EXPERIMENTAL RESEARCHES ON THE INFLUENCE OF FUNCTIONAL PARAMETERS OF GRAVITY SEPARATOR ON THE QUALITY INDICATORS OF SEPARATION PROCESS WITH APPLICATION ON CLEANING OF WHEAT DESIGNED TO MILLING

Carmen BRĂCĂCESCU[1], Simion POPESCU[2], Ioan ŢENU[3]
E-mail: carmenbraca@yahoo.com

Abstract

The paper presents experimental research of qualitative indexes of impurities separation out of grain seeds for equipment using combined principles of separation (according to specific mass and aerodynamic properties of seeds). The experimental installation used was composed of a gravity separator and an aspiration installation with fan. The experimental research has aimed at quantitative and qualitative influence on separation quality index of the following operating parameters: material flow rate of shaking separator, the air flow of aspiration installation, tilting work surface, work surface oscillation amplitude. Based on data obtained by measurements and qualitative indicators the separating process indexes have been determined, namely: degree of impurities separation, degree of good seeds loss),as well as, the index of technological effect for different types of combinations of separation installation parameters.

Key words: cereal seeds, cleaning, specific mass, index of quality separation

The cereals used as raw material for milling represent a heterogeneous mass consisting of basic culture grains (which are to be milled) and foreign bodies (impurities). Therefore, before being milled, the grains are subjected to cleaning operations aiming mainly the elimination of foreign bodies from the mass of seeds. The main properties that underlie the separation of impurities are: the difference in shape and size, the difference in specific mass (density), aerodynamic properties and magnetic properties.

Depending on the principle of separation and the type of impurities is used a wide range of technical equipment and installations for carrying out the separation of impurities. To reduce the number of technical equipment and implicitly of technological spaces, the modern milling units performing use complex installations carrying out the separation by combined principles, the most used following the specific mass difference being the ones and aerodynamic properties of various components of seed mixtures.

MATERIAL AND METHOD

In the following is presented the installation and the experimental determination research methodology used to determine the qualitative indices of the separation process of impurities from grain seeds in the case of combined separation systems (relative to the specific mass and the aerodynamic properties of seeds). Installation realised after the scheme in figure 2, consists of the gravity separator 1, model SP-00, realised at INMA Bucureşti (Figure 4), connected to a suction installation with air model IASP-0 composed of the ventilator 2 and the cyclone 3, realised at SC IMA SA Iasi./Romania (BRĂCĂCESCU, C, 2011).

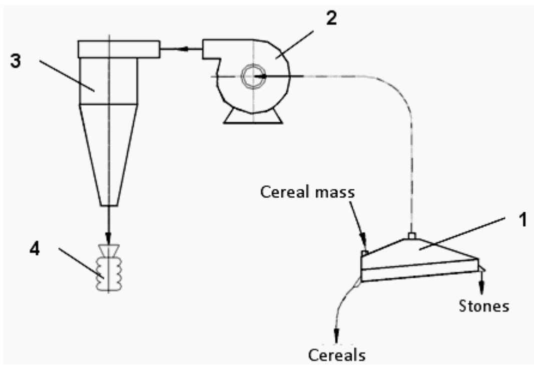

Figure 2 **Functional scheme of the separation device of impurities:**
1 - gravity separator 2- suction fan, 3 - cyclone, 4 - bags for light impurities and dust collection

The main component parts of the gravity separator SP-00 are shown in the constructive scheme in figure 2.

[1] INMA Bucureşti
[2] Transylvania University from Braşov
[3] University of Agricultural Sciences and Veterinary Medicine Iasi

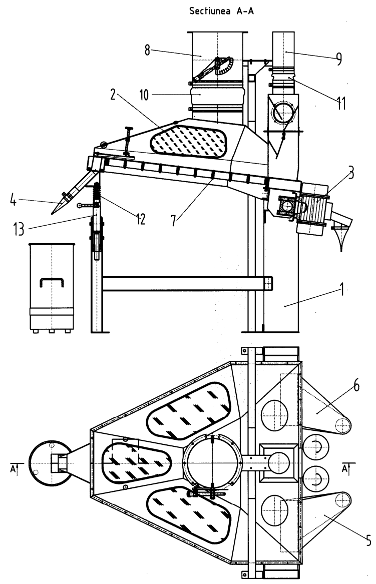

Figure2 **Constructive scheme of gravity separator SP-00**
1 - framework for support; 2 - vibrant housing, 3 - motovibrator for acting the platform of working surface;
4, 10 and 11 - elastic sleeves; 5 and 6 - pipes for exhausting of cleaned product; 7 - working surface from wire fabric;
8 - air-intake pipe; 9 - pipeline for supplying with product; 12 - elastic support system (springs) of the vibrating platform;
13 - screw device for adjusting the angle of inclination of the platform working surface

The material used at experimental researches was the wheat (as seeds) obtained from experimental plots of INMA Bucharest. This material was first introduced in the intensive vacuum separator, being subjected to the operation of separation by size.

