REVIEW OF THE MAIN EQUIPMENT USED FOR SEPARATING CONTAMINANTS FROM WHEAT SEEDS, CLASSIFICATION ACCORDING TO THEIR FUNCTIONAL ROLE

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ABSTRACT

Wheat seed cleaning require a complex set of operations to be performed in order to remove impurities from the grain mass and obtain high quality final products. These operations are carried out in a technological flow, starting from harvesting until the final processing stage, depending on the crop destination. The stages used to clean the wheat grain are usually following the operations: cleaning in aerodynamic separators, cleaning with sieves, sorting in indent cylinder separator, additional cleaning in special cleaning machines. The paper presents a synthesis of the primary processing phases of wheat seeds for the use in the food industry depending on their functional role.

INTRODUCTION

The seed mass obtained after harvesting is in most cases a mixture of seeds of the main culture, seeds of other cultural plants, weed seeds and various impurities of mineral and organic origin. The role of cleansing is to remove all foreign bodies from the seed mass and obtain the seeds of the main crop in pure form.

The role of sorting consists in separating the seeds of pure culture into assortments, depending on the requirements imposed by the consumer (material for sowing, for milling and bakery, for oil factories, animal husbandry, etc.). In most cases, the cleaning and sorting of the seeds is done simultaneously and as will be seen below, these processes are often inseparable (Banu C., 2009; Casandroiu T., 1993).

MATERIAL AND METHOD

Wheat is one of the most important plants cultivated in the world, having a large share in food production. In order to increase the purity, reduce the volume of transportation and storage, maximum preservation for a long time, eliminate depreciation of biological properties, it is necessary and mandatory for the harvested products to be cleaned and sorted by those impurities.

Wheat (Triticum) is a cereal intended almost exclusively for obtaining the flour needed for bakery products.

The shape of the wheat grain is oval, with a length of 6-8 mm and a thickness of 2.5-3.5 mm, as seen in figure.1. (Stefănescu I, 2003).

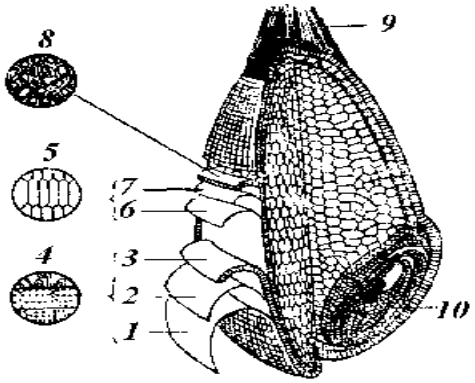

Fig. 1 - The grain of wheat. Sections and developments for putting in evidence of anatomical structure

Processing phases can be:
- mechanical: cleaning, sorting, calibration, grinding, sieving, dividing, crushing, etc.
- physical: thermal processing, drying, distillation, refining, etc.
- physico-chemical and bio-chemical: fermentation, enzymatic processing,.

Depending on the nature of the harvested material, cleaning can be:

a) ***Preliminary cleaning*** (pre-cleaning or tare) performed after the threshing operation, following the fulfillment of the conditions imposed by the use of seeds in the food industry.

b) ***Basic cleaning*** (fine cleaning or sorting). The material is separated into fractions, which differ from each other according to one of the criteria: aerodynamic properties, dimensions, weight, shape.

c) ***Additional (special) cleaning*** is applied in cases when after basic cleaning, there are still impurities in the mixture that cannot be differentiated from the mass of the seeds by size or by aerodynamic properties***.***

Cleaning and sorting is based almost exclusively on the mechanical properties of the seeds. The main physical-mechanical properties of the seed mass, on the basis of which the cleaning and sorting is done are the following:

- load-bearing coefficient;
- specific gravity;
- elasticity;
- dimensions;
- seed condition (surface condition);
- seed shape.

The physical-mechanical properties change within very wide limits and depend on the following factors:
- the nature and variety of the basic culture;
- climatic conditions of the cultivated area;
- the degree of maturity of the culture;
- seed moisture. In the literature and in regulations, tabulated values are given for the following physical-mechanical properties of the seeds:
- dimensions (a - length; b - width; c - thickness);
- critical floating speed;
- individual and absolute weight (per thousand particles);
- friction angles (coefficients);
- seed shape;
- surface condition.

In order to achieve an efficient separation of the basic crop seeds from the harvested mixture, the cleaning and sorting machines have working members that use several differentiation principles along the technological flow. In most cases it is recommended that the technological process take place in the following sequence:
- cleaning in aerodynamic separators;
- cleaning on site;
- sorting in trios;
- additional cleaning in special cleaning machines.

The process of separating the seeds with the help of the air current is based on the difference of the floating speeds, of the resistance coefficients and of the floating coefficients in the air, which characterize

the aerodynamic properties of the seeds in an air stream.

