# CORN PHYSICAL PROPERTIES DURING POSTHARVEST HANDLING

Jenő CSERMELY, Mihály HERDOVICS, Attila CSATÁR, József DEÁKVARI
[1]Hungarian Institute of Agricultural Engineering (MGI)
H-2100 Gödöllő, P.O. Box 403.
Tel.:+36-28-511610
E-mail: herdovics@fvmmi.hu, csermely@fvmmi.hu, acsatar@fvmmi.hu, deakvari@fvmmi.hu

**Abstract**

Object of the OTKA (T 037-214) assisted researches is to determine the aggregation characteristics of the corn in the course of drying. Examinations are carrying on with three selected varieties of corn under laboratory and operative circumstances. Examinations contain among others the analysis of the bulk mass and density depending on the moisture content and the shrinkage of grain by the effect of moisture abstraction. The examinations covered the determination of the compressive stress connecting with the humidity, specific compression strain, elasticity modulus and pressure work.

**Keywords**

elemental layer, corn kernel, convective drying, model dryer

**Introduction**

Object of the research was to determine the aggregation characteristics of the corn in the course of drying and special respect on the different parameters of the drying technology within the elemental layers. Variation of physical and mechanical features of the batch was analysed during the drying process.

**Material and method**

Measurements were carried out in operative circumstances, in exciccator, in laboratory drying oven, respectively. Measurements of volumetric mass and bulk density happened by sampling of 1,000 g of samples by three times repetitions. At the measuring of bulk density the method of liquid displacement was applied.

Figure 1. Laboratory-scale dryer of MGI

The operative drying measurements were carried-out by Mecmar and Stela type dryers with thick grain layer and material circulation of 105-110°C drying medium temperature. The same temperature was applied in the case of the MGI type laboratory-scale drying oven (Figure 1.), equipped with AHLBORN type measuring and data collecting system with automatic regulation system. In this case the thick of layer could be regulated within 4 x 20 cm and 10 x 10 cm measuring limit.

Figure 2. The INSTRON-5581 Type tester equipment

Determination of compressive strength was carried out by INSTRON-5581 type tester, equipped with special instrument at 30 kN compressive force (Figure 2.).

Adjustment of the tester:

- pre load: 100 N
- dislocation of the slider, belongs to it: 25 mm/min
- load: up to 30,000 N
- dislocation of the slider, belongs to it: 1 mm/min

Limit value of the applied force meter cell is 50 kN, its measuring accuracy is 0.5 % related to the measured value, from 500 N up to 50 kN. For determination the mass of corn a Kern 572 type balance was used. Its measuring accuracy was 0.1 g. Mass of each samples were 1,000 g. Diameter of the measuring instrument was 200 mm, while its height was 80 mm (see Figure 3.).

Figure 3. The measurement instrument

## Results and conclusions

### During the drying process

- The drying process within elemental layers behaves different in space and time.
- The drying itself starts at the inlet of the drying air – in case of cross-flow dryers – and moves forward along the layer.
- The drying process occurs with a time-shift by the analysed bottom and top drying blocks, and in case of a relative thin layer (depth<10 cm) the water-loss ability of the corn kernel determines the drying rate. At the beginning of the process the water-absorption ability of the drying medium determines the drying rate in case of a relative deep layer (depth>15cm), then the water-loss ability of the corn kernel becomes more significant.

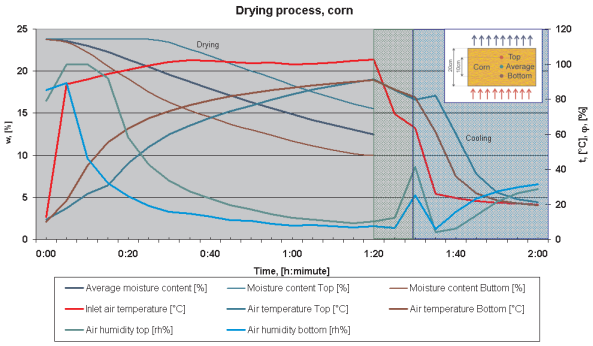


Figure 4. Variation of some drying properties as function of time

- Rewetting occurs at the top section of the drying layer at the beginning of the drying in case of more deep layers (depth>30 cm; see Figure 4.).
- On the bases of the results the relative adjusted deviation is about n-1 = ±2,5% by 10% moisture loss, which is typical for industrial systems, as well. Therefore industrial equipment without any mixing system cannot be built.
- Installation of such a mixing system must be carried-out such a way, that moisture differences must be equalized until the end of the process.

### In terms of the physical characteristics

- The average drying velocity is 2.10-2.20 moisture %/h beside 110°C medium temperature in the case of intermittent-duty, thick layer, material circulating driers. The quasi corn temperature does not exceed the 50°C value.
- The volume mass of the aggregation is continuously increasing from 640-680 kg/m³ up to 730-750 kg/m³ limit value and reaches its maximum value near the 13-15% of equilibrium moisture content during the drying process, deriving from the shrinkage and depending on variety and the starting moisture content of the corn. At over-drying (10-12% of moisture content) the volume mass of the aggregation begins to decrease down to the value of 705-730 kg/m³. In the case of radical over-drying (3.5-7.7% of moisture content) this value will decrease down to the value of 680-710 kg/m³ (see Figure 5.).
- The aggregation volume of the grain corn will radically decrease with 10-12%, down to the 14-15% of equilibrium moisture content then following it will slow down by the effect of the drying. The shrinkage comes to an end between 3.5-7.7% of moisture content. From the results we can be drawn the conclusion that in the above-mentioned moisture content range the so-called combined water removes from the crop. The grade of shrinkage comes to an end at 13.0-13.5% of moisture content in this range, reaching the maximum value (see Figure 6.).

