CONSIDERATIONS ON THE IMPORTANCE OF SEED SEPARATION TECHNOLOGY BY AERODYNAMIC PROPERTIES

MIRCEA C.[1], PĂUN A.[1], VOICU GH., BRĂCĂCESCU C.[1], ANGHELET A.[1], ZAICA A.[1], SORICĂ E.[1]

[1)]INMA Bucharest;

[2)]University Politehnica of Bucharest, Faculty of Biotechnical Systems Engineering/Romania

E-mail: costinmircea@yahoo.com

Keywords:seed, technological line, pre-cleaning, aerodynamic properties

ABSTRACT

The article is aimed at agricultural entrepreneurs interested in the implementation of organic seed production technologies in their own units with the help of the Seed Cleaning Installation - ICS.

In order to store, process or capitalise the agricultural products resulting from the harvesting process, they must undergo a pre-cleaning process that can be done depending on the aerodynamic properties of the seeds.

INTRODUCTION

Seed preparation for sowing to meet modern technology includes a complex of operations to remove all impurities and unvaluable seeds, correct humidity, calibrate by size, apply chemical treatment.

These works are carried out by using advanced machinery and aggregates, grouped into installations that are known as seed conditioning installations.

At the base of seed cleaning and sorting are those properties that differentiate to a high degree the components of the seed mixture. To indicate the separation methods, as well as the respective working parts, the physico-mechanical properties (fig.1) must first be specified:

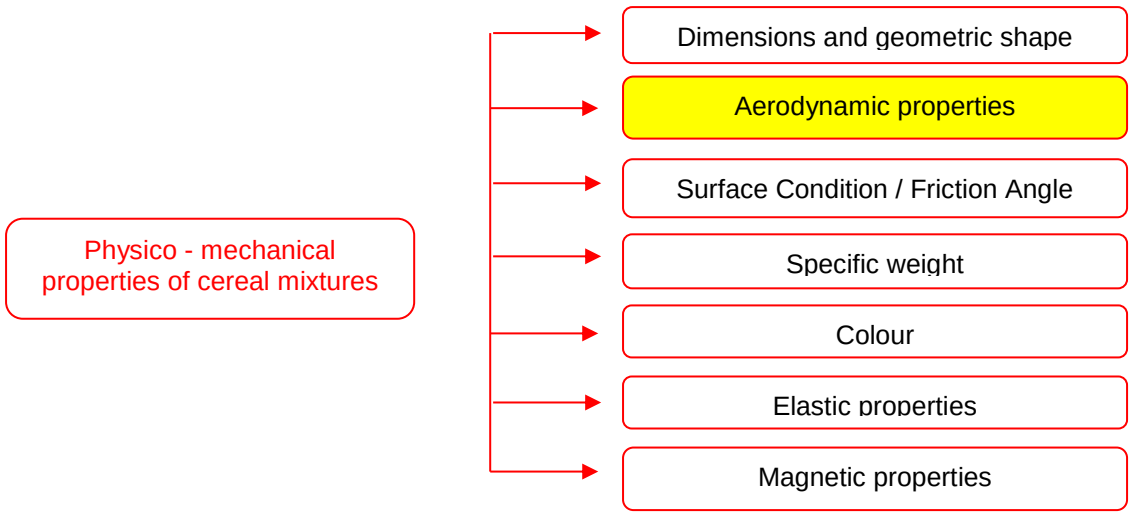


Fig.1 - Physico-mechanical properties of cereal seeds [1]

MATERIAL AND METHOD

Aerodynamic properties can be characterized by the velocity of the seed flow (the speed of ascending – vertical air flow, corresponding to the equilibrium state - the suspension of a particle therein). When the components of a seed mixture differentiate strictly in terms of floating velocity, this is the component separation criterion. Table 1 presents the floating velocities for several types of cultivated seeds but also other components, experimentally determined [1].

