STUDIES ABOUT THE INFLUENCE OF THE BULK DENSITY OF SOLID PARTICLES MIXTURE ON THE PROCESS OF AERODYNAMIC SORT

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Abstract: *The aerodynamic sorting process represents a complex process, and depends on different factors (sizes, shape, density and surface). To understand this process it is necessary to take into account the influenced factors.*
Because the density of the particle is changed, this change influences the floating speed of the particle. Aerodynamically separation of particle mixture taking into account the bulk density is possible, but is not so emphasize. The component of mixture are collected in the first collection boxes, the significant differences is made when we have 80 % particle with humidity 14 % and 80 % particle with humidity 24 % to an quantity of air 0,05 m^3/s.

Keywords*: particle density, aero dynamical separation.*

1. INTRODUCERE

In the food industry the raw materials come from agriculture, and a part from the products obtained in abaft the technological process, are submit the purification and assortment operations.

Because of this, after harvest, vegetable product is submitted firstly to the operation of purification, eliminating from their mass the impurity, following the operation of assortment.

But not only the products obtained from agriculture are submitted to assortment, but also the results obtained from the breaking up operation and from granulate or from briquette operation, where the shape and the sizes of the particles are not uniform.

A mixture of real particles represent a polydisperse a heterogeneous systems because is constituted from particles which have the different properties, and knowing these properties helps us to choose the procedures and the techniques to assortment on to different class (fractions) of respective mixtures.

Those characteristic is most marked constitute the basic criterion to choose the methods and the equipments of assortment.

The process of sort on the heterogeneous mixtures formats from solid particles is based, in roughly part, on this divisibility. The divisibility of the mixture is established after the analysis of the way of variation of all particles properties from the mixture, resulting in finally the assortment degree.

The most prevalent methods to assortment of a polydisperse heterogeneous mixture are assortment after sizes and the assortment after the aerodynamic property of the particles.

Taking into consideration the current tendency is to used aerodynamic classification equipments, replacing thus the classic assortment (on sieve), is needs to studied the process of aerodynamic assortment in the case of different type of equipments.

When the components of a mixture of solid particles are distinguished after their behavior in air flow, the assortment is can realize after the aerodynamic property. Know these properties give important information for to choose and to adjustment correctly the speed of the air flow, for the calculation and the projection the pneumatic systems fated incite of the assortment and the pneumatic transport of the particles mixture.

In principal the aerodynamic property of the particles are characterize by critical floating speed, which represents of the air flow speed (m/s) from a pipeline, whereat the particles, late fall free in this current, float [4, 7, 10, 12]. In special literature the process of aerodynamic assortment, which considers the aerodynamic features of solid particles, isn't sufficient studied, with all as exist a big number of types of used-up equipments for realization of this process [9, 12].

Because the principal factor to the process of aerodynamic assortment is represents the floating speed, majority studies was realized in the aim to determination of this for different type of particles [4, 6, 7], using different methods [3].

In most cases, the studies accomplish in the aim of an assortment of the heterogeneous mixture of solid particles have to base equipments of the aerodynamic assortment in air flow inclined [1, 2, 13].

Researches in the area behavior of solid particle in of the air flow was approached by: Torobin L.B. si Gauvin W.H. [13]; Soo S. L. [11]; Boothroyd R.G. [1]; Richardson E. G. [8]; Levich V. G. [5]; Davies C. N. [3].

In our country studies concerning a behavior of solid particles in air flow they achieved in inside of University “Politehnica” Bucuresti [6].

2. THEORETICAL STUDY

To can understand the process of aerodynamic assortment of solid particles must to know which factors influences the assortment operation, respectively the average features of thing (the air), of solid particles and the mixture of the format from two components. A solid particle find out into a vertical air flow is characterization by floating speed, which is determined with the next relation:

$$v_p = \sqrt{\frac{2 \cdot G}{k \cdot S_p \cdot \gamma_a}} \quad , \qquad \text{(m/s)} \qquad (1)$$

in which:

k is the aerodynamic coefficient of resistant which depends on for form's sake and the state surface;

S_p – the surface of the particle projection on a perpendicular plan to a direction of the speed of the air flow, m^2;

G – the weight of solid particle, N, and he can be write in the likeness of:

$$G = m \cdot g = \rho_p \cdot V \cdot g \quad , \qquad \text{(N)} \qquad (2)$$

v_p represent the speed of float the solid particle, m/s;

γ_a – specific mass of air, kg/m^3;

ρ_p – specific mass of particle, kg/m^3

From analysis of equation (1) results as floating speed is influenced by the next factors:

- the sizes and form of particle;
- the particle density;
- the particle surface.

