The Study of Different Types of Swirl Generators in a Vortex Granulator Model

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***Abstract* – The author of the article has investigated various types of swirl generators of vortex granulator. Presents the various regimes of behavior of the fluidized bed depending of the load of polypropylene pellets and air flow for each type of swirl generators.**

Key words – vortex granulator, granulation, vortex fluidized bed, swirl generator.

I. Introduction

Currently, obtaining of granulated product connected with the use of granulation towers. This type of equipment is characterized by large dimensions, low specific capacity, high capital and operating costs. Transition to vortex granulators it's one way of reducing cost of producton and improving its characteristics [1]. Vortex granulators are characterized by intense heat and mass transfer, low hydraulic resistance, high level of mechanization and automation [2].

Vortex granulators let to obtain the multilayer granules [3] and granules with special properties (for example, porous ammonium nitrate) [4].

Stability of the vortex fluidized bed is greatly affect on the process of forming granules. The purpose this study is to identify the type of swirl generator which provides a stable vortex fluidized bed at wide range on the load of polypropylene pellets and air flow.

The object of the study – conical vortex granulators.

The subject of the study – a bed behavior in the working space of the vortex granulator.

II. Experimental setup and procedure

A test rig used in this study consist of the vortex granulator model and a blower connected to the electric network through a laboratory autotransformer. The vortex granulator model consist of a conical transparent shell, a swirl generator and a branch pipe for air supply. A swirl generator is removable. Polypropylene pellets was used as the bed material in tests.

Series of tests were carried out for 5 types of swirl generators. The load of polypropylene pellets (50, 100, 150 и 200 cm^3) and air flow (10, 15, 20 dm^3/s) were varied for each of the swirl generators. The tests results were fixed by the camera at 30 frames per second.

III. Analysis of the results

Analisys of the test results showed that the behavior of the bed exhibited four regimes, namely, №1 – the fixed bed regime Fig. 1, №2 – the partially fluidized bed regime Fig. 2, №3 – the vortex fluidized bed regime Fig. 3, №4 – the vortex fluidized bed regime with carryover Fig. 4.

Fig. 1. №1 - The fixed bed regime

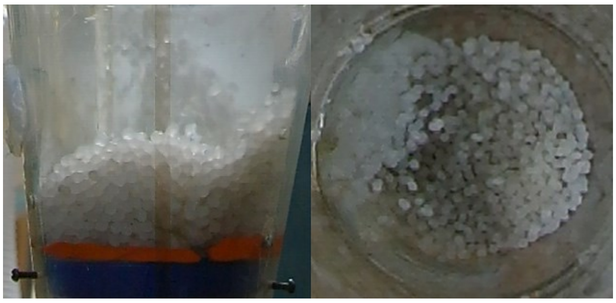

Fig. 2. №2 - The partially fluidized bed regime

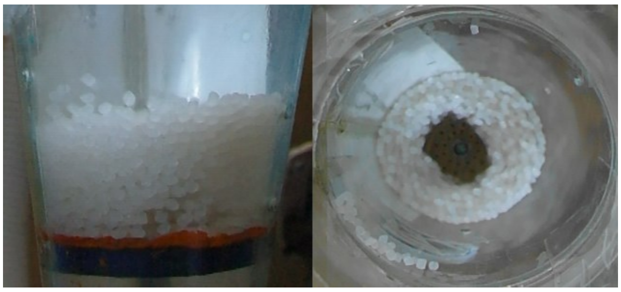

Fig. 3. №3 - The vortex fluidized bed regime

Fig. 4. №4 - The vortex fluidized bed regime with carryover

The types of investigated swirl generators below are shown in Figs. 5,6,7,8 and 9. The regimes of the behavior of the bed for each of the swirl generators are shown in the Tables I,II,III,IV and V.

Fig. 5. Swirl generator №1 – With inclined holes in the center and perpendicular holes along the periphery

TABLE 1

THE REGIMES OF THE BEHAVIOR OF THE BED FOR SWIRL GENERATOR №1

	50 cm^3	100 cm^3	150 cm^3	200 cm^3
10 dm^3/s	№2	№2	№2	№2
15 dm^3/s	№4	№3	№2	№2
20 dm^3/s	№4	№4	№2	№2

Fig. 6. Swirl generator № 2 – With perpendicular holes in the center and inclined holes along the periphery

TABLE 2

THE REGIMES OF THE BEHAVIOR OF THE BED FOR SWIRL GENERATOR №2

	50 cm^3	100 cm^3	150 cm^3	200 cm^3
10 dm^3/s	№2	№2	№2	№2
15 dm^3/s	№3	№2	№2	№2
20 dm^3/s	№4	№3	№2	№2

Fig. 7. Swirl generator № 3 – With two rows of inclined holes and two inclined slits

TABLE 3

THE REGIMES OF THE BEHAVIOR OF THE BED FOR SWIRL GENERATOR №3

	50 cm^3	100 cm^3	150 cm^3	200 cm^3
10 dm^3/s	№2	№2	№1	№1
15 dm^3/s	№3	№2	№2	№2
20 dm^3/s	№4	№3	№2	№2

Fig. 8. Swirl generator № 4 – With four inclined slits

TABLE 4

THE REGIMES OF THE BEHAVIOR OF THE BED FOR SWIRL GENERATOR №4

	50 cm^3	100 cm^3	150 cm^3	200 cm^3
10 dm^3/s	№2	№2	№2	№2
15 dm^3/s	№4	№3	№2	№2
20 dm^3/s	№4	№3	№3	№2

Fig. 9. Swirl generator № 5 – With six rows of inclined holes

TABLE 5

THE REGIMES OF THE BEHAVIOR OF THE BED FOR SWIRL GENERATOR №5

	50 cm^3	100 cm^3	150 cm^3	200 cm^3
10 dm^3/s	№1	№1	№1	№1
15 dm^3/s	№2	№2	№1	№1
20 dm^3/s	№4	№2	№2	№2

Conclusion

It was identifyed that the swirl generator with inclined slits (swirl generator №4) provides stability vortex fluidized bed at the most wide range on the load of polypropylene pellets and air flow in a vortex granulator as a result of experiments. Using the proposed type of the swirl generator in vortex granulators allow to carry out the granulation process for the most wide range described above.

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