THE POSSIBILITY OF DETERMINATION POSITION OF A FLOATING SOLID IN A PARTICLES AIR CHANNEL WITH VARIABLE SECTION

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Abstract: the Know of a behavior particle in a air channels with variable section is very importance, for the projection of aerodynamic classification equipment.
An important factor it represents the cognition of ultimate position (floating position) which have it a solid particle in the air channel, obtaining thus the level whereat must put the collection box of this. Position of the collection box is can determine on experimental path but and on analytic path (as much for the existing equipment how much fittings and for one finder out in the stage of projection).

Key words: air channel with variable section, the ultimate position.

1. INTRODUCTION

The aerodynamic assortment is can achieved when the elements what compose the heterogeneous mixture can distinguished after they behaviors in air flow and is characterized, in main, of the speed of floating. The aerodynamic assortment process of a particles blend depends so the aerodynamic characteristics of particles, but and of the constructive characteristics of the used-up installation in the frame of the aerodynamic assortment process [1, 2, 3, 4, 6, 8, 9, 10, 11, 23]. Installation utilized as the model as part as of this study is a pneumatic assortment with an alone vertical air channel with the variable section and with three rooms of calm (fig. 1) [13, 14, 15, 17, 18, 19, 20, 24].

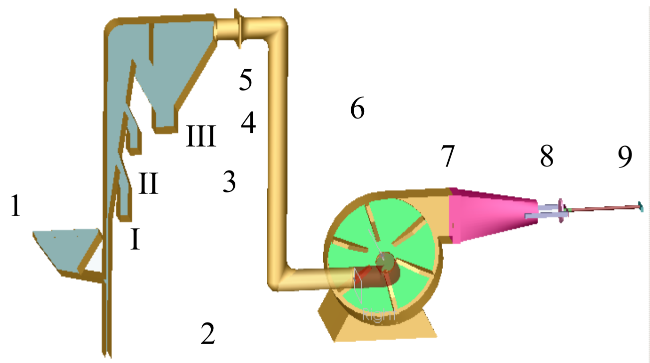


Fig.1. The scheme of equipment for the study aerodynamic of a assortment of particles mixture:

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.

2. RESEARCH METHODS

From the analysis of utilized equipment as part as the aerodynamic assortment process is noticed that he this is consisted of two transoms of pipeline, with differ sections thus:

- the portion with the height h_1 with constant section;
- the portion with the height h_2 with variable section,

This variation of section influences the casting of the air flow in channel, were put in evidence with help of FLUENT program (fig. 2).

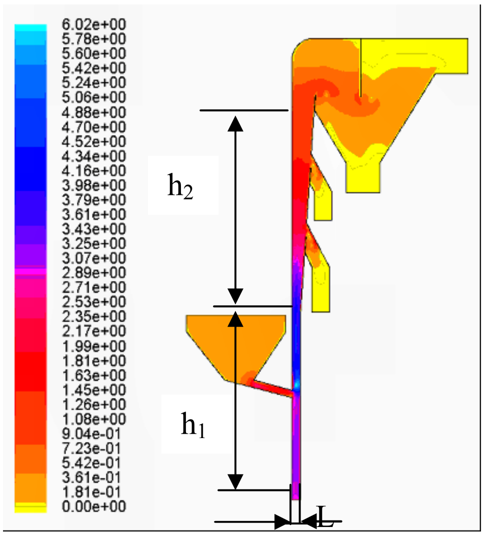


Fig.2. The variation of the speed of the air flow in the used-up equipment to the aerodynamic assortment.

The air feed which circulates through the air channel is determined with the relation [16, 21, 22]:

$$Q_a = u \cdot S_{tub} \quad [\mathrm{m^3/s}] \quad (1)$$

in wich:

Q_a is the air feed, m^3/s;
u – air speed, m/s;
S_{tub} – transversal section of pipeline, m^2.