3. Materials and equipments

For the aerodynamic assortment of a particles mixture to used-up the pneumatic equipment with an vertical air channel with three rooms of appeasement (fig. 1).

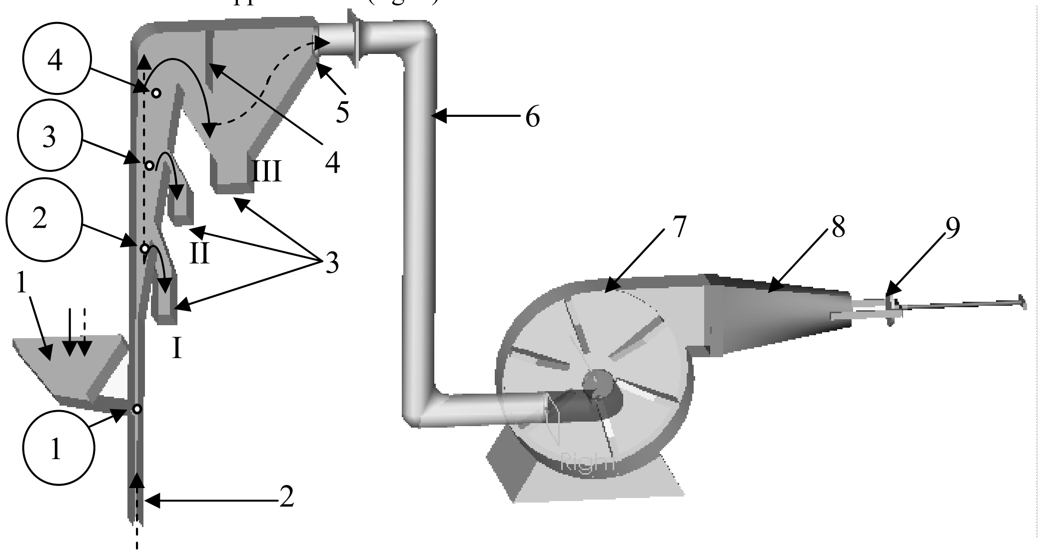


Fig. 1. The scheme of equipment for the study aerodynamic of a assortment of particles mixture: 1 – alimentation basket; 2 – pipeline with variable section; 3 – collection box; 4 – deflector wall; 5 – evacuation air connection; 6 – pipeline; 7 - axial – radial fan; 8 – evacuation connection of air from equipment; 9 – brutish adjustment device on air flow from equipment.

1, 2, 3, 4 *- measurement points of pressure variation;*

I, II, III – order of boxes collection.

—— *- the route of solid particles;* ---- *- the route of air flow.*

The air feed from installation can be adjust with help of adjusting device rough, so that range values of the air flow speed is into very large interval. The three boxes of solid particles collection are disposed to differed height against the feeder connection of the particles mixture, having situating on differently section of the air channel.

The variation of the airflow pressure was putted in evidence with helps of electronic transcribers capacitive of differential pressure TIP CE3D, which are connected to the acquisition plate NI PCI 6251 CB incorporate into a computer Pentium IV, having the memory Hard 40 GB and the RAM MEMORY 512. In frame of these experiments was used the heterogeneous mixture formats from wheat to the humidity of 14 % - wheat to the humidity of 24%.

For the particles mixture used in frame of this experiment type have the next characteristics:

- friction coefficient $\mu_f = 0{,}445$;
- sphericity $\Phi_s = 0{,}62$;
- equivalent diameter $d_e = 3{,}5$ mm.

The density wrack the wheat particles varying in depending on these humidity conform to the charts from figure 2.a. Taking count of the variation of particles humidity, the float speed of these don't shall have the same value, variation of this is presented in figure 2.b.

