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THE HYDRODYNAMIC FLOWS AND INERTIAL ENVIRONMENT INFLUENCE ON THE PRODUCT QUALITY AT GRANULATION USING DISPERSION

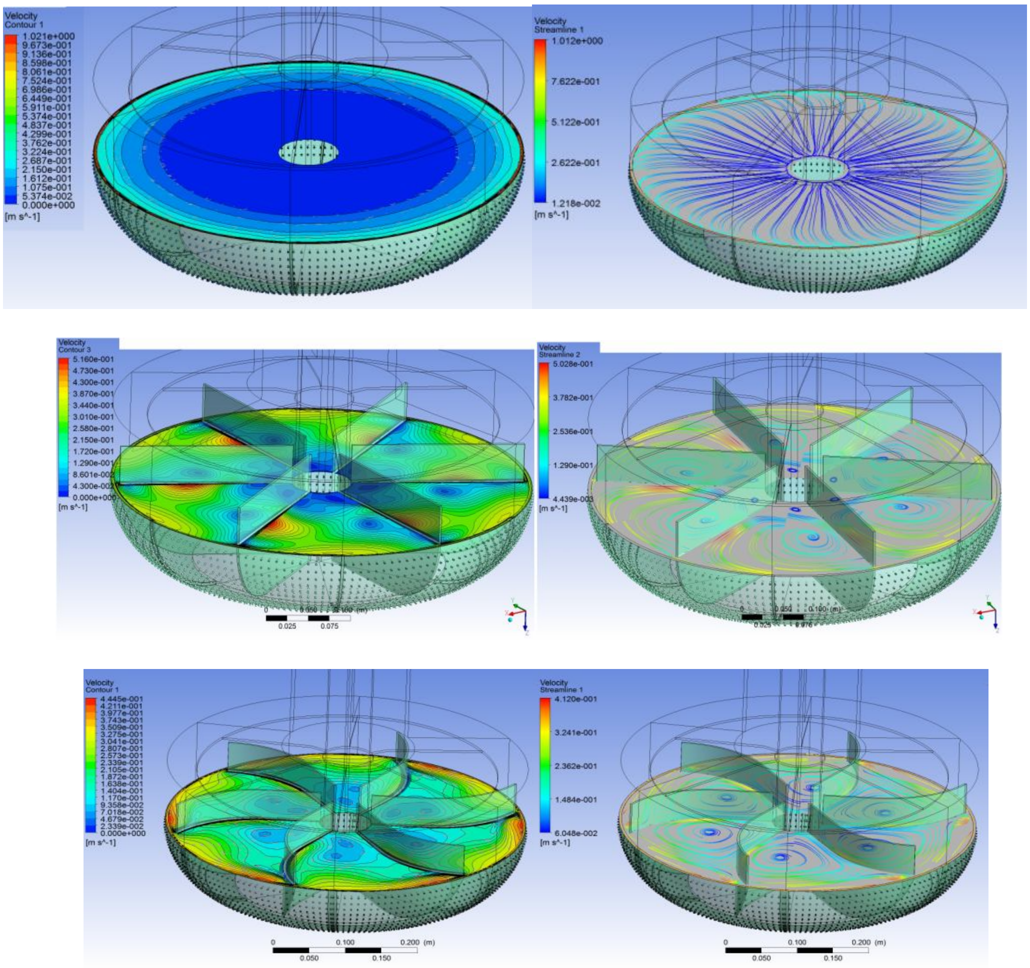
Solution (liquid melt) dispersion method, when the liquid melt is dispersed in the riser air flow or in the inertial environment is widely used in the large capacity mountings for granulation product manufacturing [1]. It is used because of high efficiency and output product wide range. The apparatus for getting mono dispersion drops (granulators) have various constructions. When choosing the cooler one takes into account the dispersion product characteristics. One has the principal demands to the output product which are high mono dispersion degree and regular shape. When the fraction has deviation from the necessary shape and irregular spherical form it causes the granules consumer quality reduction (for agrarian sector – too high soil deoxidization when using fertilizer or its quick solution, for mining industry – granules lower holding capacity in the diesel fuel or oil, their destruction while transporting to the blasting and so on).

Dispersion environment flow formation conditions (the way of its egress from the granulator outlet and splitting) and inertial environment peculiarities influence greatly on the drop formation and its crystallization.

