DRYING OF MINERAL FERTILIZERSRESEARCH OF HYDRODYNAMIC PROCESSES

Akhunbaev Adil
Fergana Polytechnic Institute, Fergana Uzbekistan

Muydinov Abdusamad
Fergana Polytechnic Institute, Fergana Uzbekistan

Abdulazizov Abdulloh
Fergana Polytechnic Institute, Fergana Uzbekistan

Xoshimov Avzabek
Fergana Polytechnic Institute, Fergana Uzbekistan

Xalilov Ismoiljon
Fergana Polytechnic Institute, Fergana Uzbekistan

Alizafarov Bekzod
Fergana Polytechnic Institute, Fergana Uzbekistan

Xusanboyev Muhammadbobur
Fergana Polytechnic Institute, Fergana Uzbekistan

Ortiqaliyev Bobojon
Fergana Polytechnic Institute, Fergana Uzbekistan
E-mail: b.ortiqaliyev@ferpi.uz

Annotation

Thermal drying is one of the most energy-intensive processes in the entire technological chain of processing mineral fertilizers and is a necessary process to achieve the desired quality of finished products. The cost of thermal drying is 10% of the total cost of processing. In such conditions, it remains an urgent task to create highly efficient, energy-saving drying regimes and to solve drying apparatuses, first of all, by regulation and optimization of heat exchange processes.

Keywords: drying, process, materials, quality, transferred, convective.

Introduction

It is known that the drying process of materials depends on its humidity, the size of the material particles and the way they move in the drum, the hydrodynamic conditions of the movement of the particles with the drying agent, and the environmental parameters. The combination of these factors determines the conditions of the drying process.

Research object and method.

It is known that there are two types of heat exchange in a drum dryer - contact and convective methods. However, a large amount of heat transferred to the dried material is carried out by convective heat exchange. The amount of heat transferred to the material being dried in a drum dryer by convective method is up to 20 times higher than the amount of heat transferred by contact method. The intensity of convective heat transfer in a drum dryer, in turn, directly depends on the opening of the particle surface [1-3]. The more the material spreads over the surface of the drum, the greater the surface area of the particles exposed to convective heat exchange. Summarizing the above, we see that The drying efficiency of mineral fertilizers in a drum dryer depends significantly on the uniformity and surface of the dried material film falling from the nozzles of internal drum devices. The main purpose of internal devices of the drum is to ensure the scattering of particles across the section of the drum.Based on the above, in order to intensify the drying process of superphosphate fertilizer and increase the heat exchange surfaces, a constructive scheme of the nozzle forming heat exchange surfaces was developed and a laboratory copy of the dryer was created. Figure 1 shows an overview of the experimental setup [4-9].

The principle of operation of the dryer is as follows:The product is transferred to the dryer through the hopper (1). A hatch (2) is installed in the lower part of the bunker (1), which performs the function of measuring the product to be dried. When the product enters the dryer, it moves due to the angle of inclination of the dryer relative to the plane and the rotation of the drum, and passes between the nozzles (4) installed in the inner body of the dryer (3) in a zigzag manner. The blade-like surface of the nozzle carries the product to be dried up along the diameter of the drum (5), and when it reaches its highest point, the product flows down the nozzle blades [10-15].

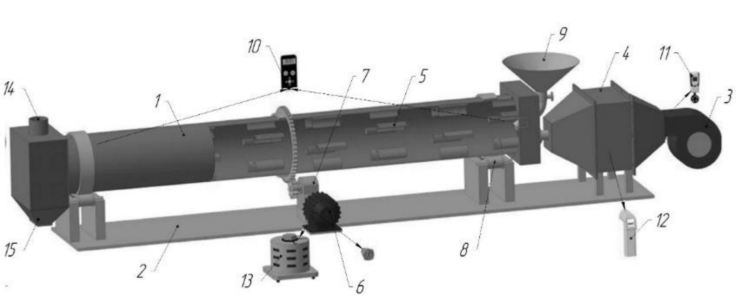

Figure 1. General view of the drum dryer. 1-dryer body; 2nd base; 3-fan; 4-calorifer; 5th nasadka; 6-electric motor; 7th reducer; 8th base roller; 9th product hopper; 10-electronic pressure gauge; 11th anemometer; 12-electronic thermometer; 13th LATR; 14th smoke pipe; 15th product discharge hopper.

The fact that the nozzle is installed in the inner body at an inclined angle relative to the horizontal axis of the dryer ensures an increase in the heat exchange surface. This, in turn, increases the opportunity to use the entire working surface of the dryer. The heat agent is transferred through the heater (6) installed in the product inlet part of the dryer. The product and the heat agent are in contact during the flow down and down the nozzle of the dryer. The product, which has undergone complete heat exchange process, is discharged from the discharge part (15) of the dryer. Among other technical measures designed to expand the curtain area, the checkerboard arrangement of the nozzles and the scalloped edge of the nozzle are used [16-20].