The density of the particles mixture is modified because the difference from humidity among the which particles compose the mixture and by reason of percentage report in carry retrieve in mixture of the fractions (fig. 3.)

4. EXPERIMENTAL RESULTS

After experimental determinations, for five quantities of mixture used, was obtained the variation of the total pressure of air flow represented in figure 4.

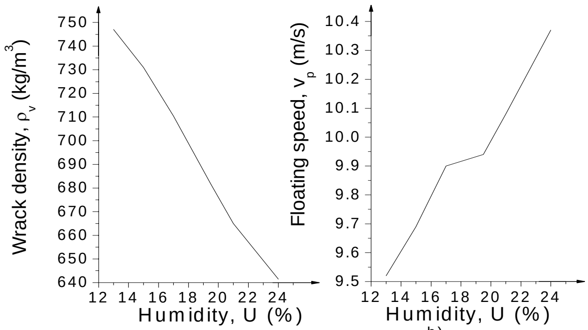


Fig. 2. The influence of variation of the humidity over variation of:
a) wrack density of solid particles; b) floating speed of solid particles

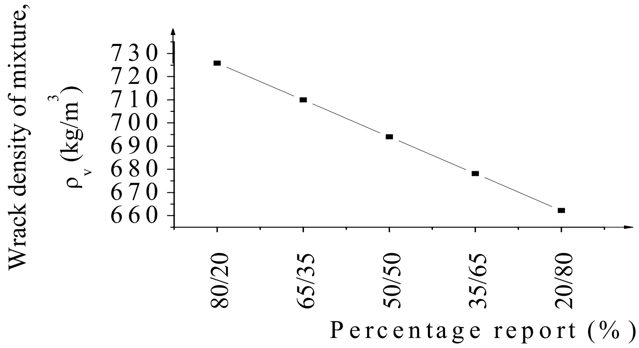
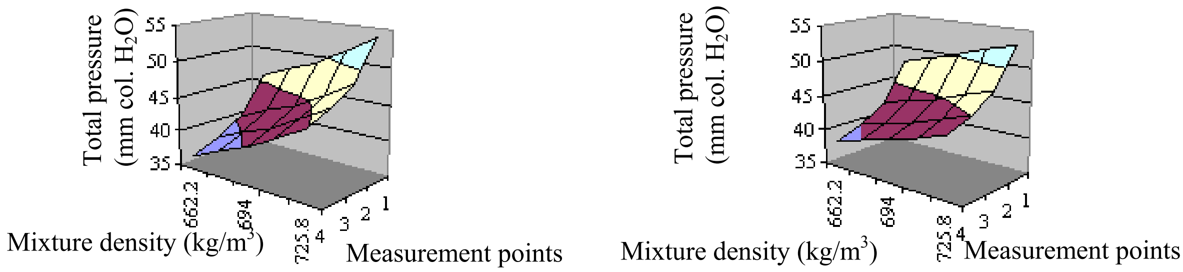


Fig. 3. Variation of mixture density of particles in according with the percentage report of the phases from the wheat particles mixture.



a) b)

