APPLICATION OF COMPUTER SIMULATION FOR THE DESCRIPTION OF DEVICES WITH SUSPENDED LAYER HYDRODYNAMICS

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The work covers the substantiation of the computer simulation application possibility for description of flow motion hydrodynamics in small devices with different configuration of suspended layer. The usage of the investigations results enables to create the methodology of the represented devices constructions engineering calculation

The usage of the suspended layer at the contact of phases is one of the most effective methods of the realization of the heat- and mass-transfer processes. Such system is characterized by a number of advantages, mentioned in works of foreign and native scientists: even product heating, which enables to apply high temperatures of the drying agent, intense motion, close to ideal mixing of particles, maximum of the phases contact surface, low hydrodynamic resistance of the product's layer, simplicity of construction and operation convenience etc.

The work covers the substantiation of the computer simulation application possibility for description of flow motion hydrodynamics in small devices with different configuration of suspended layer.

Generalization and comparison of the certain previous authors results in this field provide the opportunities to reduce influence of the factors, destabilizing the suspended layer, by means of an offer of new devices constructions with stable hydrodynamic indicators:

- vortex devices with variable cross-section of the operating space and reduced flight altitude of particulate material [1] (figure 1, a);

- suspended layer devices with vertical sectionalization of inner space and creation of multistage counterflow contact of particulate material and fluidizing agent [2] (figure 1, b).

The indicators of the heat- and mass-transfer processes in the suspended layer become mainly clear by means of the solid (gas) and disperse (hard) flow motion hydrodynamic indicators. The efficiency of the suspended layer devices work to a large degree depends on the flow field of gas stream, which distribution on the working volume of the device has an influence of disperse material trajectory.

The results of computer simulation of solid and disperse phases hydrodynamic descriptions in vortex granulators and multistage gravity shelf dryers have been examined.

For calculation of the hydrodynamic motion flow and for visualization of the results of the investigations, the complexes COSMOS FloWorks (www.solidworks.com) and Flow Vision (www.flowvision.ru) have been used in this work.

Vortex granulators

During of small vortex granulating devices designing the special attention is paid to hydrodynamic modes of granules motion in operating volume of the device under the influence of the swirling gas flow and determination of their conditions in terms of equilibrium. The selection of gas flow parameters, which enables the granule to be in active volume the ample time, is performed depending on design features of the vortex device. While operating hydrodynamic granule motion, it is necessary to provide their receipt of the specified qualities without demolition of their structure.

Computer simulation includes such stages:

- investigating of the operating vortex device volume configuration influence upon hydrodynamic solid phase motion;

- investigating of the swirler construction influence upon the hydrodynamic solid phase motion

- selection of the vortex device optimal construction in accordance with granules quality requirements.

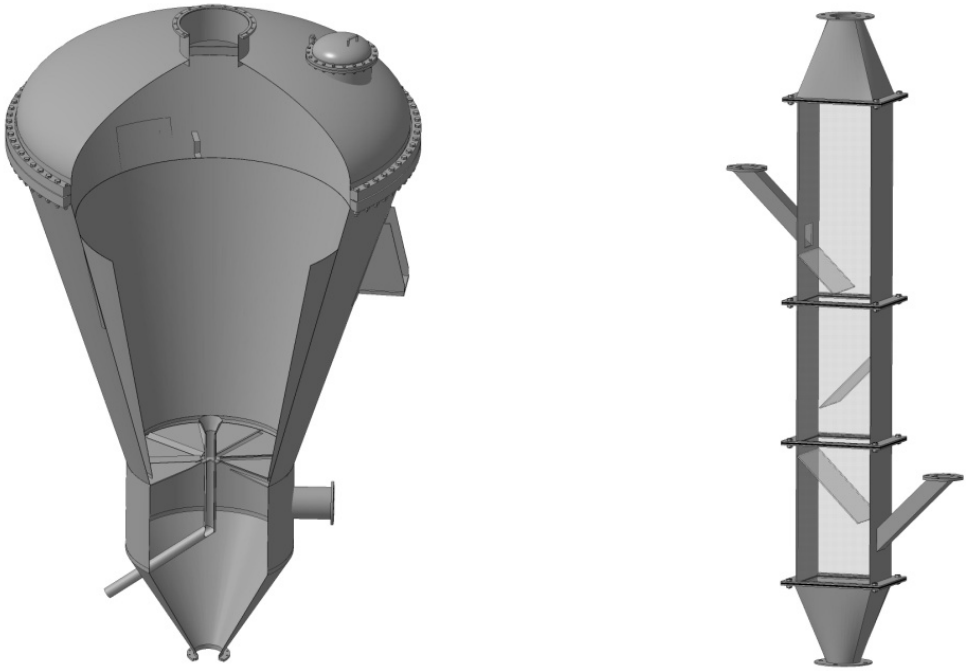

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Figure 1 – Devices with suspended layer: a – vortex device with variable cross-section of the operating space and reduced flight altitude of particulate material; b – devices with vertical sectionalization of inner space and creation of multistage counterflow contact of particulate material and fluidizing agent

In the sequel field distribution of the solid phase speed according to the height and radius of the device is researched according to the results of swirled gas flow hydrodynamics computer simulation for several operating place configurations and a way of gas flow swirl. At the same time places of possible formation of stagnant zones, zones of lower gas flow motion speed, where distribution of gas flow speed becomes uneven, are determined. After that correction of vortex granulator constructive parameters together with detection of optimal operating volume configuration are performed.

The trajectory of granule motion, speed fields of gas flow and granules stipulate time, spent by the granule in operating place of vortex granulator. This

time must be enough to enable liquid-alloy droplet to come through the stage of crystallization. Analysis of the granule motion trajectory according to the initial conditions and set of geometrical and engineering characteristics enables to detect their influence upon the change of the granule motion trajectory and the least necessary time of its staying in the device operating volume.

Thereby, application of computer simulation while investigating of hydrodynamics vortex flows enables to choose the optimal configuration of operating place and swirler construction for vortex device. Therewith the necessary quality of ready-made products, which depends on the requests to heat treatment and durability, is provided.

Multistage gravity shelf dryers

Research of hydrodynamics single-phase and two-phase flow motion in gravity multistage shelf device enables getting of qualitative and quantitative picture, describing the peculiarities of the development of the sectioned suspended layer under conditions of counterflow interaction of the fluidizing agent and particulate material.

The results of experimental research and computer simulation enable to ascertain salience of the particulate material motion in the device operating place, to light the presence of areas with lower speed, intensive vortex formation, separation and so on. Such approach to hydrodynamics flow motion enables to reveal constructive drawbacks of the under study device and eliminate them in the design phase of prototype, that reduces cost price of the industrial devices.

Computer simulation includes such stages:

- investigating of the construction of the shelf upon the hydrodynamics of solid phase motion and trajectory of the disperse material motion;

- selection of the shelf dryer optimal construction in accordance with the requests to the product.

The introduced constructions of the devices have the following advantages:

1. Possibility of simultaneous performing of several processes (e.g. process of drying and classifying of material) in the same device.

2. Reduction of the devices sizes by means of extension of the particle motion trajectory (for vortex and shelf devices), creation of separate contact degree flow in the volume of device (for shelf devices).

3, Possibility of granular material staying time control in the device.

4. Recycling of the fluidizing agent (for drying processes), that enables reduction of the expenditure of energy for the process implementation.

The usage of the results received from the research, supplemented by the mathematical description of the disperse materials treatment processes in suspended layer, enables to create engineering calculation methodology of the introduced devices constructions with detection of their overall sizes concerning industrial conditions.

References

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