On-site cleaning includes the following main moments:

1) the displacement of the seed mass distributed in a uniform layer on the sieve surface;

2) the separation of the seeds through the holes of the sieve due to the passage of the seeds with dimensions smaller than the holes of the sieve.

Following the action of the sieve, the mass of seeds is divided into two fractions: the fraction that flows from the sieve, which consists of seeds whose dimensions are larger than the dimensions of the sieves' holes and the part that passes through the sieve which consists of seeds whose dimensions are smaller than the dimensions of the sieve holes.

The main shapes of holes used in sieves for cleaning and sorting seeds are circular and elongated.

Separation by thickness is performed on the site with elongated (rectangular) holes (fig.2). [5]

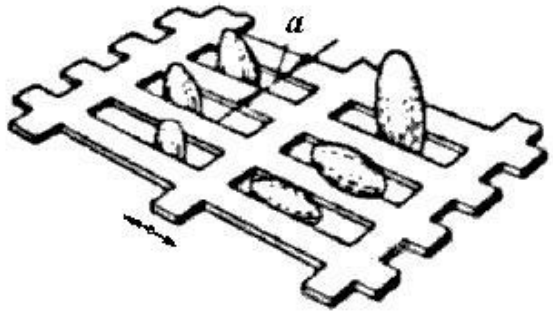

Fig. 2 - Rectangular holes sieves- separation by thickness

The holes have a length in the direction of movement of the separating mass of particles, and the seeds must move on the sieve. The separation condition is as follows:

$$a_{particle} \leq a_{hole} \leq a_{impurity}$$

The separation by width is made on the site with circular, triangular or square holes (fig. 3) [5]. Seeds that satisfy the conditions can pass through the holes of the sieve: b ≤ d and a ≤ 2b.

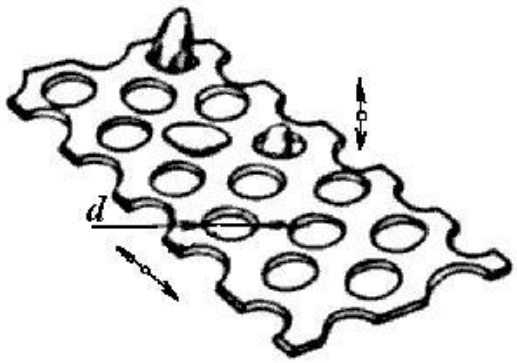

Fig. 3- Circular holes sieves - separation by width [5]

Separation by length it is made on surfaces with alveolar slots, and the equipment in which this operation is performed are called triplets (fig.4) (Stefănescu I, 2003). The trior have different shapes of alveolar surfaces, in most cases being in the form of a cylinder with inner alveolar shape.

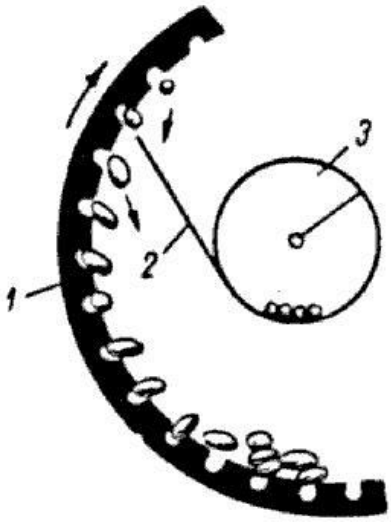

Fig. 4 – Alveolar inner cylindrical surface (trior) - separation by length;
1 - alveolar surface; 2 - reception trough; 3 - exhaust auger;

Sieves - are the basic organs in the construction of seed cleaning and sorting machines. They are placed in frames subject to oscillating movement, most often in the longitudinal plane and less frequently in the transverse plane.

The constitutive element that characterizes the possibility of separating the mixture with the help of the sieve is represented by the shape and dimensions of the holes distributed on the work surface. The dimensions and shape of the holes are chosen depending on the material to be processed on site and the requirements imposed on the final product.

The assessment of the cleaning and sorting operation with the help of sieves is done by means of quality and quantity indicators.

The quality of the separation is assessed with the help of the separation index, and the quantity with the help of the productivity index.

The characteristic values of the separation index ε for weed sieves can be considered as follows:

- for high quality separation, ε = 0.8;
- for medium quality separation, ε = 0.65;
- for lower quality separation, ε = 0.50. (Panturu D.,1997)

RESULTS AND DISCUSSIONS

The mechanical separation according to the shape and dimensions is done with the help of flat or cylindrical sieves, and from a functional point of view they can be oscillating (longitudinally or transversely), rotary, centrifugal, vibrating (fig. 5) (Stefănescu I, 2003).

