PRINCIPLES OF THE THEORY OF WORKING OUT INTENSIVE PROCESSES OF DRYING AND GRINDING OF BIOLOGICAL PRODUCTS

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SUMMARY: Using system approach to describing combined processes of drying and grinding of moist material the results of solving the problem of changing dynamics of particle moisture content field are given.

INTRODUCTION: The current development of drying technology is characterized by the combination of drying with other processes including the combination of drying and grinding processes of moist material in one apparatus. Complex phenomena take place during drying and grinding processes: size and specific surface alteration of the material being processed as well as the change of thermal physical and structural mechanical characteristics due to heat and mass exchange between the medium and disperse material. As the final aim of the processes which occur in the drying-and-grinding apparatus is obtaining the disperse material of predetermined final moisture content and particle size one should take place into account the change of temperature and drying agent moisture content in the apparatus, the change of particle moisture content and material temperature along the length of the drier during studying the combined process of drying and grinding. In studying combined processes the application of systematic analysis as investigation strategy and mathematical simulation as investigation method is the most promising one.

MATERIALS AND METHODS: System analysis is carried out at 5 hierarchy levels: the investigation of the drying object at atomic-molecular level (the first level); the research of heat and moisture transfer in a single particle (the second level); the investigation of outer changes in heat and mass transfer in the process (the third level); the investigation of the particle inside the apparatus taking into account the change of the particle size distribution function (the fourth level); the connection of the above-mentioned phenomena with design features of the apparatus (the fifth level). Mathematical simulation is carried out in five stages: 1 - the formulation of physical model of the process; 2 - mathematical description of the process (the basis equation and boundary conditions); 3 - the transformation of mathematical description into computer algorithm; 4 - the solution of key problem; 5 - the validation of physical model of the process for adequacy of the solution received.(1). In order to solve the equation in a unique manner it is necessary to apply the law of interaction between material surface and the environment (boundary condition) and moisture distribution inside the material in the initial time moment (initial condition).(2) The initial condition reflects assymetric heating of the particle (the coordinates take their origin on the surface). For solving the problem of complex interconnected processes of grinding and drying

taking into account the changes in the body temperature and moisture content along the length of the apparatus it is promising to apply a combined (zonal) method, the idea of the method is as follows. The duration of the whole drying process is a continuous chain of τ_{np} small enough time intervals (microprocesses).(3), $\Delta\tau_i$.

RESULTS AND DISCUSSION: Thermal physical phase parameters and coefficients of interphase transfer may be obtained in i microprocess as constant but they may abruptly change in going from one microprocess to the other; combining in sequence the solutions for all zones of the drying apparatus along the length of the apparatus it is possible taking into consideration the variables of thermal physical characteristics under the conditions of changing medium parameters to get a complete pattern of the development of moisture content and temperature fields in the material.

CONCLUSION: Therefore analytical solution of boundary problem of non-stationary heat transfer for i microprocess followed by the application on numerical method of process description in the apparatus is a special feature of the combined (zonal) method. Study of combined processes with application of system analysis gives an idea of intensification mechanism and allows to shorten the duration of process. That allows to improve the quality of products produced.

$$\frac{\partial U(z,\tau)}{\partial \tau} = a_m \frac{\partial^2 U(z,\tau)}{\partial z^2}, \quad (1)$$

Differential equation of moisture content

$$U(z,0) = U_0(z),$$
$$U(0,\tau) = U_p,$$
$$U(R,\tau) = U_p, \quad (2)$$

where is equilibrium moisture content

$$\tau_{np} = \lim_{\Delta\tau \to 0} \sum_{i=1}^{n} \Delta\tau_i, \quad (3)$$