Table 1

Floating velocity values for some seeds and components of cereal mixtures [1]

Seed name	Floating velocity (m/s^2)
Wheat	8.9 – 11.5
Wheat sharps	5.5 – 7.6
Threshed ears	3 – 5
Short straw (10.0 mm)	5 – 6
Chaff	0.7 – 3.1
Corn-cockle	6.8 – 9.8
Weed seeds (some)	4.5 – 5.6
Rye	8.4 – 10.5
Barley	8.4 – 10.8
Maize	9.8 – 17
Bean	11 – 16.5
Lentils	4 – 13
Soybean	9 – 20.2
Sunflower	4 – 14

According to the data in the table, it can be noticed that, using the differences between the values of seed mixture components' floating velocities we can separate short straw, chaff, threshed ear parts, dry and shrivelled seeds, sharps and many weed seeds from the main culture. With the help of the air flow, light and heavy seeds can be preselected [1].

The process of seed cleaning by means of an air flow created by a fan is based on the difference in floating velocities, resistance coefficients and air floating coefficients, which characterize the aerodynamic properties of seeds in an air flow [1].

Taking into account the direction of the air flow used to separate the impurities, the following are distinguished according to the scheme in figure 2:

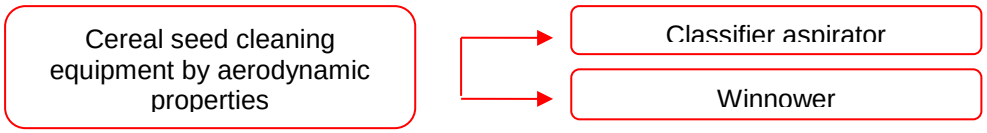


Fig.2 – Types of cereal seed cleaning equipment by aerodynamic properties

Classifier aspirators are machines with the air flow having a direction that opposes particle falling (fig.3):

The following equation corresponds to the vertical movement of seeds in an air flow:

$$\mathbf{m}\frac{\mathbf{dv}}{\mathbf{dt}} + \mathbf{R} = \mathbf{G}$$

where:

m – is the seed mass, (kg);

$\frac{\mathbf{dv}}{\mathbf{dt}}$ the acceleration of seeds moving in the air flow;

v – particle falling speed, ($\frac{m}{s}$);

t –seed movement time, (s);

R – air flow resistance, (N);

G – seed weight, (N).

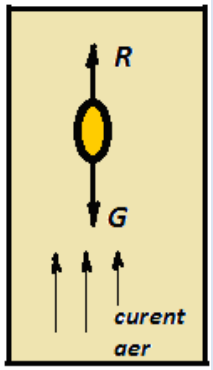
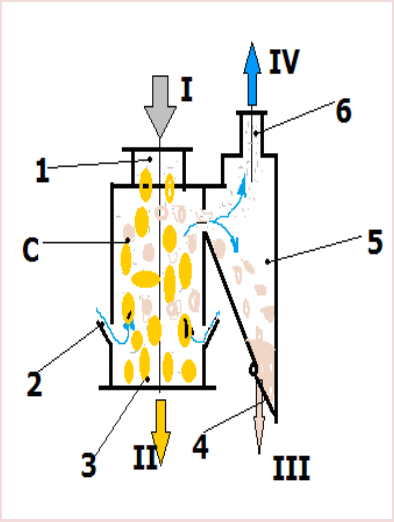


Fig.3 –Air flow direction opposed to seeds fall [1]

Description. The simple classifier aspirator, illustrated in fig. 4, consists of the vertical channel **C**, fed with cereals with impurities **I**, the feed connection **1**, provided to the bottom with two slots **2**, for penetration of the air aspirated by a fan through the suction connection **6** of the decanting chamber **5**, provided at the bottom with the articulated flap **4**[2].