Research results

The following limits of variable factors for conducting research are the installation angle of the nasdka relative to the horizontal axis of the drum b=15 30 and 45o, The speed of the heat agent coming out of the radiator y= 1.4÷14.2 m/s, The device's efficiency Qunm =0.18÷0.46 kg/s, The angle of inclination of the dryer drum to the plane a=3÷10% , the frequency of rotations of the dryer drum is set n=2÷4 revolutions/min. Experimental studies were conducted in two stages on the influence of the proposed design of the device nozzle on the hydraulic resistance and its dependence on the heat exchange surface.

The following limits of variable factors for carrying out studies, the slope of the part of the discharge of the material of the nasdka R=15; 30 and 45o, the number of heat exchange zones is 5, the number of nozzles in one row is 5 (the nozzles are arranged in a checkerboard row by zone), the speed of the heat agent (air) coming out of the radiator is y= 1.4÷14.2 m/s, the operation of the device productivity Qunm =0.18÷0.46 kg/s, the angle of inclination of the dryer drum relative to the plane a=2.24gr (according to the technological regulation), the frequency of rotations of the dryer drum was set n=4 revolutions/min. From the JM-510 electronic measuring device in the experimental determination of hydraulic resistance [21-35]. A sample of experimental results is presented in Figure 6.

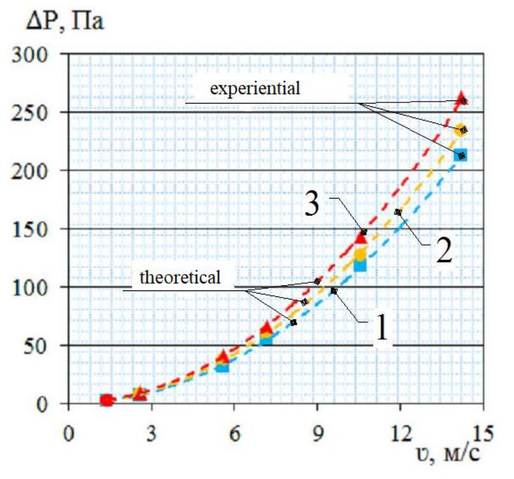

Figure 2. Dependence of hydraulic resistance on gas velocity (Q=0.18 kg/s).

1-the slope of the material pouring part of the nozzle R=15o; 2-slope of the material pouring part of the nasdka R=30o; 3-the slope of the material pouring part of the nasdka R=45o

2- the graphical relationships presented in the pictures can be expressed by the following regression equations determined by the method of least squares;
The slope of the material pouring part of the nasdka is R=15o
$y = 1.037x2 + 0.3127x - 0.7683$ $R^2 = 0.9999$ (12)
$y = 1.1507x2 + 0.0772x + 0.1076$ $R^2 = 0.9999$ (13)
$y = 1.3233x2 - 0.3806x + 0.7827$ $R^2 = 0.9987$ (14)
The slope of the material pouring part of the nasdka is R=30o
$y = 1.8813x2 - 0.2381x + 0.3982$ $R^2 = 0.9971$ (15)
$y = 2.1493x2 - 0.5588x + 0.8606$ $R^2 = 0.9846$ (16)
$y = 2.1493x2 - 0.5588x + 0.8606$ $R^2 = 0.9923$ (17)
The slope of the material pouring part of the nasdka is R=45o
$y = 2.7308x2 + 0.0846x + 0.1638$ $R^2 = 0.9871$ (18)
$y = 2.7308x2 + 0.0846x + 0.1638$ $R^2 = 0.9924$ (19)
$y = 2.9072x2 - 0.2993x + 0.682$ $R^2 = 0.9904$ (20)
Summary
The nozzle design of the drum dryer used in the fertilizer production, its performance parameters, the nozzle system with different designs were analyzed, and the improved design of the nozzle was determined based on the analysis. It was recommended to have two parts. The proposed design of the nozzle was used in real production conditions and it was experimentally determined that it fully meets the requirements of the technological regulation [36-48]. Based on the systematic analysis of the constructions of different nozzles installed on drying drums using the MATLAB program, the advantage of the two-part nozzle was justified and its main parameters were determined. The optimal dimensions of the installation of the two-part nozzle and the parameters that increase the filling coefficient of the drum surface were determined based on them. The hydraulic resistance of the gas velocity in the drying drum was found to optimize the granulometric composition of the fertilizer when using a two-part nozzle.

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