Computer simulation of drying granules in a fluidized layer

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Комп'ютерне моделювання процесу сушіння грануляту у псевдозрідженому шарі

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***Анотація*—The simulation model of drying granules in a fluidized layer was developed. On the basis of computer models conducted an experiments and designed the basic parameters, factors and dependences, to optimize the corresponding process.**

***Abstract*—Розроблена імітаційна модель процесу сушіння грануляту у псевдозрідженому шарі. На основі розробленої моделі проведений комп'ютерний експеримент і розраховані основні параметри, фактори і залежності, що дозволяють оптимізувати відповідний процес.**

Ключові слова*—*математична модель, псевдозріджений шар,імітаційна модель, сушіння грануляту, технологічний процес.

Keywords*—*mathematical model, fluidized layer, simulation model, granules, technological process.

I. INTRODUCTION

Drying in fluidized layer - the best way to monitor, uniform drying granules. This process is characterized by a number of parameters: quality and quantity of raw material and finished product, temperature and relative humidity of environment, product residence time in the dryer and others.

The essence of the drying process that takes place in a fluidized layer, is next: the passage of a certain rate of warm air goes through a layer of granular material (grain, chips, etc.), a layer of particles obtains properties of liquidity and resembles a boiling liquid. With such an active mixing of warm air and granular material the drying process becomes more intensive [1-3].

II. PROBLEEM SETTING

Model understanding of the process of drying of dispersed materials in fluidized bed insufficiently developed, due to the complex, heterogeneous structure of layer and the insufficient degree of scrutiny it hydrodynamics movement phases.

According to the above, material balance equations for dryers, heat balance equations for dryers, as well as for each component are presented in the form of equations (1) - (6):

$$\frac{dM}{dt} = m_1 - m_2 + m - m_{n2}\ , \qquad (1)$$

$$\frac{d(McT_4)}{dt} = mT_2c_D - m_{n2}c_{par}T_4 + m_1T_1c_{gr} - m_2T_3c_{gr}\ , \qquad (2)$$

$$\frac{d(MC_3)}{dt} = m - m_{m2}C_D \qquad (3)$$

$$\frac{d(MC_3)}{dt} = m - m_{m2}C_Д \quad \frac{d(MC_e)}{dt} = m_1C_B - m_{n2}C_e - m_2C_{B1} \qquad (4)$$

$$\frac{d(MC_g)}{dt} = m_1 C_g - m_2 C_g \qquad (5)$$

$$\frac{d(MC_B)}{dt} = m_1 C_B - m_2 C_{B1} - m_{n2} C_e \qquad (6)$$

where dM/dt - rate of change of mass, m_1 - the consumption of moist granules, that goes into the apparatus, m_2 - consumption of dry granules, that goes out from the section, m - consumption of the heating air, m_{n2} - the consumption of the heating air, that goes out from the section, c_D – heat capacity of the air, c_e - heat capacity of the heating steam, c_g - heat capacity of the granules, c_B – heat capacity of the humidity, C_D - concentration of the air, C_e - concentration of the steam, $C_Г$ - concentration of the granules, C_B - concentration of humidity m_1 – the consumption of moist granules, that goes into the apparatus, m_2 – the consumption of dry granulate that comes from section; T_2 - temperature of the heating air, T_4 - temperature of the pair, that goes out from section, $c_{par} = c_D \frac{c_D}{\rho_D} + c_e \frac{c_e}{\rho_e}$, $c_{gr} = c_g \frac{c_g}{\rho_g} + c_B \frac{c_B}{\rho_B}$ - heat capacity of the steam, that goes out from section, T_1 - temperature of the moist granules, T_3 – the temperature of dry granulate, c_D - heat capacity of the heating air, c_{par} - heat capacity of the steam, that goes out from section, c_{gr} – heat capacity of granules.

