

EXPERIMENTAL RESEARCHES REGARDING THE DENSIMETRIC SEPARATOR FOR CLEANING OF THE WHEAT DESTINED TO MILLING

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ABSTRACT

The cleaning of cereal seeds represent an essential operation of the conditioning chain. Taking into account all considerations, the experts' attention has been drawn by the study of phenomena which influence upon the impurities separation process, aiming at a maximum reduction impurities. The paper presents the constructive and functional scheme of an densimetric separator driven by means of electrical motovibrators, in view of theirs utilisation with best results for the drive of vibrating sieves. The results of the experimental researches are highlighted, after which the optimal operating parameters were established.

INTRODUCTION

The continous progress related to improving the primary processing methods as conditioning operations and technical and material base periodically determines the enhancement of requirements in terms of foreign bodies removal and other quality aspects. Therefore, profoundly knowing the technology to be used, the operating method of technical equipment appropriate to relevant technology and technical-functional parameters adjusting represent an important preriquisite to obtain the maximum quality with reduced power and man labour consumption.

To reduce the number of technical equipment and implicitly of technological spaces, the modern cleaning technologies 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 (Costin I., 1999, Didyh V.F., 2002, Geankoplis Chr., 2003, Rus Fl., 2001). Cleaning of the wheat before milling is a complex technological process that includes more constructive types of machines and installations for the separating and removing of the impurities from grain mass. Elimination of the impurities being in the grain mass carries out by more technological procedures depending on their physico-mechanical characteristics. The separation of the mixtures after specific mass achieves both as effect of the combined action of one continuous, ascendant air flow having constant pressure that acrosses the grain stratum being on wire cloth surface, inclined after two directions (longitudinal and transversal) and of this surface vibration. So, due to simultaneous action of the vibration and a air flow, it obtains the stratification and the imposing of the different trajectories to seeds (Falko O., 2014).

MATERIAL AND METHODS

It was designed and achieved a densimetric separator having a capacity of 2 – 4 kg/h for equipping of the wheat cleaning technological line destined to grain milling (Fig. 1). The separator is a complex structure equipped on inferior part with operation surface made up from wire cloth and discharging pipes of the product after separation. On the upper part, the case is provided with aspiration and feeding pipes. Each pipe has one clack for regulating air flow respectively feeding product flow. The case is provided with plastic visor for the controlling of operation process.

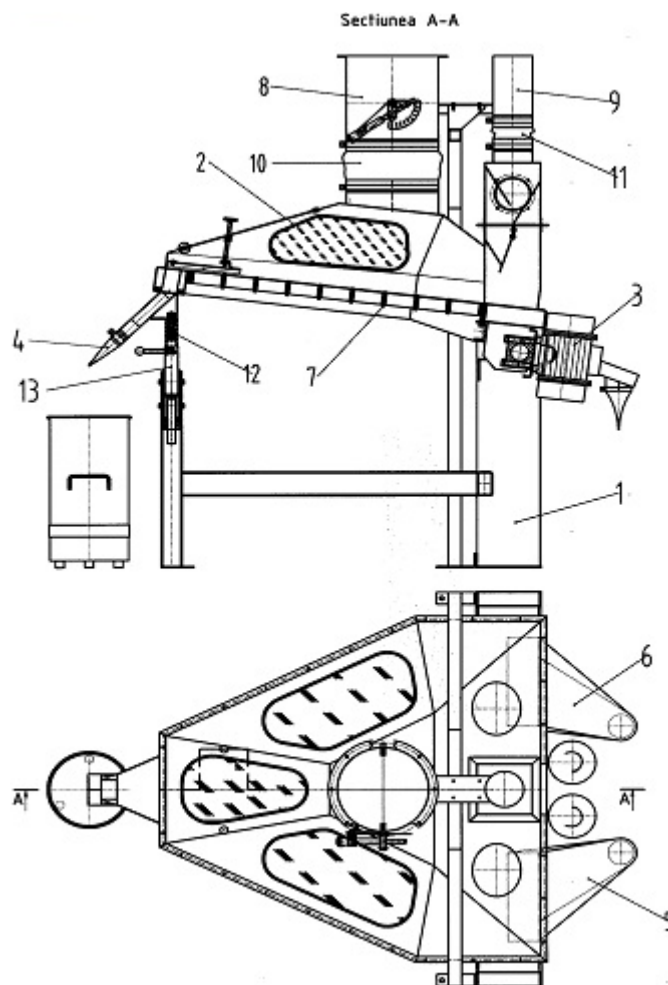


Figure 1. Constructive scheme of densimetric separator [1]

1 - sustaining frame; 2 - separator case; 3 - driving system (electric motovibrators); 5, 6 – finished (cleaned) product discharging pipe; 10- air aspiration pipe; 11 - product feeding pipe; 12 - pipe for discharging heavy impurities; 13 - screw mechanism

The experimental model of densimetric separator (figure 1) was realised at INMA Bucharest as experimental model. The separator case 2 is fixed on a sustaining frame 1 by one elastic (springs) system and a screw mechanism 13 that regulate the inclination angle of the operation surface. The cleaning product is introduced in separator by the feeding pipe and it is divided uniformly on the sieve operation surface. The product feeding flow is regulated by means of one clack. Under the oscillations action and of air flow, the

heavy impurities are moved to upper side of the operation surface but the grain are moved to inferior side, after that they are evacuated by two connecting pipes 5 and 6 . The wheat cleaning process is influenced by the following parameters: product feeding flow; air flow; inclination angle of the operation surface and the amplitude of the oscillatory motion. The product and air flows are regulated by means of clack being on feeding connection pipes. The inclination angle of the operation surface is continuously regulated (between limits 5...10⁰) by means of the screw mechanism that fixes the case against frame. The amplitude of the oscillatory motion is regulated between limits 1.5...2.5 mm by modification of the vibrator with eccentric masses.

