elevator, under the force of diagonal shot intensive knocking of the grains on the cloak of the elevator is significant. In our working conditions with corn grains the speed of elevator transport tapes must not be over 2 m/s.

The breakage is increased on gravitational pipe and buffer cell R1 for loading to transport vehicles. At the end of the grain transport it can be seen that the quarter of the grain mass is crumbled.

REFERENCES

1. ALIMPIC M., M. BRKIC, 1974. *Deformations due to dynamic grain maize strains in the system of artificial drying and storage.* Proceedings of the International Symposium: "Agricultural and Mechanical Sciences", Faculty of Mechanical Engineering Belgrade-Novi Sad, 325-341,

2. BRKIC, M., JANIC, T., SOMER D., 2006. *Process devices and equipment for the finalization of agricultural products,* Agriculture Faculty internal script, 96-103,

3. JANIC, T., BRKIC, M., BORENOVIC, V., POPOV, D., 2002. *Management in the construction of facilities grain storage facilites of agricultural products,* Journal PTEP, Yugoslav Society for process engineering and energy in agriculture, Noni Sad VI (1-2): 62-64

4. STATISTICAL YEARBOOKS, 2001-2006, Federal Statistical Office, Belgrade, s.358

5. PROJECT DOCUMENTATION SILO "Bafi in Futog