The solution of equations were looked up by the following data: m_1=6,33 kg/s; m_2=5,56 kg/s; m_{n2}=68,9 kg/s; c_D=1,009 kJ/kgK; c_e=1,9 kJ/kgK; c_g=1,25 kJ/kgK; c_B=2 kJ/kgK; ρ_D=0,973 kg/m^3; ρ_e=0,5 kg/m^3; ρ_g=1610 kg/m^3; ρ_B=972,69 kg/m^3; T_1=18 ^{0}C; T_2=90 ^{0}C; T_3=50 ^{0}C and the corresponding to initial conditions.

III. PROBLEM SOLUTION

The solving of the problem of modeling of technological process of drying granulate was carried out by construction of a simulation model. The algorithm of the program, the software and simulation model were developed.

The application package Simulink Matlab was used to implement the mathematical model of the process:

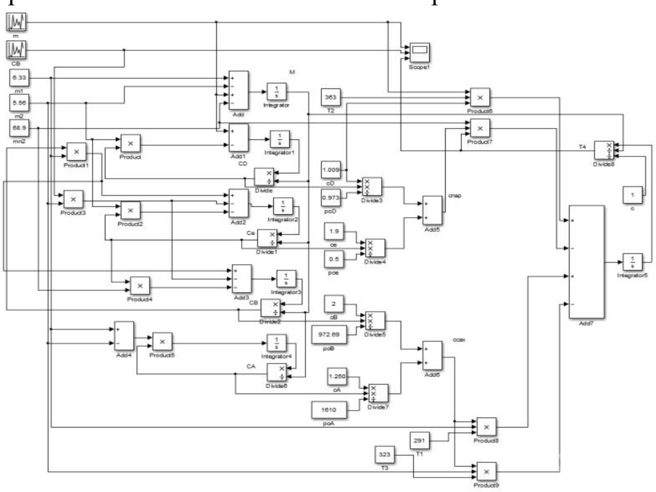

Fig. 1. A simulation model of dry granulate

As a result of simulation we obtained:

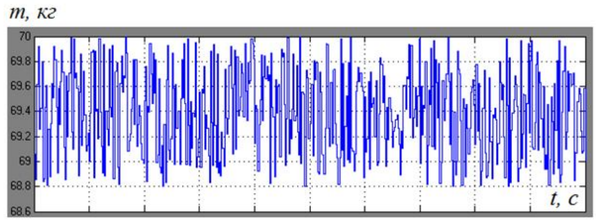

Fig. 2. Changing the heating air mass

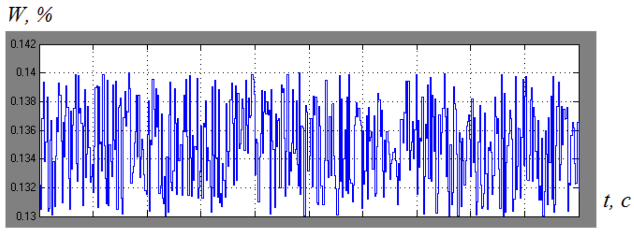

Fig. 3. Changing the concentration of humidity in the granulate

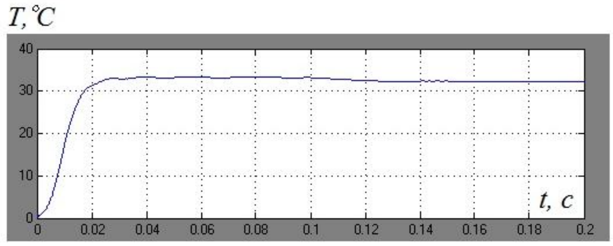

Fig. 4. – Changing the temperature of the heating air

As we can see from Fig. 2-4, the maximum warming air mass does not exceed 70 kg, the concentration of humidity in the granules should not exceed 0.14 %, and the optimum temperature of heating air in the device is no more than 32 °C

CONCLUSIONS

A mathematical model was build. It describes the dependence of mass change of heating air, changing the concentration of humidity in the granules, changing the temperature of the heating air. The solution of mathematical model was found by using the application package Simulink Matlab.

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