The fluid flow egress regularity depends on its movement speed distribution peculiarities in the granulator operating chamber and on the outlet hole.

One made computer modeling using finite element (MKE) analysis program system ANSYS CFX (http://www.ansys.ru/) in accordance with the created model with analysis grid for computation for granulator inner environment hydrodynamics research and for typical fluid movement zones indication. Fluid flow parameters calculation is done by solving a system of different equations which describe the general case of the fluid environment movement –Navier-Stokes equations using averaged Reynolds and continuity equations [2].

One gives the computer modeling results of the fluid speed movement hydrodynamics inside the granulators of different constructions shown in the figures 1-3.



a

b

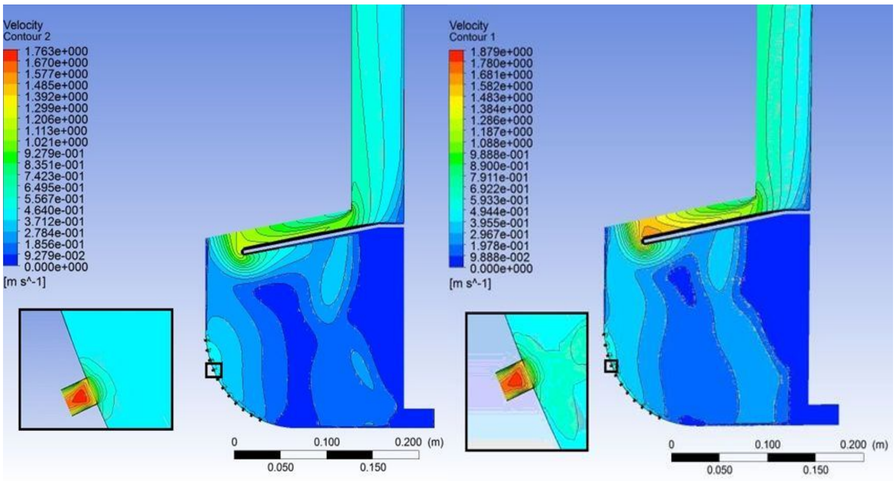
c

Figure 1 – fluid flow lines and its speed fields for the revolution granulator with revolution speed 50 revolutions per minute: a – without blades, b - with 6 straight blades, c – with 6 rounded blades.

Having used computer modeling one obtained the following results:

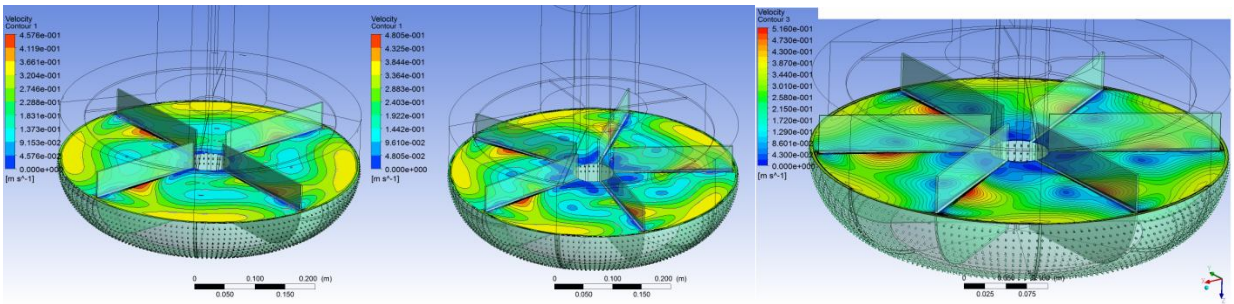
- output fluid speed egress dependence on the forcing blades quantity. When we add one more forcing blade outlet fluid speed egress growths on 7% in average and it has polynomial dependence like $\upsilon = 0.0121n^2 + 0.0578n + 0.8997$ (υ - fluid speed egress from the outlet n- blades quantity);
- maximal quantity of the forcing blades in the apparatus must be 6,

because when we continue adding blades in the inter phase behind the egress holes one can see the vortexes formation, which create additional weak vibrations causing irregular dispersion liquid melt mode;



a *b*

Figure 2 – Revolution granulator speeds fields with 6 straight blades (a) and 7 straight blades (b) when revolution speed is 50 revolutions per minute



a *b* *c*

Figure 3 - Revolution granulator speeds fields with 4 straight blades (a) 5 straight blades (b), 6 straight blades (c) when revolution speed is 50 revolutions per minute

