Journal of the Technical University of Gabrovo, Vol. 47'2014 (23-25)

ИЗВЕСТИЯ
на Технически университет
Габрово

WAY OF COOLING WITH THE HELP OF THE AIR – PULSATION METHOD

СПОСОБ ОХЛАЖДЕНИЯ С ПОМОЩЬЮ ВОЗДУШНО – ПУЛЬСАЦИОННОГО МЕТОДА

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Received 25 November 2013, Received in revised form 9 March 2014, Accepted 17 March 2014

Abstract

This article presents an approach to cooling by means of the air-pulsation method. The mechanism for creating a pulsation has been explained. The operating schedule of the mill, results of experiments and efficiency of the cooling system have been shown.

Key words: a mill, shutter, a pulsation, food, moisture movements, air, a capillary.

INTRODUCTION

Processes of crushing of materials are widely applied in the food and chemical industry. The necessary intensification of process of crushing can be reached only on the basis of profound knowledge as principle of action and design of the corresponding equipment, and properties of its exploitation.

On the basic way of mechanical influence on a material crushing machines can be divided into splitting, crushing rubbing and colloid grinders. Depending on a design cone, shaft and hammer crushers, drum-type, ring (roller-pendular), spherical vibrating and jet mills are distinguished. At the food enterprises hammer crushers (machines of blowing action) used for receiving of a mixture of crushed particles are distributed greatly. They are effective at destruction of fragile materials (granulated sugar, salt, grain, etc.) and are less effective at crushing of damp products with the high content of fat. In such machines destruction of a product is resulted from of steel hammers, of particles of a product about a casing of a crusher and rubbing away them on the stamped sieve which is the basic part of the case of a crusher [1].

Existing ways of receiving of powders consist of two stages: drying and crushing. They are bulky in hardware registration, power-intensive, enduring. The way of receiving of the cooled weight is realised by means of air which is forced by means of the fan and by means of applying of a water stream on external side of a mill. It can be applied for crushing jerusalem artichoke [2-4].

The supercharger of air, distinguished an with elevated pressure, in comparison with internal pressure of a chamber of crushing on 20-35% also is applyed to a grid in a chamber. Usually at absence of a cooling stream at the expense of kinetic energy in existing mill and blowing of particles of air about metal surfaces there is a heating and grid temperature increases to 90 ^{0}C and above. It is known that Caramel inulin occurs at temperature 70-80 ^{0}C. For this reason it is necessary to reduce formations of firm coverings over a surface of a grid and mill walls. The cooled grid in our way is exposed to influence on acoustic impulses which are generates with the fan with rotating shutter. Not to reduce efficiency, the fan of the type capacity for preservation of kinetic and potential energy of air is established. This energy in used at each start (at opening shutter) in the chamber.

STATEMENTS

Automatic rotation shutter is realised for the account of non-symmetric actions of a stream of air and air impulse on a rough surface. The rotary motion of a shutter is formed as a result. But in purpose it has not got fixed position, a part of weight which is more in comparison with cutted part, upper is made 50% thicker and thanks to existence of the chamber with capacity the formed depression allows to lose stability and to continue a rotary motion (fig. 1).

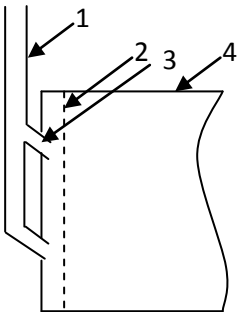

Figure 1. *Installations of tubules for blowing off of grids: 1-air pipe; 2-grid in a mill; 3- air stream in the chamber at an angle of 20-45 °, i.e. an angle depends on speed of air and a backlash between a grid and a chamber wall; the mill 4-case*

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Technical characteristics of air cooling:

1. The forcing System consists of the fan with capacity of 0,5-0,8 Vt;
2. Shutter has the circle shape where partial cutting of a segment is done a diameter of an shutter 1/3R;
3. Diameter of the big tube is 50 mm;
4. Diameter of a small tube is 30 mm;
5. The Backlash between a tube of a wall and shutter is 2 mm;
6. Volume in capacity is 1,5 l, the steel cylinder.

In particular, the method has been offered and approved, allowing to establish generators of low-frequency elastic waves in the mill chamber. It has been realised as follows. It is known that in a pressure chamber the stream of air forced by a fan. Between the fan and a drum the shutter has been installed by the, capable to close a gas stream, thereby to increase pressure of gas to shutter. Rotation of on shutter allows to receive harmonious signals in the form of pressure differences. For increase of efficiency of a design it is offered to install a tank between shutter and the fan. It will allow to save up potential energy of compression in a tank installed to shutter, during that phase an shutter is closed, as a result energy of compression in the given tank is accumulated as the condenser. At opening shutter to force of the fan, the reserved weight is made or compulsorily added pressure of gas or air of which are in the compressed kind [5-6].

Such mechanism allows to create pulsation a mode, thereby creates possibility of cooling and favorable conditions of a separation of the saved up firm weights on a grid surface (fig. 2-3).