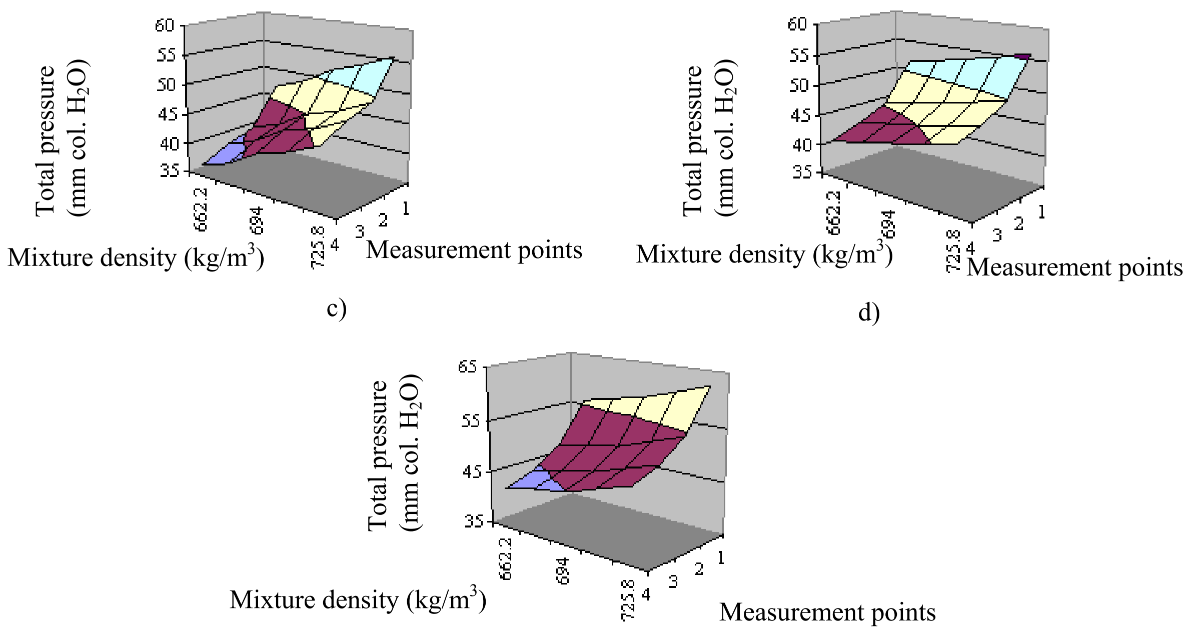


Fig. 4. The variations of total pressure of air in function by phase report of both components of particles mixture for different air flow:
a) 0,05 m^3/s; b) 0,054 m^3/s;c) 0,0578 m^3/s; d) 0,061 m^3/s; e) 0,0648 m^3/s.

In the figures 5 ÷ 9 are presented the variation of particles quantity collected in boxes in function by difference between the wrack densities of the particles.

Efficient assortment was analysis through the weight of the particles mass from each particle types collected in the three boxes.

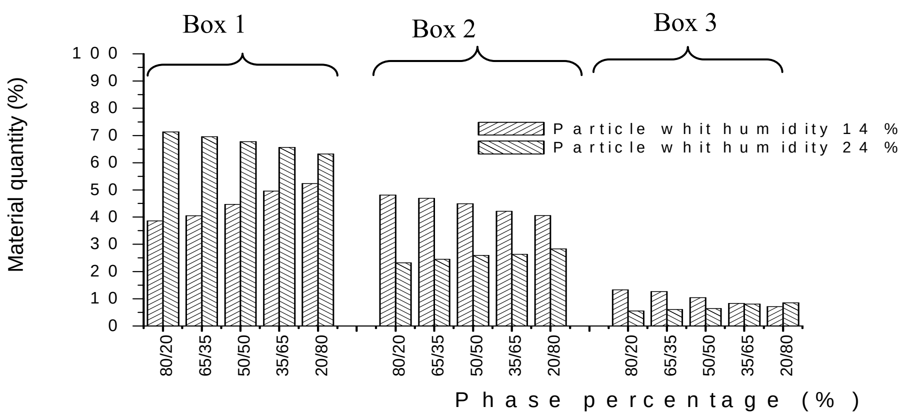


Fig. 5. The variation of the particle quantity (%) collected on three density class (three box) in function by component reports for a Q_a = 0,05 m^3/s.

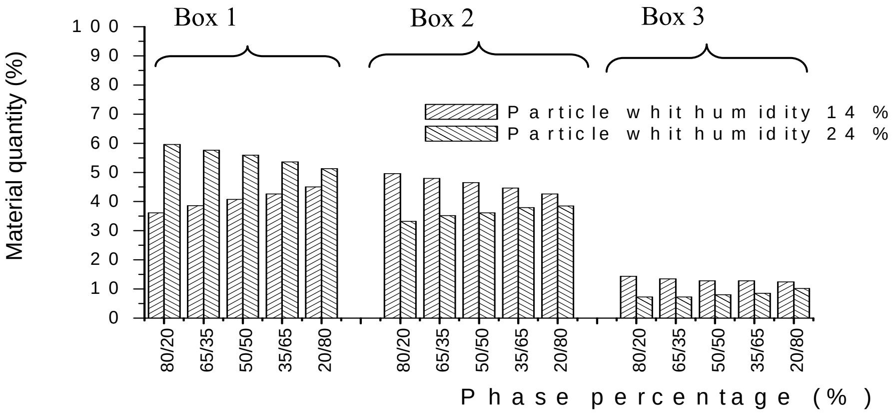


Fig. 6. The variation of the particle quantity (%) collected on three density class (three box) in function by component reports for a $Q_a = 0,054\ m^3/s$.