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.

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:

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

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):

$$E_{cs} = [(C_{csi} - C_{cse}) / C_{csi}] \times 100 \quad [\%] \quad (2)$$

where: C_{csi} is content foreign bodies (impurities) at the entrance in equipment, %

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

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

$$W = (P_a \cdot t) / 3600 \quad [\text{kWh}] \quad (3)$$

where P_a is the power absorbed by electric motovibrators (kW),

t - operating time at tests (s)

Specific electricity consumption q was determined by calculation with the following formula:

$$q = \frac{P_u}{Q \cdot \eta_{me}} \quad [\text{kWh/kg}] \quad (4)$$

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.

RESULTS AND DISCUSSIONS

Table 1

The results of the tests effected for the determination of optimal regime of the densimetric separator

Crt. iss.	Determined parameter	U.M.	Parameter value
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; - hectolitic 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

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 of which we exemplify.

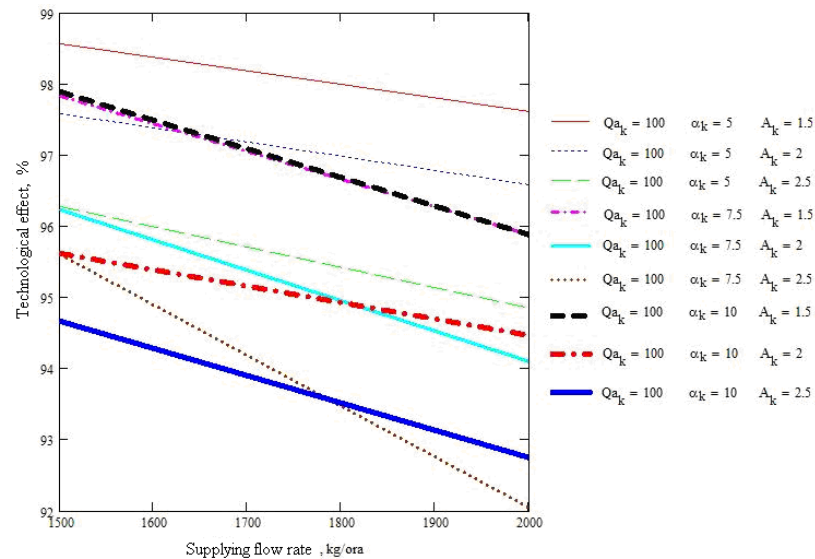


Figure 2. Variation of the values of technological effect index E_{cs} depending on the supplying flow rate with material (wheat) Q_g at suction installation flow rate of $Q_a=100 \text{ m}^3/\text{min}$ and the following adjustment parameters: inclination angle of the working surface α_k and working surface amplitude A_k

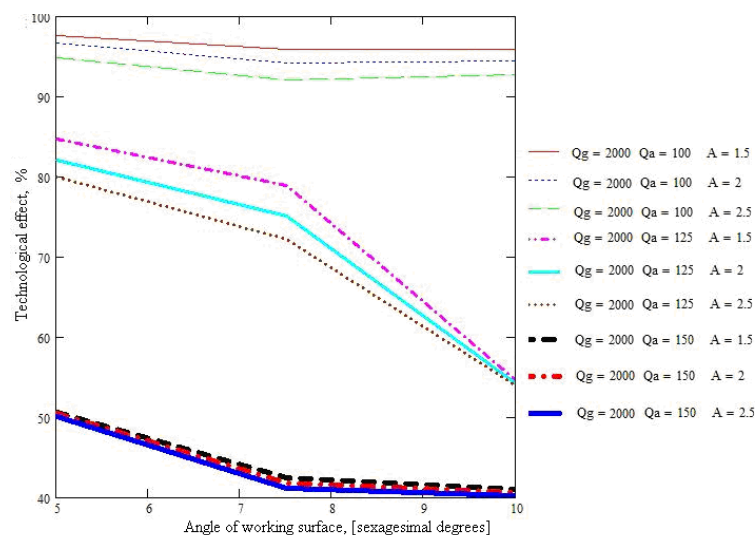


Figure 3. Variation of the values of technological effect index E_{cs} depending on the angle of the working surface α at the supplying flow rate with material $Q_g=2000 \text{ kg/h}$, for the following adjustment parameters: air flow rate Q_a and working surface amplitude A

It finds the following aspects after analyse of the experimental results:

- The performance of the densimetric separator increases by the increasing of air flow due to that it achieves a better stratification of product strata depending on specific weight of particles.
- By the increasing of the inclination angle of the operation surface, it diminishes the wheat quantity eliminated through impurities pipes. We have to mention that if it increases inclination angle more then 10° , the performance of separator becomes worst.
- The oscillations amplitude influences the operation regime, in such way that for values of 2 and 2.5 mm the separator performance increases.

CONCLUSIONS

The results obtained during the experimental researches reveal that the experimental model of densimetric separator 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.

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