TO QUESTION THE DESIGN OF THE MODEL SERIES ELECTROMAGNETIC MECHANOACTIVATION

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The article presents the results of studies of electromagnetic fields in the working volume of the electromagnetic mechanical activators (EMMA). Abstract design modification devices, representing the most common group - the group of cylindrical EMMA. Based on research developed a method of constructing the electromagnetic field in the working volume model series EMMA. The presented method allows you to build a magnetic field in the working gap electromagnetic mechanical activators cylindrical structures and define parameters field (induction and tension) at any given point of the working gap, in which the force contact interaction between the ferromagnetic layer through the grinding elements of the processed product. The method used in the design type series EMMA designed for fine grinding of liquid and semi-liquid disperse systems in the agricultural, food and paint industries.

Electromagnetic mechanical activators, the structure of the magnetic field, the method of calculation

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Introduction

A method of forming a grinding effort using a constant electromagnetic field is implemented in various hardware design of electromagnetic mechanical activators (EMMA) [1]. EMMA different design and material of the magnetic circuit, the number of control windings, and their location with respect to the axis of the device, the amount and form working chambers and a structure of grinding bodies and the material properties of the magnetic filler working volume [2]. Analysis developed constructive forms EMMA intended for treatment of liquid, semi-liquid and bulk powders revealed that the most expedient is the integration of these devices into the following three main groups: the cylindrical structures in which the working volume is formed by one or several cylindrical surfaces arranged coaxially or asymmetrically ; disc with a working volume containing a single disc or formed is shifted relative to each other surfaces of multiple drives; uniform working volume formed in a ring shape, cone or polygonal shape in cross-section chamber. EMMA division into three main groups on these design features provides the most dramatic difference in their performance and imposes severe restrictions on possible applications.

Objective:

Development of a technique of construction of the electromagnetic field in cylindrical working volume model series EMMA.

Material and methods:

The subject of research is the magnetic field in the working volume of the cylindrical EMMA performance. The method of integral equations.

Results and discussion:

The priority in the new research direction of the electromagnetic method of mechanical activation belongs to the development of devices with a cylindrical working chamber execution. According to the adopted classification [1,2], these machines are a group of cylindrical devices with unipolar DU coaxially arranged rotor and containing a grinding chamber. The difference lies in the amount of rotor poles and coils OC. Thus, in the W-EMMA (Figure.1), representing the subject of the invention (Russian patent № 1457881), introduced an additional OC, contributing to strengthening contact between the grinding elements and the creation of the specified security conditions for semi-finished grinding process of chocolate production with an increase in the working volume of the chamber system. The studies revealed that the device can also be effectively used for fine grinding of liquid and semi-liquid disperse systems in the agricultural, food and paint industries. [3]

For the calculation and design of typical EMMA series for hardware and technology of raw materials processing systems, the method of construction of electromagnetic fields in the volume of product processing.

