Magnetic separator model using Halbach array

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Abstract **The paper shortly deals with hard magnetic materials used in this application. Then, it deals with Halbach array and its possible use in magnetic separation. Also, some results of magnetic flux density distribution in separator working space are presented.**

Keywords **permanent magnet NdFeB, magnetic flux density, Halbach array, magnetic separator**

I. Introduction

Magnetic separators are of use in the field of magnetic separation. Magnetic separation is used for concentration of magnetic particles and their removal from fluids. The separation is done by passing the suspension with particles through a non-homogeneous high gradient magnetic field.

The most used permanent magnets material are sintered NdFeB magnets. They are anisotropic. But, there exist some differences between them, see demagnetization curves J = f (H) and B = f (H) in Fig. 1.

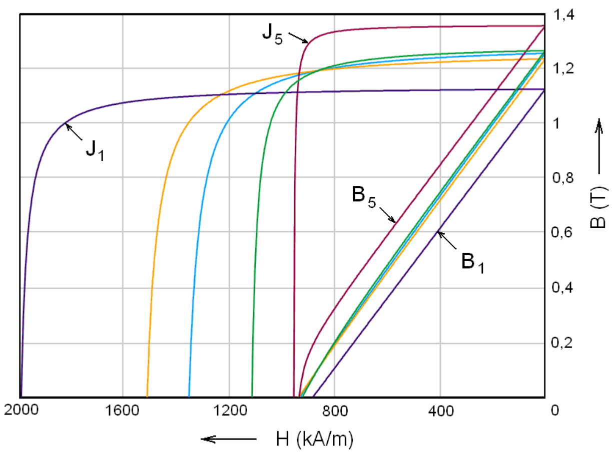

Fig.1. Sintered NdFeB permanent magnets demagnetization curves

In the presented application, it is used a sintered magnet with demagnetization characteristic near to No. 1 in Fig. 1. In some cases could be used bonded permanent magnets with demagnetization characteristics J = f (H) and B = f (H) presented in Fig. 2.

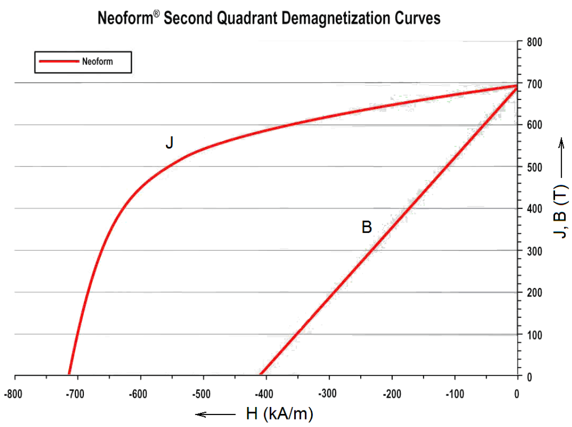

Fig.2. Bonded NdFeB permanent magnets demagnetization curves J = f (H) and B = f (H)

Many other pieces of information about permanent magnets can be found in [1].

II. Magnetic separators Configurations

Many types of magnetic separators exist, see [3], e.g. In this paper, Halbach array or two Halbach arrays will be presented as a main part of a separator.

A. One Halbach array

This array, see Fig. 3, was realized by Klaus Halbach at about the year 1980 [4].

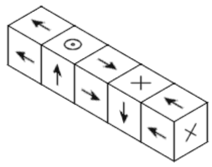

Fig.3.Halbach array. The arrow is representing the direction of permanent magnet magnetization

A Halbach array increases the magnetic field on one side of the device and decreases the field on the other side, see Figs 4. and 5.

