DEVELOPMENT OF VIBRATION EQUIPMENT FOR THE PRODUCTION OF POLYCOMPONENT PHYTOMIXTURES

Vitalii YANOVYCH[1], Daniel DUDA[2], Olena RUBANENKO[2], and Václav URUBA[4]

[1] Faculty of Mechanical Engineering, University of West Bohemia in Pilsen, Univerzitní 22, 306 14 Pilsen, Czech Republic: yanovichvitaliy@i.ua

[2] Faculty of Mechanical Engineering, University of West Bohemia in Pilsen, Univerzitní 22, 306 14 Pilsen, Czech Republic: dudad@kke.zcu.cz

[3] The Regional Innovation Centre for Electrical Engineering, University of West Bohemia in Pilsen, Univerzitní 22, 306 14 Pilsen, Czech Republic: olenarubanenko@ukr.net

[4] Faculty of Mechanical Engineering, University of West Bohemia in Pilsen, Univerzitní 22, 306 14 Pilsen, Czech Republic. Institute of Thermomechanics, Czech Academy of Sciences, Dolejškova 5, 182 00, Prague, Czech Republic: uruba@kke.zcu.cz

1. Introduction

One of the most important stages of the technological process of manufacturing complex pharmaceutical mixtures is the grinding of pre-dried phytosteramines with a gradual sifting and giving it a homogeneous consistency of up to 97-98% with additional pharmaceutical ingredients due to mixing.

Thanks to the grinding, the specific surface of the treated material increases from 270-520 $cm^2 \cdot g^{-1}$ to 4100-4300 $cm^2 \cdot g^{-1}$, which makes it possible to significantly accelerate dissolution, chemical interaction and the separation of biologically active substances from the raw material [1].

Sifting is used as an auxiliary operation for preliminary preparation of the material for grinding, as well as an independent stage for obtaining the finished product with a particle size of 0.1-0.07 mm.

2. Disadvantages of existing technology for the production of phyto-mixtures

The technological scheme of production of pharmaceutical mixtures, which exists today, has a number of shortcomings, in particular energy-cost gradual implementation of technological operations of grinding, separation and alternate mixing phytocomponents with pharmaceutical ingredients in the form of certain powdery masses (talc, lactose).

Obviously, the solution of the problem of increasing the efficiency of the processes of preparation of pharmaceutical mixtures is possible by developing and creating equipment that combines the execution of the above technological operations into a single system [2].

3. Development and research of a vibrating equipment

On the basis of the analysis of the process of shredding of pharmacological materials the task was to develop a fundamentally new vibration equipment, which could realize the idea of integrated implementation of processes of crushing and mixing of bulk materials.

Constructive implementation of the equipment is presented in Fig. 1.

Fig. 1. Construction of a vibration equipment. Phytomixture material before a) and after b) processing.

The principle of this equipmentis to combine the vibration and rotation of the working container in relation to two mutually perpendicular planes. In turn, the working container consists of dividing

sections, for shredding and mixing of the processed material. In the section for crushing, there are crushing balls.

In the process of grinding, the size of the particles is reduced, they begin to be classified: particles that have fewer sieve openings – enter the mixing compartment, others – before regrinding.

Such a combination of technological and constructive factors can significantly increase the degree of destruction of particles and their simultaneous mixing with additional components, creating an effective comprehensive impact on the material being processed.

4. Results of experimental studies

Experimental studies were carried out using valerian roots, melissa leaves, peppermint and hawthorn fruit as a material for processing.

On the basis of the experiments, the dependence of the amplitude of the oscillations on the parameters of the labor force of the forced force F = 3.6 kN was obtained from which it is evident that with increasing angular velocity ω, the curve of the analytical amplitude of the fluctuations of the container A is divided into three zones. First – resonance, in which there is a gradual increase in the amplitude A = 3 mm in the range of values of the angular frequency ω = 0-36 rad·s^{-1}. The second – resonance, where the maximum value of the amplitude A = 7.8 mm is observed at ω = 36-60 rad·s^{-1}. Third zone – after resonance, the amplitudes of oscillations in the range A = 2.0-2.2 mm are stabilized. With the increase of the load of the total volume of the working chamber of the vibration equipment, the peak values of the amplitude of oscillations, namely during the period of resonance, decrease as a result of the growth of the dissipative forces of the technological environment. The analysis of the experimental dependence of the velocity of oscillation of the oscillation of the executive body on the vibration equipment from the angular velocity showed a peak value of 350 mm·s^{-1} as a result of the resonant phenomenon at 45 rad·s^{-1} . While the vibration acceleration of the executive body of the vibrating equipment acquires its maximum values a = 24-28 m·s^{-2} also at 45 rad·s^{-1}. We also conducted a series of experiments to determine the effect of the oscillation frequency of a vibration equipment on the qualitative characteristics of the investigated process.

Analyzing the relationship between the efficiency of material shredding and the frequency of oscillations of a equipment, one can conclude that the increase in the specific surface of the material increases with the frequency of oscillations due to the increase in the magnitude of the impact pulse crushing balls. At the same time there is a decrease in the area of the treated material, as well as processing time depending on the physical and mechanical parameters of raw materials.

On the basis of the obtained data on the kinetics of material shredding, it was concluded that the efficiency of the process to a large extent depends on the amplitude-frequency parameters of the equipment. However, it should be noted that the technological load in the form of balls with a diameter of 12-18 mm is better to use for rough grinding. Although for fine grinding it is better to use small diameters – 6-9 mm, which leads to an increase in the number of collisions with the material and reduce the probability of its aggregation. It can also be concluded that the greatest productivity of the grinding process is achieved when the balls are loaded at 75-80% of the total volume of the chamber. However, the results of experimental data show that when the filling of the technological environment reaches 50% of the total volume of the chamber, the energy consumption remains constant. However, when the amount of technological environment is 75-80%, energy costs are rising sharply.

The productivity of the developed equipment is 450 kg·h^{-1}. The specific surface of the crushed material is 4080-4190 cm^2·g^{-1}. Homogeneity of the resulting mixture is 98-99%.

Acknowledgements

We want to express our deep gratitude University of West Bohemia in Pilsen for all-round support in scientific activity.

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