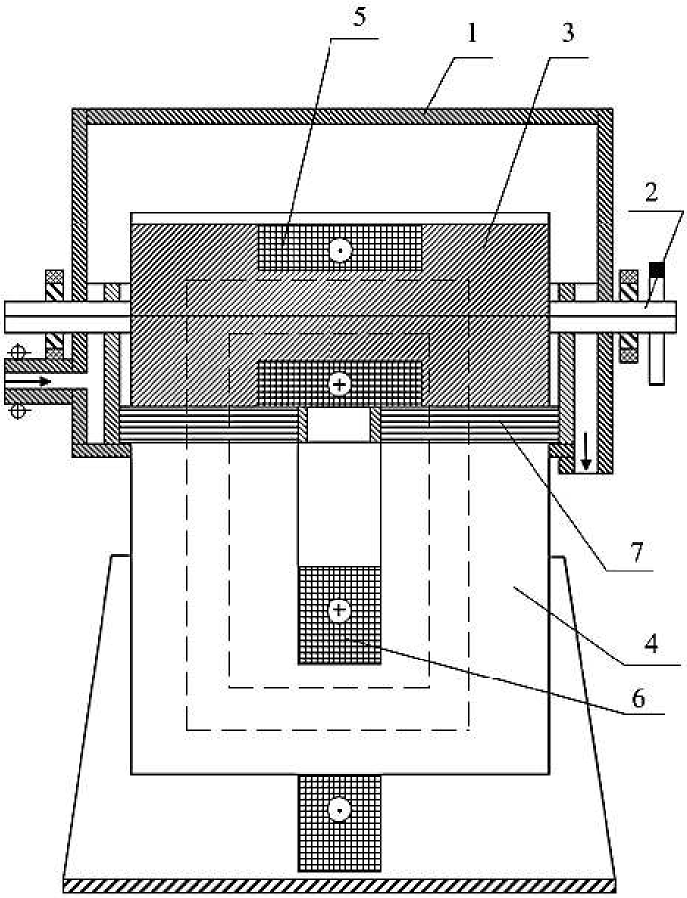

Figure 1- constructive scheme electromagnetic mechanical activators

I - the body; 2 -rotor; 3 - cylinder; 4 - External magnetic, 5.6 -winding management; 7 - cylindrical grinding body

The method of integral equations [4]. Ferromagnetic rotor EMMA replaced by the current sheet $\sigma(Z)$. In this case, the total capacity of the vector $A_\varphi(r, Z)$ magnetic field equality

$$A_\varphi(r,z) = A_\varphi^*(r,z) + A_\varphi^{**}(r,z), \tag{1}$$

где A_φ^* - potential field created by the winding;

A_φ^{**} - potential field produced by the current layer.

$$A_\varphi^*(r,z) = r_0 \int_{-c}^{c}\int_{0}^{2\pi} \frac{\sigma(z_Q)\cos\varphi d\varphi dz_Q}{\sqrt{r^2 - 2rr_0\cos\varphi + r_0^2 + (z_Q - z)^2}} \ . \tag{2}$$

When changing the magnetic field lines through the side surface of the rotor EMMA tangential component of the field is continuous. For the projection of the magnetic induction vector B_Z^* we have the current sheet

$$B_\varphi^*(r,z)=\frac{r_0}{r}\int_{-c}^{c}\int_{0}^{2\pi}\frac{\sigma(z_Q)\cos\varphi d\varphi dz_Q}{\sqrt{r^2-2rr_0\cos\varphi+r_0^2+(z_Q-z)^2}}-$$

$$-r_0\int_{-c}^{c}\int_{0}^{2\pi}\frac{\sigma(z_Q)\cos\varphi(r-r_0\cos\varphi)d\varphi dz_Q}{\left[r^2-2rr_0\cos\varphi+r_0^2+(z_Q-z)^2\right]^{3/2}}\ . \tag{3}$$

The second integral is the normal derivative (ie the derivative in the direction normal to the side surface of the rotor) of the single-layer potential. It is known that this derivative jumps at the intersection of a single layer. This circumstance and allows an integral equation for the unknown density of a single layer

$$B_Z(r,z)=B_Z^*(r,z)+B^{**}(r,z)\ . \tag{4}$$

Letting r к r_0 inside and outside of the current layer, we obtain

$$B_Z^e(r_0,z)=\frac{1}{\mu}B_Z^i(r_0,z)\ , \tag{5}$$

where

$$B_Z^e=-2\pi\sigma(z)+B_Z^*(r_0,z)+B_Z^{**}(r_0,z)\ , \tag{6}$$

$$B_Z^i=2\pi\sigma(z)+B_Z^*(r_0,z)+B_Z^{**}(r_0,z). \tag{7}$$

After a series of transformations of the equation for determining the density of the current layer takes the form $\mu\left[-2\pi\sigma(z)+B_Z^*(r_0,z)+B_Z^{**}(r_0,z)\right]=2\pi\sigma(z)+B_Z^*(r_0,z)+B_Z^{**}(r_0,z)$