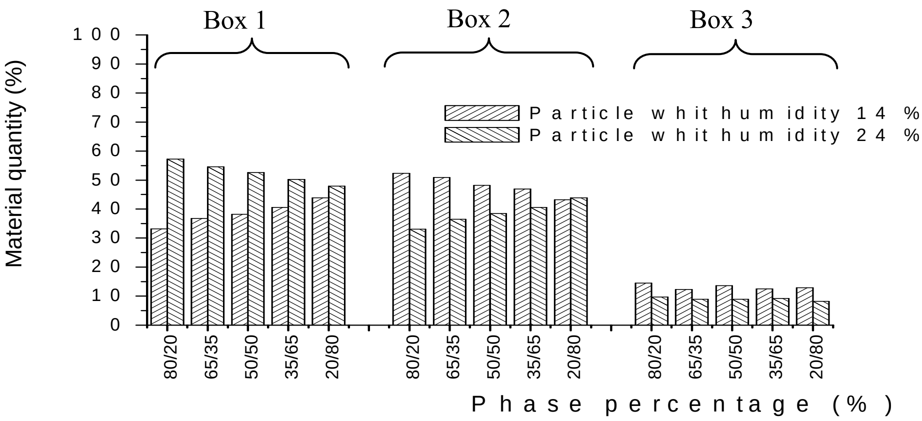


Fig. 7. The variation of the particle quantity (%) collected on three density class (three box) in function by component reports for a $Q_a = 0,057\ m^3/s$.

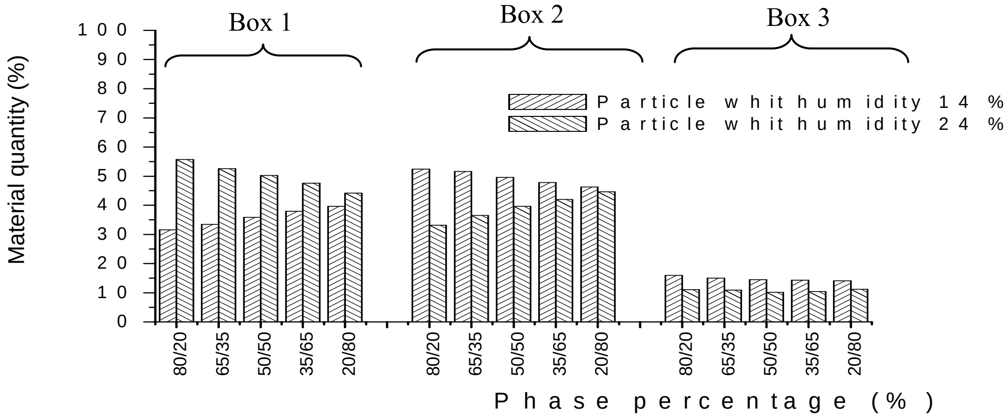


Fig. 8. The variation of the particle quantity (%) collected on three density class (three box) in function by component reports for a $Q_a = 0,061\ m^3/s$.