For experimental measurements were used measurement devices and / or registration of the following sizes (parameters):

- masses of products and impurities in the separation process;
- inclination angle respect to the horizontal of the working surface of the separator (vibrating sieve);
- air flow rate of the suction installation by determining the velocity of air currents in the suction pipe;
- oscillation amplitude of the working surface;
- frequency of oscillation of the electro-vibrators, by determining their rotation speed;
- power consumption of electro-vibrating system of the separator;
- humidity and temperature of processed product.

The air flow rate from suction pipe was determined indirectly by calculation by measuring the air velocity.

On entry and exit of wheat in the separator and at evacuation of impurities in the process of separation were determined the following parameters: humidity and hectoliter mass of wheat grains at the entrance in the separator; hectoliter mass of the resulting product in the process of separation; impurities content of wheat at the entry and exit from separator.

For the calculation of the technological effect index were determined by weighing and calculation for the following sizes, reported to 1,000 kg of wheat processed by the separator: total quantity of impurities separated, kg; the quantity of eliminated stones, kg; the quantity of other impurities eliminated (seeds of other nature including broken, non-eliminated light seeds, soil, etc.), kg; the quantity of lost good seeds, kg.

The coefficient of loss of good seeds C_{ps} is calculated with the relation:

$$C_{ps} = (m / M) \cdot 100 \quad [\%] \qquad (1)$$

where: *m* is the good seeds mass which are found at the exit from equipment in the quantity of total impurities eliminated; *M*- good seeds mass at the entry into equipment.

The index of technological effect E_{cs} represents the percentage of foreign bodies (impurities) eliminated from the mass of processed product and is determined with the relation (Costin I. ,1999):

$$E_{cs} = [(C_{csi} - C_{cse}) / C_{csi}] x100 \quad [\%] \qquad (2)$$

where:

C_{csi} is content foreign bodies (impurities) at the entrance of the material in equipment, %;

C_{cse} - content foreign bodies (impurities) at evacuation of material from equipment, %.

The quantity of electricity *W* consumed by motovibrators is calculated by the relation:

$W = (P_a \cdot t)/3600$ [kWh] (3)

where P_a is the power absorbed by the pair of motovibrators (kW), measured with the phase and frequency analyzer model CA 8334; t - operating time at tests (s)

The working capacity Q of the gravity separator was determined by calculating with the relation:

$Q = 3600\frac{m}{t}$ [kg/h] (4)

where: m is the initital material mass (m=1000 kg); t - time required for experimental determination,s.

Specific electricity consumption q represents the amount of electricity (in kWh) consumed to process one kilogram of product and was determined by calculation with the following formula:

$q = \frac{P_u}{Q \cdot \eta_{me}}$ [kWh/kg] (5)

where P_u is the the effective power of the machine, kW; Q- the flow rate of processed product, kg/h; η_{me}- actuation yield.

The values resulting from processing determined parameters are mentioned in Table 1.

Table 1

Functional operating parameters of the stand

Crt.iss.	Determined parameter	U.M.	Parameter value determined at tests
1.	Material supply flow rate (test versions)	kg/h	1500; 2000
2.	Sample mass	kg	1000
3.	Duration of test	s	2400; 1800
4.	The quality of the processed product at the entry into machine - humidity; - hectolitric mass; - impurities	 % Kg/hl %	 11.92 78.7 2.41; 2.47
5.	the suction air flow rates of the installation (test versions)	m^3/min	100; 125; 150
6.	air speed in the suction pipe at air flow rates of the suction installation (test versions)	m/s	17.36; 21.7; 26.04
7.	Power absorbed by the of the gravitational separator	kW	0.7
8.	Power absorbed by of the suction installation	kW	7.5
9.	Total absorbed power	kW	8.2
10.	Specific electricity consumption of the gravimetric separator	kWh/kg	0.00045
11.	Specific electricity consumption of the stand (separator and suction installation)	kWh/kg	0.0046

RESULTS AND DISCUSSIONS

By processing the obtained experimental data were made synthetic tables with the parameters determined experimentally for variants established by experimental research program. For an intuitive analysis of the influence of various constructive and functional parameters of the combined separation installation on the global technological index values E_{CS} were drawn graphics expressing the following technological the dependency of the index values of functional parameters (adjustment) of the separator: the supplying flow rate with product subjected to processing (wheat), the air flow rate of the suction installation, the angle of inclination respect to the horizontal working surface of the separator and the oscillation amplitude of the separator working surface.