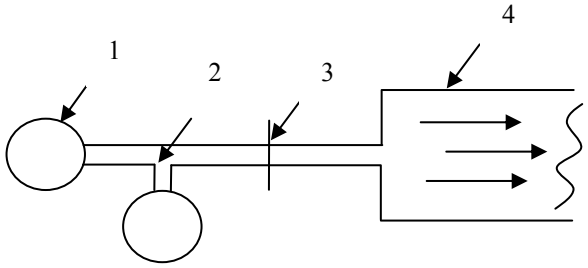

Figure 2. The scheme of air pulsation mode for a mill:
1-fan, 2-tank for accumulation of energy compression, 3-rotating shutter, 4-chamber of a mill.

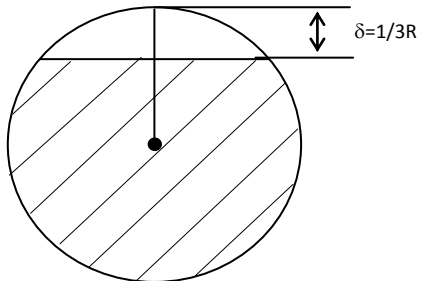

Figure 3. *A frontal type of shutter for automatic rotation*

Experiments have shown that air pulsation mode effectively works for porous materials, as for firm materials as root crops or large segments of agricultural products system of effectiveness decreases and time of drying is decreased to 5%. For leaves and branches jerusalem artichoke drying time decreases to 15 %.

The author has made experiments on applying pulsation an ordinary valve applied for closing and opening of heated masses of gas, rotates by means of the low power electric motor. Frequency of rotation of an shutter of a pipeline has been defined proceeding from the average sizes of lumps. A complex lump filled with air in leaves and branches of jerusalem artichoke, is deformed under the influence of waves of compression and decompression if in environment has a running wave. For example let the average value of the big lumps is 16 sm. Then it is easy to understand that their compression or decompression occurs during a half-cycle of fluctuations and the length during a half-cycle is called as a half wave $\lambda/2$. It is known, $\lambda=CT=C\cdot 1/\gamma$, where γ-frequency of fluctuations (fig. 4).

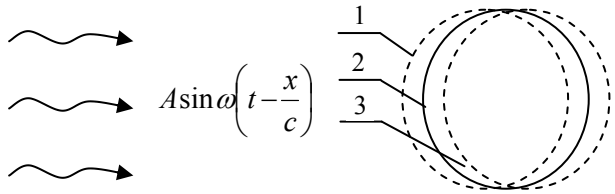

Figure 4. *The scheme of falling of a flat wave on a material: 1-amplitude of expansion of a lump, 2-equilibrium position, 3-amplitude of compression of a lump*

It is known that the structure of dehydrated object is multicomponent. There are possibilities of capillary movement of a moisture under certain conditions. In particular, scalding root crops leads to formation of cracks that accelerates drying. Let consider the mechanism of action of difference of pressure in time intervals of t_1 and t_2. Let there is a certain capillary (fig. 5). It is known that humidity on a surface of jerusalem artichoke particles at certain a moisture tend to formation. For this reason removal of a moisture from blankets of particles of jerusalem artichoke reduces formation of firm masses. Let consider efficiency of cooling system as a remover of from moisture blankets of particles of jerusalem artichoke.

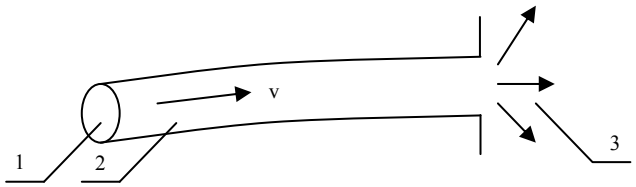

Figure 5. *Movement of moisture in capillaries inside jerusalem artichokea:*
1-area π^2R, and length of a circle 2 πL;
2-environment moving with speed V; 3-external pressure, which permanent at time t_2-t_1.

Let's write Newton's equation for a capillary tube (fig. 5):

$$S\rho\frac{dv}{dt}=S\Delta P-2\pi L\cdot\mu v \qquad (1)$$

Where: μ-factor of cohesion "liquid-wall" on perimetre which is equal to 2πL; μv - corresponds to force of resistance against liquid movement. Then we get:

$$\dot{V} + 2\frac{\partial}{L}V = \Delta P \qquad (2)$$

Where ΔP - at deep consideration is a part of the general task where all interactions are considered.

But for the purpose of bulkiness reduction, we assume that

$$P = P_0\theta(t - t_1)\theta(t_2 - t) \qquad (3)$$

Where t_1-time of starting-up of low pressure, t_2-time of the end of work of a vacuum pump.

We have the solutions,

$$V = V_0 e^{-2\frac{\partial}{л}t} - P_0\frac{2\partial}{л}\left[1 - e^{-4\frac{\partial}{л}(t_2 - t_1)}\right]e^{-2\frac{\partial}{л}t} \qquad (4)$$

The formula (4) shows that speed decreases at the expense of a friction and increases at the expense of a difference of pressure P_0. Decrease in radius of capillaries reduces target speed of a moisture from "neck" 1, and law - hyperbolic.

CONCLUSIONS

Indeed, certain final time is necessary for carrying of mass from depth on a surface, with of cracks. Developers have considered in (2) elasticity of walls, and presence $\Delta P=P_0$ allows to increase radius *L* at the expense of skeleton deformation under of the Hooke's law.

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