- forcing blades rounded form (fig. 1c), provides big egress speed comparing with straight blades under equal operating conditions and it is the optimal forcing blades configuration;

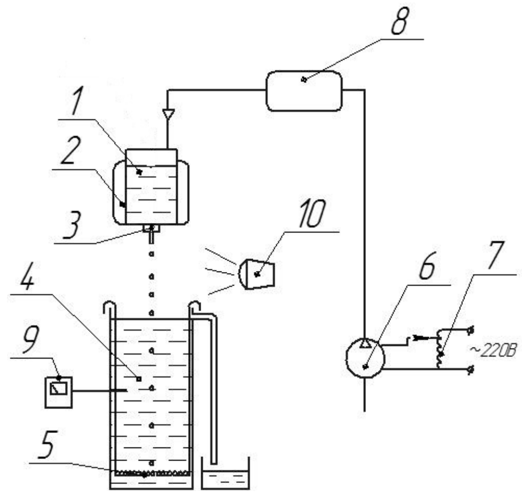
The improved apparatus construction can make the operating mode better thanks to:

- additional fluid pressure formation behind the egress holes rises the fluid egress speed and it makes it possible operating having bigger fluid pressure range (fluid pouring from the granulator basket takes place later) and also it provides apparatus operating without pressure fluctuation;

- less blockage and egress holes geometrical seizes changes thanks to additional pressure created behind them;

- less output products losses in the form of the dust, less atmospheric emissions.

One made a research of the granules quality dependence on the agar – agar solution concentration and inertial type environment making experiments on the pilot plant, the operating principals' scheme is on the fig. 4.



1- dispergator; 2 – heating system; 3 - nozzle; 4 – micro granules collecting tank; 5 – perphorial dividing plate; 6 – compressor; 7 – electronic transformer; 8 - extra pressure system; 9 – digital multimeter, 10- stroboscope.

Figure 4 – the experimental stand principal scheme

Solution temperature influences on the mono dispersion granules compound. While having experiments it was found out that not depending on the fluid physical characteristics solution temperature must be in the range. The upper limit – the temperature when no fluid physical and chemical changes take place and low limit temperature must be 5 ºC higher than crystallization temperature.

If the solution temperature is lower than the low limit than the surface forces have no time to form ball-like volume and the granule will have not spherical form or the fluid can solidify in the nozzle, disturbing the technological process. When solution dispersion takes place under the temperature which is higher than the crystallization temperature ball-like mono dispersion granules are formed.

When the solution concentration is 90:1 and is cooled in the petrol and also 100:1 and less (using Vaseline oil for cooling) most of the granules have irregular shape. It happens because the formed drop in the gas environment under the influence of surface tension forces tends to take spherical shape but because of low crystallization temperature it can't fix the volume (make a tight shell). Before the drop gets into the inertial environment it is to pass the surface tension on the inter phase boarder. When penetrating the drop undergoes deformation because shell is not tight enough and so it is crystallized not having time to take spherical shape.

The lower agar-agar water solution concentration is, the smaller is surface tension force (this force tends to make a drop spherical) and crystallization solution temperature.

When one analysis experimental research results one can identify physical and chemical characteristics of the environments which influence on the granules cooling process, their mono dispersion and geometrical parameters of the output product:

- when the fluid temperature for dispersion is chosen correctly one can get mono dispersion granules and avoid nozzle hole blockage;

- when the solution is dispersed in the inertial environment which is too much cooled most of the granules get crystallized not having enough time to take spherical shape. When the inertial temperature is risen to some critical level we can see that situation is changed – granules have enough time to get spherical shape before crystallization;

- one should also remember about the surface tension force of the fluid where crystallization take place. So if the total force influences on the drop is less than the inertial environment surface tension force, the drop stays on the inter phase surface. When continue dispersion the drops get joined and becoming one big granule sediment in the collecting tank;

- inertial environments combining: low layer – more sluggish substance (transformator fluid), upper layer – less sluggish substance (petrol), comparing with the substance which is dispersed, it lessens the inertial environment height and at the same time the granules preserve their spherical shape.

On the basis of the experiments and computer modeling results one found the optimal apparatus constructive parameters for getting mono dispersion granule-like products of different substances. The necessary technological characteristics are chosen considering dispersion fluid and inertial environments physical and chemical properties.

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