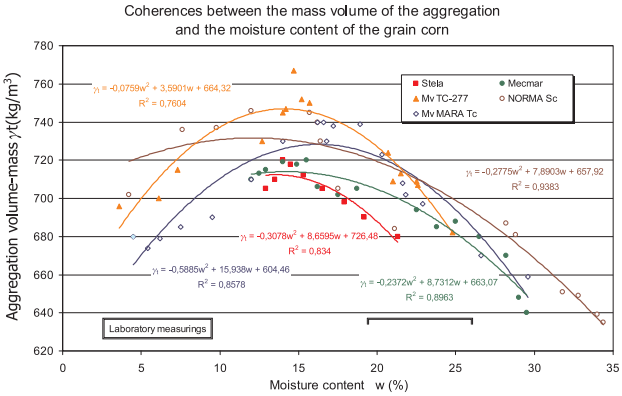


Figure 5. Coherences between the mass volume of the aggregation and the moisture content of the corn kernels

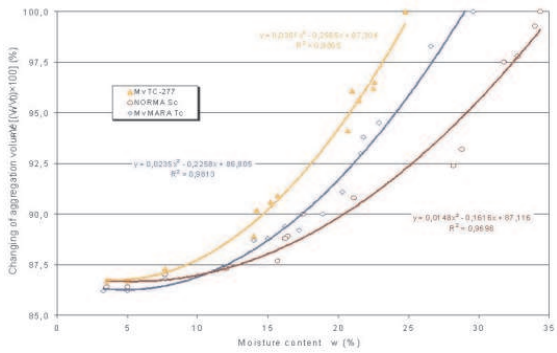


Figure 6. Changing of aggregation volume of the corn kernels in the course of drying (%)

### In terms of the mechanical characteristics

- The mechanical examinations were carried out within extreme moisture contents limit (3.5-31.5%) at same variety.
- The specific compression strain belong to the maximum compression strain, is changed between 12.5-33.0 % (see Figure 7.).
- In the case of the specific compression strain (e) and the elastic modulus (E) the minimum and maximum values of the curves can also be experienced at 10-12 % of moisture content. The specific deformation is considerable growing above the equilibrium moisture content and at the same time the elastic modulus of the aggregation decreases (see Figure 8.).

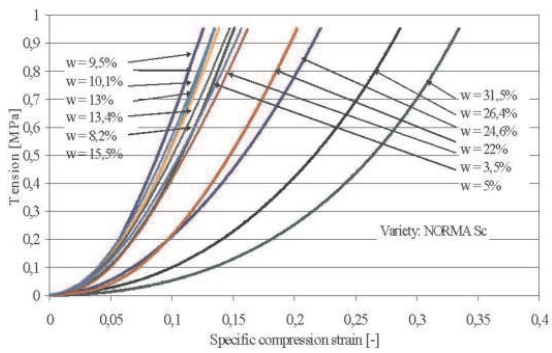


Figure 7.Compression test of grain maize aggregation with different moisture contents

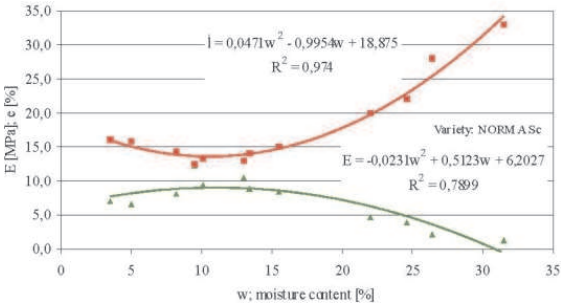


Figure 8. Effect of the moisture content on the elastic modulus (E) and the specific deformation (e) of the grain maize aggregation

**Acknowledgements**

The authors are grateful to the OTKA (T 037-214) foundation for the financial support.

**References**

**Csermely J., Herdovics M., Pazsiczki I.,** Environmental and Heat aspects of Cereal Drying. 4th CHOPS, Budapest 2003/Vol 2 7-11

**Csermely J., Herdovics M., Csatár A.,** Connections among the heat technical and physical characteristics of the maize drying processes. AgEng, Louven 2004 CD Rom 1092-1093.

**Fenyvesi L.,** Mezőgazdasági termények sérülésvizsgálata. Akadémiai Kiadó, Budapest 2004.

**Sitkei Gy.,** Mezőgazdasági anyagok mechanikája. Akadémiai Kiadó, Budapest 1981.

**Sitkei Gy., Csermely J., Fenyvesi L.,** General regularities of compaction for viscoelastic agricultural materials. AgEng '92 Uppsala 467-493 p.

**L.Fenyvesi – M.Herdovics – J.Csermely:** Analisis of Drying Process in Grain Batches 16.th IDS Hyderabad 9-12.Nov.2008. Volume C 1326-1328 p.