The variation of section of the air channel, for the air channel with variable section, as per on the figure 3, is come on the relation:

$$S_{tub} = (a + b) \cdot L \quad [\mathrm{m^2}] \quad (2)$$

or:

$$S_{tub} = [a + h \cdot \tan(\alpha)] \cdot L \quad [\mathrm{m^2}] \quad (3)$$

in which:

a is base little the rectangular trapezium, or the portion with value constantly in the pipeline (depth), m;
b – increase of section of the pipeline, m;
L – the depth of the rectangular section, I carry has the constant value on whole pipeline, m;
α – the banking wall angle of the pipeline, grad;
h – the height of the portion from stand with variable section, m.

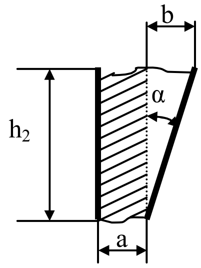


Fig. 3. The scheme of determination the section variation of the pipeline.

So from the equation (1) is can caused the speed of the air flow for different section of utilized equipment [7]:

$$u = \frac{Q_a}{S_{tub}} \qquad [\text{m/s}] \qquad (4)$$

replacing the relation (3), the equation (4) becomes:

$$u = \frac{Q_a}{\left[a + h_2 \cdot \tan(\alpha)\right] \cdot L}, \qquad [\text{m/s}] \qquad (5)$$

The movement speed of a particle situate in a vertical ascending air flow is determine with the relation [12, 5]:

$$v = u - v_p \cdot \frac{\left(1 + e^{t \cdot \frac{2 \cdot g}{v_p}}\right)}{\left(e^{t \cdot \frac{2 \cdot g}{v_p}} - 1\right)}, \qquad [\text{m/s}] \qquad (7)$$

in which:

v_p is float speed of solid particle, m/s;
u – the air speed in the air channel with variable section, m/s;
t – the time which is followed the movement speed of particle, s;
g – the gravitational acceleration, m/s^2.

For the determination of ultimate sprocket of solid particles inside out the air channel with variable section used-up three methods:

- used the laboratory equipment presented in the figure 1, blocked the collection boxes I and II;
- uzed the simulation program FLUENT;
- used the mathematical relation (7).

For the air channel else is know the next constructive sizes:
- the banking angle of wall is $\alpha = 4^o$;
- the height $h_2 = 0, 735$ m;
- the portion with section constantly a = 30 mm.

As part as experimental determinations were used-up three types of particles having same density 1200 kg/m^3, spherical form, but of different sizes $d_{p1} = 3$ mm, $d_{p2} = 4$ mm and respective $d_{p3} = 5$ mm.

The experimental determinations were realized in five repetitions, afterwards be presented the average values obtained for each parameter studied.

3. EXPERIMENTAL RESULTS

By reason of the section variation of air channel, the solid particle is shall stabilized to the level whereat the channel is wandered through of a current speed is coequal on floating speed of the respective particle. With help of FLUENT program, is represented the behavior in a particles what wanders the vertical air flow through the channel with the variable section (fig. 4).

The dial represents the speed of displace particle in the vertical air flow. From the analysis effectuated through FLUENT program, consisted that the solid particles are shall displaced and positioned, toward the inclined wall of the air channel, respectively the wall on which placed the collection box.