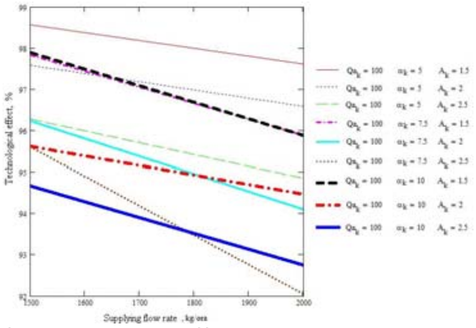

Figure 3 **Variation of the values of technological effect index E_{CS} depending on the supplying flow rate with material (wheat) Q_g at suction installation flow rate of Q_a=100 m^3/min, for the following adjustment parameters: inclination angle of the working surface α= 5; 7, 5; 10° and working surface amplitude A= 1.5; 2; 2.5 mm**

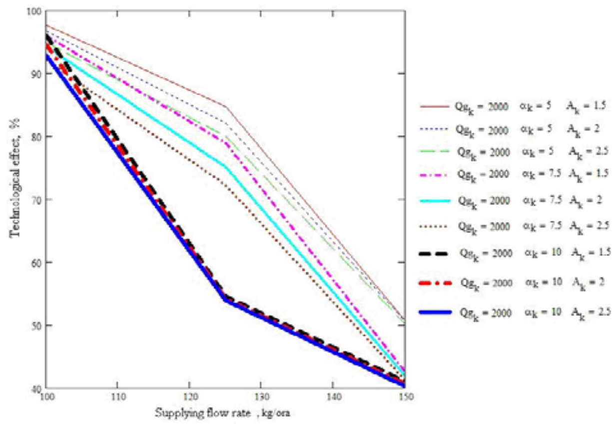

Figure 4 **Variation of the values of technological effect index E_{CS} depending on the air flow rate Q_a for the suppling flow rate with material (wheat) Q_g=2000 kg/h for the following adjustment parameters: inclination angle of the working surface α= 5; 7, 5; 10° and working surface amplitude A= 1.5; 2; 2.5 mm**

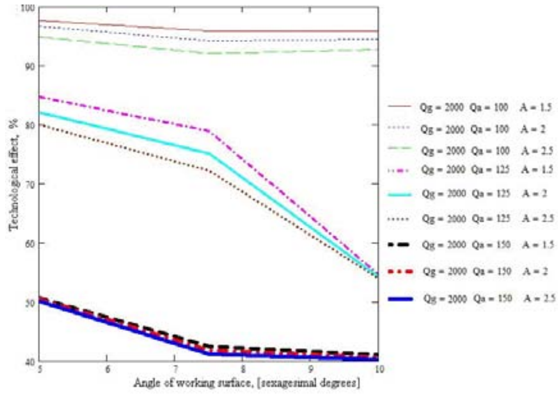

Figure 5 **Variation of the values of technological effect index E_{CS} depending on the angle of the working surface α at the supplying flow rate with material Q_g=2000 kg/h, for the following adjustment parameters: air flow rate Q_a=100; 125;125 m^3/min and working surface amplitude A= 1.5; 2; 2.5 mm**

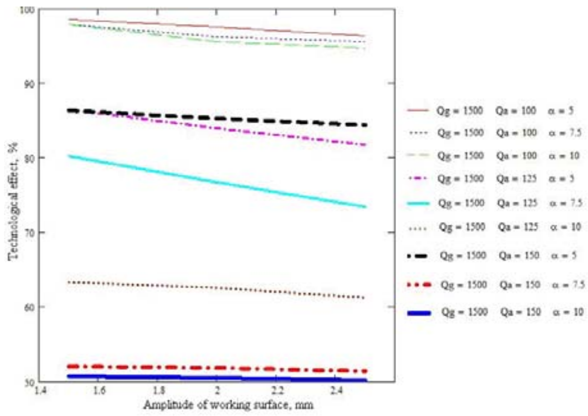

Figure 6 **Variation of the values of technological effect index depending on the working surface amplitude A for the supplying air flow with material Q_g=1500 kg/h , for the following adjustment parameters: air flow rate Q_a=100; 125;125 m^3/min and inclination angle of the working surface α= 5; 7.5; 10°**