$$\sigma(z)=\frac{1}{\pi}\frac{\mu-1}{\mu+1}\left[B_Z^*(r_0,z)+B_Z^{**}(r_0\ ,z)\right]\ , \tag{8}$$

where

$$B_Z^*(r_0,z)=\int_{-c}^{c}\int_{0}^{2\pi}\frac{\sigma(z_Q)\cos\varphi d\varphi dz_Q}{\sqrt{2r^2(1-\cos\varphi)+(z_Q-z)^2}}-r_0^2\int_{-c}^{c}\int_{0}^{2\pi}\frac{\sigma(z_Q)\cos\phi(r-r_0\cos\phi)\,d\phi dz}{\left[2r_0^2(1-\cos\phi)+(z_Q-z)^2\right]^{3/2}}. \tag{9}$$

For submission to the elements of Figure 2 of the magnetic field source of the projection of the magnetic induction vector B_Z^{**}, defined by the following equations:

$$B_Z^{**}(r_0, z) = \frac{I}{2\pi(r_2^2 - r_1^2) r_0} \int_{r_1}^{r_2} \int_{-\alpha}^{\alpha} \int_{0}^{2\pi} \frac{r_Q \cos\varphi d\varphi dz_Q}{\sqrt{r_Q - 2r_Q r_0 \cos\varphi + r^2 + (z - z_Q)^2}} -$$

$$- \frac{I}{2\pi\alpha(r_2^2 - r_1^2)} \int_{r_1}^{r_2} \int_{-\alpha}^{\alpha} \int_{0}^{2\pi} \frac{r_Q (r_0 - r_Q \cos\varphi) \cos\varphi d\varphi dz_Q dr_Q}{\left[r_Q^2 - 2r_Q r_0 \cos\varphi + r_0^2 + (z - z_Q)^2\right]^{3/2}}. \quad (10)$$

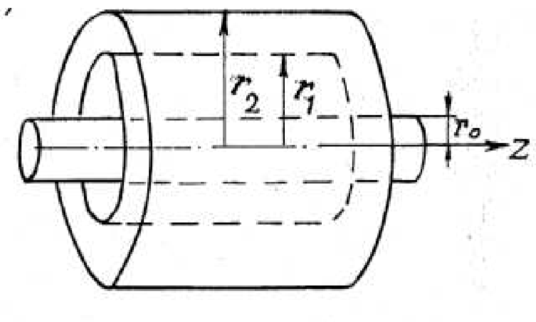

Figure 2 - The calculation of the magnetic field in the working volume EMMA:

Conclusion

The presented method allows you to build a magnetic field in the working gap electromagnetic mechanical activators cylindrical structures and define parameters field (induction and tension) at any given point of the working gap, in which the force contact interaction between the ferromagnetic layer through the grinding elements of the processed product. The method used in the design type series EMMA (RF patent № 1457881), designed for fine grinding of liquid and semi-liquid disperse systems in the agricultural, food and paint industries

References

1. Bezzubtseva MM, VS Volkov, AV Kotov An innovative way of electromagnetic mechanical activation ferromagnetic elements in magnetic liquefied layer overview // Scientific Review. Technical science. - 2016. - № 2. pp 8-13.
2. Bezzubtseva M.M, V.S.Volkov, V.A.Ruzhev Classification of electromagnetic mills // International Journal of Experimental education - 2015. - № 9. pp.103-104.
3. Bezzubtseva M.M, Volkov V.S, Obukhov K.N, Kotov A.V Determination of forces and moments acting on the grinding system of ferromagnetic elements in a cylindrical shape magnetic liquefied layer overview of the working volume of the electromagnetic mechanical activators // Basic Research. - 2014. - № 11-3. - pp. 504-508.
4. Bezzubtseva M.M, Ruzhev V.A, Volkov V.S Theoretical studies of the deformed magnetic field in the working volume of the electromagnetic mechanical activators with magnetic liquefied layer grinding elements cylindrical form // Basic Research. - 2014. - № 6-4. - pp. 689-693.