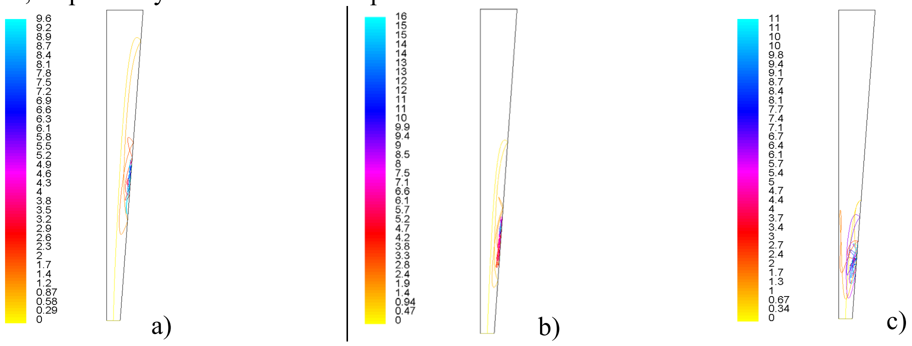
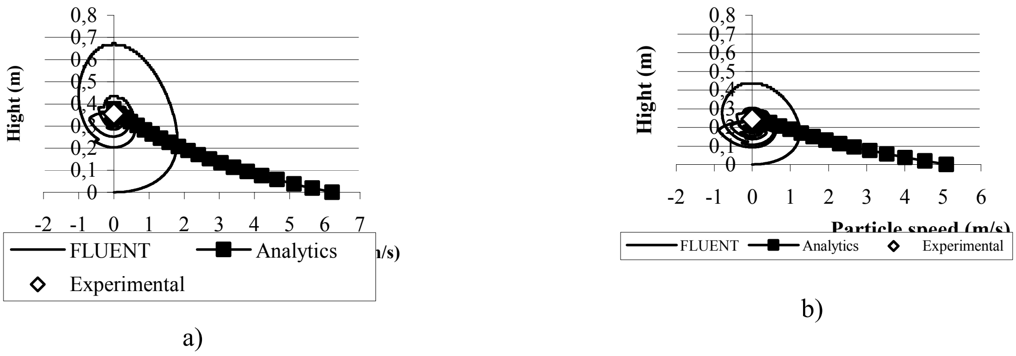
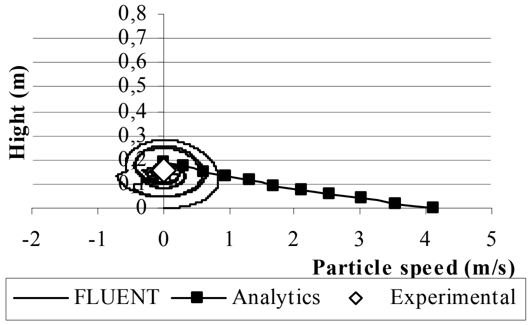


Fig. 4. The ultimate position of solid particles in the air channel with variable section, for a flow of air 0,62 m^3/s: a) d_{p1}; b) d_{p2}; c) d_{p3}.

In the figure 5 was presented the ultimate sprockets of solid particles obtained through three methods:
a) on experimental path, through close the boxes of collection;
b) analytics, with help of the relation (7), awhile of 3 s;
c) through simulation, by using the FLUENT program.





c)

Fig. 5.The final position of solid particle finded out in a pipeline with variable section:
a) d_{p1}; b) d_{p2}; c) d_{p3}.

From the comparative analyses obtained the next consideration:

- the difference among the values obtained with the relation (7) and the values obtained on experimental path is insignificant, observing that the value 0 of the particle speed (the speed of floating) is obtained at the same level;

- comparative with the values obtained with the relation (7), the values obtained for particle speed with the simulating program FLUENT differs significantly, but is obtained the same level of solid particle positioned in the air channel with variable section.

In the results obtained with help of FLUENT program I can noticed the oscillations executed of the solid particle within the moment this stabilization to the proper section of his speed of floating.

3. CONCLUSION

As part as the process of aerodynamic assortment, choose the type of classification equipment has an important role, therefore must knowed, as far back as the stage of projection, the ultimate sprockets (of floating) of the solid particles in concordance with the type of the installation.

The ultimate sprocket which has it a particle in the air channel with variable section is can determined on experimental path, analytics and through simulation with the FLUENT program. The difference between the results obtained through three methods is insignificant.

A significant influence, in the case to determination of ultimate sprocket of solid particle on mathematical path, is making of the relation among the speed of which air flow wanders through the channel with variable section and the speed of float the solid particle.

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