Mode of operation. The cereal mixture introduced through the charging hole **1**, reaches channel **C**, encountering an ascending air flow which penetrates the slots **2**, is cleaned of light impurities which are carried by the flow to the decanting chamber **5** while the clean seeds **II** are discharged by connection **3**. The air with light impurities, extracted from the cereal mixture in channel **C**, arrived in the decanting chamber **5**, decreasing its speed due to the transition from a small section of the channel **C** to a large one of the decanting chamber **5**, causes the deposition of the heavy fraction **III**, at the bottom of the decanting chamber **5**, pressing on the articulated flap **4**. When the weight of the deposited fraction is bigger than the pressure exerted by air on the outer face of the flap (due to the depression in the decanting chamber), the flap opens removing the fraction **III**, then it returns to the closed position. Further, the air dust is discharged through the connection **6** to a separating installation [2].



I –cereal mixture to be cleaned; II –cleaned seeds; III –small impurities
IV –air dust;

Fig.4 – Technological scheme and components of simple classifier aspirator

Winnowers are machines with the air flow having a direction perpendicular to the particle fallingdirection (fig.4):

If we consider two particles A1 and A2, having the resistance forces through the air flow, **P1> P2**, and **G1> G2**, by the composition of these forces we'll obtain a certain trajectory. The two trajectories located at the deviations from the vertical, OB and OC respectively, make it possible to separate the mixture of the two components [2].

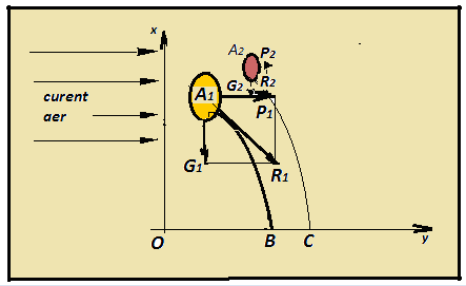
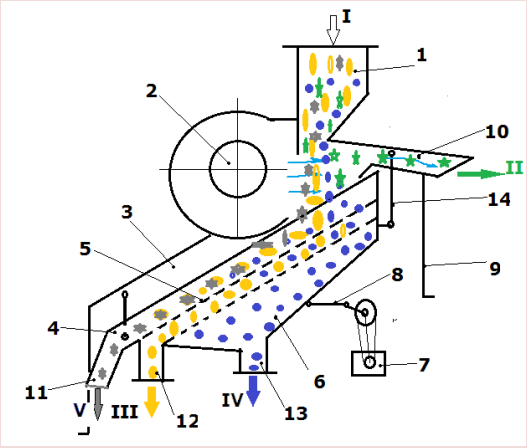


Fig.4 - The air flow direction is perpendicular or oblique to the seed falling direction [2]

Description. The winnower shown in fig. 5 consists of: supply connection **1**, fan **2**, a housing **3**, separation sieves support **4**, separation flat sieves **5**, light impurities collecting tremie pipe **IV**, **6**, drive group **7**, crank-connecting rod mechanism **8**, support legs for the housing **9**, light impurities outlet **10**, big impurities outlet **11**, clean seed outlet **12**, small impurities outlet **13**, elastic arms **14**.

Mode of operation. The cereals mixed with impurities introduced through the feed connection **1** pass perpendicularly through an air stream produced by the fan **2**, being pre-cleaned by light impurities and removed by the connection **10**. The other particles, having higher floating velocities than the air through which they pass, reach the flat sieves being separated by size. The sieving system is provided by a crank-connecting rod mechanism **8**, driven by a gear motor **7**.



I - cereal mixture to be cleaned; II –light impurities; III –cleaned seeds; IV –small impurities; V- big impurities [12]

Fig.5 - Technological scheme and components of winnower

The winnowers perform cereal pre-cleaning, by removing light impurities from the mass of cereals which have a floating speed lower than the air sent by a fan perpendicularly to the grain falling direction, and cereal sorting by size [2].

At INMA Bucharest was created a seed conditioning installation designed to improve production technologies for organic seeds of cereals, legumes for grains, oilseeds, industrial plants and fodder, aromatic and medicinal plants, to solve practical problems concerning the production of organic seed for field cultures at farmers, in order to produce seed and planting material organic certified and reduce losses on processing chain links (cleaning, sorting, storage, transport, processing, packaging, pre-commercial storing, distribution and marketing) [3].