Applying linear regression method at determined experimental data processing is obtained the technological effect function *ET*, as a function of the supplying flow rate with material (wheat) Q_g (in kg/h), flow rate air sucction Q_a (m^3/min), angle α (in sexagesimal degrees) of inclination of the working surface and the amplitude of oscillation A (în mm), expressed by the relation:

$$ET(Qg, Qa, \alpha, A) = -0.015892Qg - 0.848367Qa - 3.256444\alpha - 2.736111A + 237.645463 \quad (6)$$

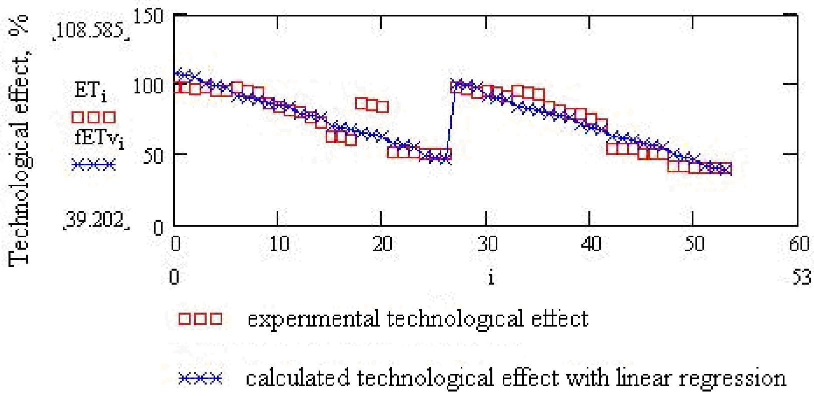

Figure 7 **Comparison of the experimental data with those obtained by linear regression at the determination of the technological effect index**

From the the graphical representation in figure 7 of the formula (6) result that the index of global technological effect decreases with the increase of the supplying flow rate with material, of the working surface angle, of the working surface amplitude and of the suction air flow rate.

CONCLUSIONS

From the analysis of data obtained by processing the experimental data revealed the following conclusions: the suction current introduced into the gravimetric separator favors the stratification of particles uniform dimensionally but with different specific weights, their movement on the surface of the separator being possible even under the minimum impulses; the values of the effect of technological working index decrease with the increase of the supplying flow rate with material (wheat) of the separator, being more evident at low angles of inclination of the working surface (5^0) and at lower flow rates of air suction; the values of working technological effect index decrease with increasing of air flow rate of the suction installation in about . 83% of cases tested; in 17% of cases (where there is intervals of increase and decrease with increasing of air flow rate) variation of this index is neither monotonically increasing nor decreasing monotonically.

The analysis the experimental data shows that 67% of cases opt for convex variations technological effect relative to the air flow rate, the remaining reflecting a concave variation; within the experimented working range in the researches on installation showed that the index of the technological working effect had an approximately linear variation with the oscillation amplitude of the working platform surface. Overall there was a decrease in the technological effect index with increasing of amplitude of working surface; although the amount of separated heavy impurities is higher it is found an increase in mass of good seeds eliminated in the mass of impurities.

The results obtained during the experimental researches reveal that the installation used consisting of gravity separator model SP-00 and the suction installation model IASP-0 comply with the requirements in terms of destination, of the purpose and functioning mode, of the possibilities for adjustment and servicing, working having a working capacity suitable technological flows from milling units.

BIBLIOGRAPHY

Brăcăcescu, C., **2011** - *Theoretical and experimental researches regarding the optimization of working processes* of gravimetrical separators aimed at cereals impurities. PhD Thesis, Transilvania University of Braşov.

Brăcăcescu, C., Cojocaru, I., 2010 - *Contributions to study of kinematics and dynamics of vibrating conveyors endowed with non-balanced mass mechanism* / INMATEH, Agricultural Engineering, volum 30 / Nr. 1/2010, ISSN 2068 - 4215, pag.5-13.

Brăcăcescu, Carmen, Popescu, S., 2009 - *Considerations on kinematics and dynamics of shaking sieves electromagnetically driven for cereal primary processing*, In: Anales of the University of Craiova, Agriculture, Mountain knowledges, Cadastre (ISSN 1841-8317), Vol. XXXIX/B, 2009, pag. 430-436.

Costin I., 1999 - *Miller's Book*, Technical Publishing House, Bucharest, Romania.