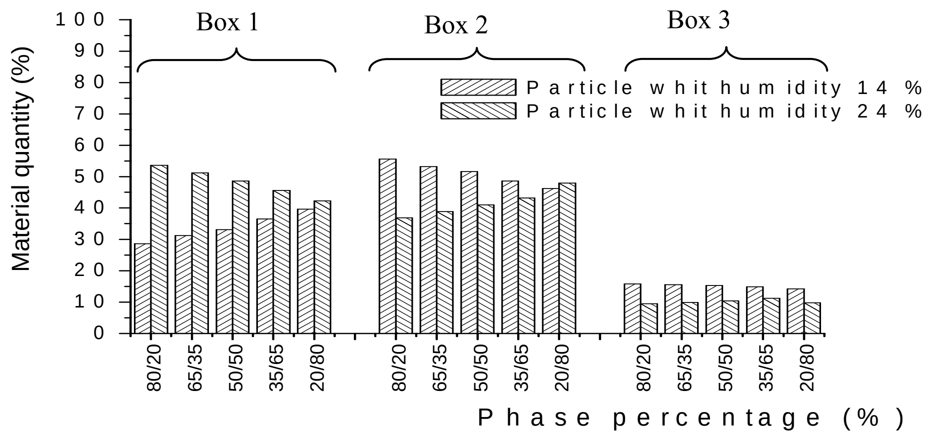


Fig. 9. The variation of the particle quantity (%) collected on three density class (three box) in function by component reports for a Q_a = 0,064 m^3/s.

5. MATHEMATICALLY MODEL

The results obtained after experimental determinations show as the process of aerodynamic assortment depends so the characteristics of the particles and the particles mixture and of the air flow.

Utilizing the software to generate the linear and nonlinear equations Tablecurve 3D, they obtained the mathematical models of the variation of total pressure for each collection point of in fractionally in function with the air flow and the characteristically impose for the aerodynamic assortment.

$$p_t = a + \frac{b}{Q_a} + c \cdot \rho_v + \frac{d}{Q_a^2} + e \cdot \rho_v^2 + \frac{f \cdot \rho_v}{Q_a} \tag{3}$$

in which:

ρ_v represent the number of particles from blends;
Q_a - the air flow which cross through the installation.
a, b, c, d, e and *f* – equation coefficients (table 1).

The correlation coefficient corresponding of this equations is r^2 = 0,88 for wheat with humidity 13 % and 0,89 for wheat with humidity 24 %.

Table 1

The representation of using constants in mathematical model.

No. crt.	Constants					
	a	b	c	d	e	f
1.	93,3066	6,120	-0,30144	-0,197	0,00034	-0,00390986
2.	163,1348	2,77	-0,46656	-0,12	0,0004	-0,0007

In the next equation is presented the factorial mathematical model 3^3:

$$y_{grau14} = 39,47 + 0,005 \cdot Q_a - 5,22 \cdot S - 0,005 \cdot r + 21,65 \cdot Q_a \cdot S + 0,008 \cdot Q_a \cdot r - 2,75 \cdot S \cdot r - \\ -0,675 \cdot Q_a \cdot S \cdot r - 0,005 \cdot Q_a^2 - 9,2 \cdot S^2 - 0,005 \cdot r^2 \tag{4}$$

$$y_{grau24} = 43,19 - 16,4 \cdot S + 0,02 \cdot r + 9,33 \cdot Q_a \cdot S - 2,83 \cdot Q_a \cdot r - S \cdot r - 2,83 \cdot Q_a \cdot S \cdot r - 0,12 \cdot Q_a^2 - \\ -14,55 \cdot S^2 - 0,05 \cdot r^2 \tag{5}$$

in which:

Q_a represent air flow, (m^3/s);
r – phases concentration, %;
S - air channel section, (m^2).

6. CONCLUSIONS

Concerning to the process of aerodynamic assortment of solid particles after this density is can conclude as:

- the density of solid particles is inverse proportionate with humidity, thus for wheat particles to the humidity of 0, 24 is obtained a density In wrack of 641 kg/m^3, and to the humidity of 0,3 a density in wrack of 747 kg/m^3;
- the floating speed of a particles is direct proportionate with variation this humidity;
- the of a mixture density of particles is inverse proportionate with humidity of which particles enter into this structure, obtained thus for a mixture of grain particles in component whom have 80 % particles with humidity of 0,14 and 20 % particles to the humidity of 0,24 a wrack density of 725,8 kg/m^3, and in the case which in is inverted the proportion of those two components is obtained a wrack density a grain particles mixture of 662,2 kg^3;
- the variation of the pressure of the air flow is direct proportionate with the variation density of the mixture particles and with the variation of the air feed
- the report of the phases obtained after the process of aerodynamic assortment, in all three boxes of collection, is influenced to the weight from the mixture of solid particles of the phases and of the air feed;
- is possible to realize the mathematical model for process of aerodynamic assortment of solid particles after their wrack density;

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