RESULTS AND DISCUSSIONS

The installation is intended for the use of:

- households having their own capacity to produce organic seed and planting material and own seed storage systems;
- service providing units, which can serve several small peasant households;
- small and medium bases for the reception of cereal products, etc.;
- agricultural research resorts producing seed and planting material, organic certified [3].

The seed conditioning installation ICS in fig.6 is made of two main parts:

- seed pre-cleaning module MPS-0;
- cylindrical sieve SC-0.

Separation of coarse foreign bodies and light impurities from processed seeds is done by means of the pre-cleaning module MPS in Fig. 7. It is made up of two sieve drums and a built-in fan which performs intensive aspiration [3].

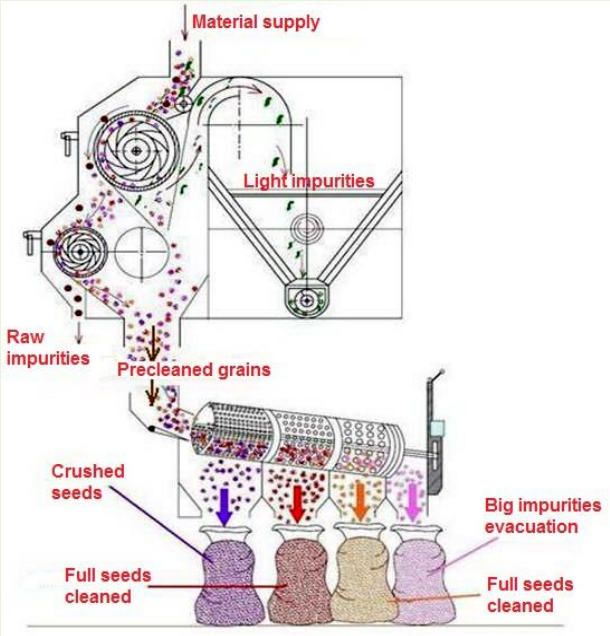


Fig.6 –Technological scheme of the Seed conditioning installation - ICS

1 – pre-cleaning module MPS; 2 – cylindrical sieve SC

Fig.7 - Seed conditioning installation - ICS

The installation is provided with two air pressure and flow control systems to meet the aspiration conditions according to the density of the primary product to be cleaned and its purity. Depending on the purity of the primary product to be selected and its density, in order to meet the aspiration conditions, the installation was fitted with two flow and air pressure control systems.

The product introduced in the seed pre-cleaning module, through the feed tube, is uniformized by means of the feed roller and the adjusting flap, reaching the main drum with sieves where the separation takes place, as plus material, of the coarse foreign bodies (large lumps, paper, strings, chaff, etc.)

Coarse foreign bodies are led to a second sieve drum where the remaining product grains removed by the first sieve drum are recovered. Row impurities are removed outside the installation through a discharge hopper, and the pre-cleaned product, from both drums, is subjected to intensive aspiration by the fan incorporated in the machine.

The air is directed through a side air intake to an external purification plant (cyclone, bag filter, etc.) belonging to the beneficiary, or it can be expelled directly into the atmosphere, if environmental conditions allow it [3].

Technical characteristics Seed pre-cleaning module MPS-0 [3]:

Productive capacity	max. 8 t/h
for a standard product like:	
- wheat, with hectolitre mass	min.75 daN/hl
- humidity	max. 17%
- impurities	6...8%
Cleaning degree (for impurities compatible with installation functions)	40...50%
Overall dimensions (L x l x h)	2300x1515x3000mm
Active parts' dimensions:	
- feed roller:	
- diameter	116 mm
- length	940 mm
- main sieve drum:	
- diameter	450 mm
- length	990 mm
- holes size	12.5x30; 14.5x30; 16.5x30 mm
- recovery drum:	
- diameter	250 mm
- length	990 mm
- holes size	12.5x30; 14.5x30; 16.5x30 mm
- horizontal screw conveyor:	
- screw diameter	120 mm
Drive systems:	
- feed roller, main sieve drum, recovery drumand screw conveyor, from a:	
- electric gear motor:	21-A-20-1.1/1000; H01 CMG022
- power	1.1 kW
- speed	940 rpm /1400 rpm
- protection	IP 54
- gear motor output speed	47 rpm /46.8 rpm i=29.93-B14-ROBITAL, SF average
- with chain drives of type 08 A:	
- feed roller speed	32 rpm
- sieve drum speed	16 rpm
- recovery drum speed	23 rpm
Radial monoaspirant fan	V40-400/1 FV
- flow rate	3550 m^3/h
- pressure	160 mm CA
- assembly D;	Type ASA-IMV1(vertical,
- with electric motor:	resting on the aspiration hole flange)
- power	2.2 kW
- speed	2850 rpm