The sieves used in the construction of cleaning and sorting machines are made either of sheet metal with a smooth or embossed surface, provided with holes of different shapes and sizes, or of a fabric or braid of metal, textile or synthetic yarns, fixed on a frame.

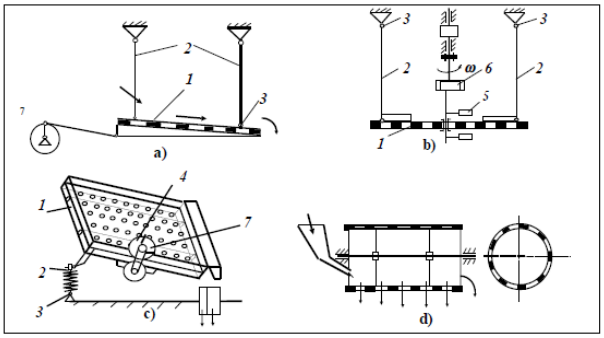

Fig. 5 - Constructive types of site:[5]

a - flat sieve with rectilinear oscillating motion; b - flat screen with circular oscillating motion; c - flat screen with vibratory movement; d - cylindrical sieve with circular movement.
1 - sieve frame; 2 - suspension system; 3 - joints; 4 - counterweight disc; 5 - counterweights; 6 - eccentric; 7 - eccentric mass.

Cylindrical sieve Rotary cylindrical sieves compared to other separation machines, have the advantage of achieving an intense mixing of particles, in a simple construction, with small size and low electricity consumption. Cylindrical sieves are used in the process of cleaning and sorting seeds with a cylindrical or prismatic polygonal working member. Cylindrical sieves are constructed of perforated sheets with round or rectangular holes ensuring the separation of seed mixtures both by width and thickness.

The component elements of the cylindrical separators are:

- feeding funnel;
- drive shaft;
- cylindrical sieve;
- action group;
- evacuation funnel for small seeds passing through the meshes of the cylindrical sieve;
- evacuation funnel for refusal (seeds that have not passed through the meshes of the cylindrical sieve).

The cylindrical sieve can be made so as to have holes of the same size along its entire length or in the form of sections in which the holes are of different sizes, separating the seed mixture into several varieties.

In general, the motion of the particle on the inner surface of the cylindrical

sieve comprises the following three states:

- relative rest (on the surface);
- relative motion (sliding on the surface);
- free movement (independent of the surface).

The mass of grains penetrated inside the cylinder is found in a layer of a certain shape and size that is in a mobile equilibrium (fig.6) (Stefănescu I, 2003).

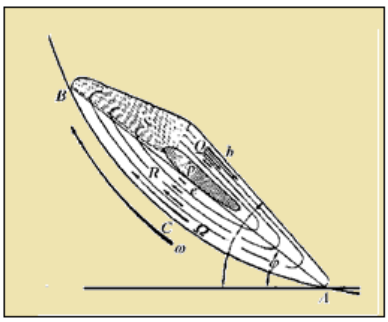

Fig.6- The structure of the grain layer in case of penetration inside the cylinder

The central part (area P) of this layer is fixed, and the rest performs a complex movement around the central axis; this movement occurs due to the friction that arises between the seed layer and the cylinder surface of the sieve. The linear velocity of the surface (ω) exceeds the velocity of the first row of seeds in the layer, which is in direct contact with it.

The movement of the layer depends primarily on the dynamic coefficient of friction (φ). With increasing angular velocity of the sieve surface (ω), the speed of rotation of the layer around the fixed core (P) also increases. The grains In contact with the sieve cylinder, have the highest speed (Ω) (Panturu D., 1997; Stefănescu I, 2003).

The moving layers (zone R) have a lower and lower velocity as they approach the fixed core (P). In the upper part of the mobile layer it moves by collapsing (zone S) making a vortex around the central nucleus (P).

The subsidence process does not depend on the cylinder, the subsidence occurring at a greater or lesser angle depending on the properties of the seeds of the respective crop. In area (S) the directions of movement are not well defined; here the grain moves without a set direction. Zone (Q) comprises seeds which move by collapse from zone (S); the direction of movement of the seeds in this area is inverse to the direction of movement in the area (R). At the end of the cycle, the grains, passing through the zone (Q), enter one of the concentric rows of the zone (R).

The working capacity of a cylindrical sieve requires the absence of the relative resting phase on the surface of the sieve cylinder.

CONCLUSIONS

The role of cleansing is above all to remove all foreign bodies from the seed mass and obtain the seeds of the main crop in pure form. The role of sorting consists in separating the seeds of pure culture into assortments, depending on the requirements imposed by the consumer (material for sowing, for milling and bakery, for oil factories, animal husbandry, etc.). In most cases, the seeds are cleaned and sorted at the same time.

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