Features of magnetization of the ferromagnetic composite on an example of granulated media: Role of grain chains

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Abstract. An original approach to measuring magnetic (micro) flows along cores of different radii in a magnetized chain of ferromagnetic spheres has been developed and described. It is based on the use of radially different circular circuit sensors created using the technology of printed circuit boards and placed between contacting spheres in a chain. Such stepwise magnetic flux data also made it possible to judge the data of stepwise changes in magnetic flux in conventional tubular layers (limited by adjacent circular sensors). Based on all these data, extensive information was obtained on the magnetic parameters of the cores and "pipe-layers" of the magnetized chain of spheres (as quasi-continuous ferromagnets), namely, the values of flux density (induction) in the cores and "pipe-layers", their magnetic permeability, susceptibility, magnetization in a wide range of magnetizing field intensity. The purpose of the article is to develop a model of chain-by-chain magnetization, which makes it possible to solve a number of actual scientific and practical problems of fine magnetic separation using ferromagnetic granular media, in which chains of granules are basic elements.

Keywords: magnetic (micro) flows, magnetic flux, a model of chain-by-chain magnetization.

Introduction

The magnetic properties of different heterogeneous mediums, including ferro- and ferrimagnetic composites [1-3], for example, granular mediums, are usually studied from the standpoint of the model of the so-called effective medium when it is formally likened to quasi-continuous (throughout the volume). In relation to such heterogeneous (discrete) mediums as filling of ferromagnetic granules (used to solve scientific and practical problems), the physical model of their chain magnetization is additionally informative [4]. According to this model, the chains of granules that carry information about the magnetic properties of the granular medium as a whole (Fig. 1), in connection with which a detailed study of their magnetic properties is of independent interest.
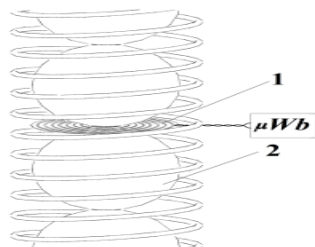

Figure 1: A chain of spheres 2 (located in solenoid) with a circular loop-sensor 1 connected to the microwebermeter

Results and discussion.

Measurements of magnetic properties (for the beginning - magnetic flux) were carried out using flow-measuring loops-sensors. They are positioned on a thin printed circuit board, and then the board is located in the plane of symmetry of the hollow volume between the spheres. Values of magnetic induction, magnetic permeability, susceptibility, magnetization were obtained in a wide range of magnetizing field intensity. To calculate these parameters, as well as to calculate the demagnetizing factor of the cores and "pipe-layers" (in relatively short chains), the corresponding phenomenological dependencies are obtained.

Acknowledgement

References

[1] Bai K., Casara J., Nair-Kanneganti A., Wahl A., Carle F., Brown E. (2018) Effective magnetic susceptibility of suspensions of ferromagnetic particles. *J Appl Phys* 124: 123901.

[2] Moore R. L. (2019) Development of a volume fraction scaling function for demagnetization factors in effective media theories of magnetic composites. *AIP Advances* 9: 035107.

[3] Yurasov A. N., Yashin M. M. (2020) Accounting for the influence of granule size distribution in nanocomposites. *Rus Techn J* 2: 59–66

[4] Sandulyak A.A., Sandulyak A.V., Shitikova M.V., Tkachenko R.Yu., Sandulyak D.A., Gorpinenko Y.O. (2021) Concentrated dispersed magnet with different relative lengths: Basic properties and characteristics (on the example of a polyspherical structure). *Mechanics of Advanced Materials and Structures*, DOI: 10.1080/15376494.2021.1943575