It is recommended to use on the air exhaust network, belonging to the beneficiary, a Supercyclone for a flow rate of 4800 ... 5700 m^3/h. [3]

CONCLUSIONS

After harvesting, agricultural products (fruits, vegetables, seeds, etc.) cannot be used for different purposes (consumption, industrialization, storage, marketing of sowing material etc.) because they contain impurities (plant remains, soil, foreign bodies, etc.) and damaged products. Agricultural products harvested, prior to receiving a new destination, must undergo specific cleaning and sorting operations in order to increase product purity, reduce transport volumes and store in optimum storage conditions. Agricultural products cleaning and sorting to a higher level involves raising quite complex problems related to the nature of the product (vegetables, fruits, seeds), as well as its destination (preservation, industrialization, consumption, etc.).

Therefore, the Seed Conditioning Installation - ICS, made at INMA Bucharest, is trying to help farmers, responding to their demands and needs.

AKNOWLEDGEMENT

This paper was financed with the support of ADER Project - ADER 1.2.2. Elaboration of an integrating system producing seed and planting material, organic certified, at field cultures: cereals, legumes for grains, oilseeds, industrial plants and fodder, aromatic and medicinal plants.

The research work was funded by the Sectoral Plan Program of the Ministry of Agriculture and Rural Development, through financing contract no. 6.2.2 / 2015 for the project "Determining the effects of processed feed on ruminal environment and the productive performance of ruminants"

BIBLIOGRAPHY

[1] – **Tudor Casandroiu** - Equipment for primary processing and storage of agricultural products – 1993

[2] – **Ioan Danciu** - Technology and equipment of the milling industry - Lucian Blaga University Publishing House - Sibiu – 1997

[3] – Scientific work INMA – 2015

[4] – **R.K.Gupta, G.Arora, R.Sharma** - Aerodynamic properties of sunflower seed (Helianthus annuus L.) - Journal of Food Engineering, Volume 79, Issue 3, April 2007, Pages 899-904

[5] – **R.Khodabakhshian, B.Emadi, M.Khojastehpour, M.R.Golzarian** - Aerodynamic separation and cleaning of pomegranate arils from rind and white segments (locular septa) - Journal of the Saudi Society of Agricultural Sciences, Available online 11 January 2016

[6] – **C. Aydin** - Physical Properties of Hazel Nuts - Biosystems Engineering, Volume 82, Issue 3, July 2002, Pages 297-303

[7] – **S.Calisir, T.Marakoglu, H.Ogut, O.Ozturk** - Physical properties of rapeseed (Brassica napus oleifera L.) - Journal of Food Engineering 69 (2005) 61–66

[8] – **F.Ozguven, K.Vursavus** - Some physical, mechanical and aerodynamic properties of pine (Pinus pinea) nuts - Journal of Food Engineering 68 (2005) 191–196

[9] – **M. Paksoy,C. Aydin** - Some physical properties of edible squash (Cucurbita pepo L.) seeds - Journal of Food Engineering, Volume 65, Issue 2, November 2004, Pages 225-231

[10] – **T.O. Omobuwajo, E.A. Akande, L.A. Sanni** - Selected physical, mechanical and aerodynamic properties of African breadfruit (Treculia africana) seeds - Journal of Food Engineering, Volume 40, Issue 4, June 1999, Pages 241-244.