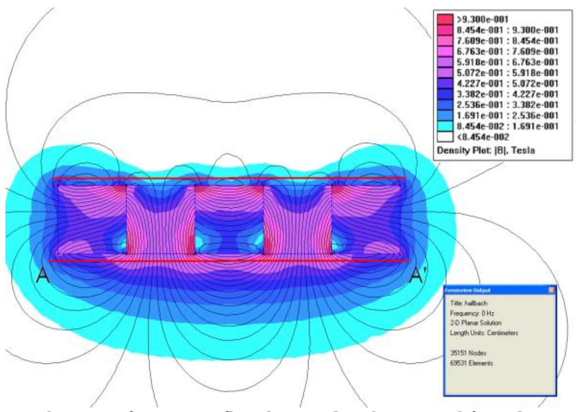

Fig.4. The map of magnetic flux density distribution and force lines with line A-A´

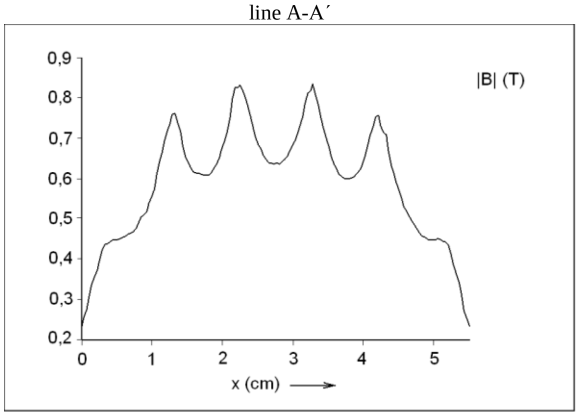

Fig.5. Magnetic flux density absolute value along line A-A´

B. Two Halbach arrays

In this case, the magnetic circuit of separator is realised by two Halbach arrays, oriented as is shown in Fig. 6. The distance between arrays is 1 cm. The cross section of used NdFeB magnets is 1 cm square.

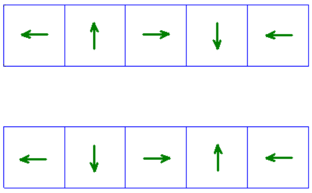

Fig.6. Magnetic circuit of model with two Halbach arrays

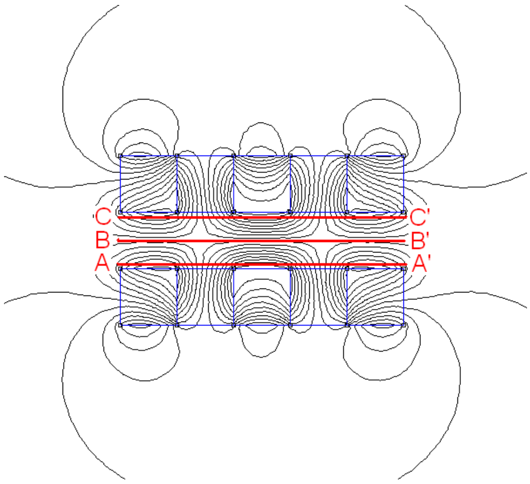

Fig.7. Magnetic force lines in discussed configuration with lines A-A´, B-B´and C-C´

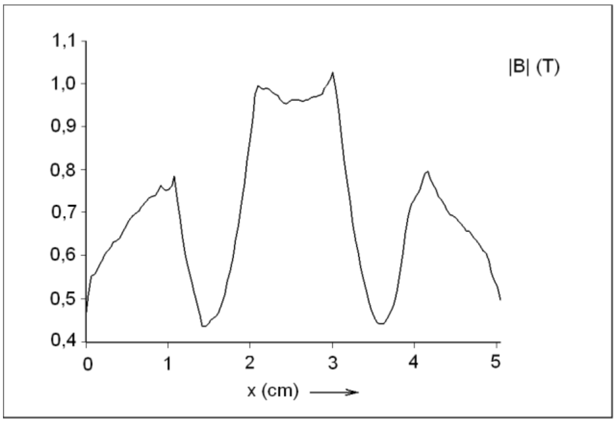

Fig.8. Magnetic flux density absolute value along line A-A´ (and line C-C´)

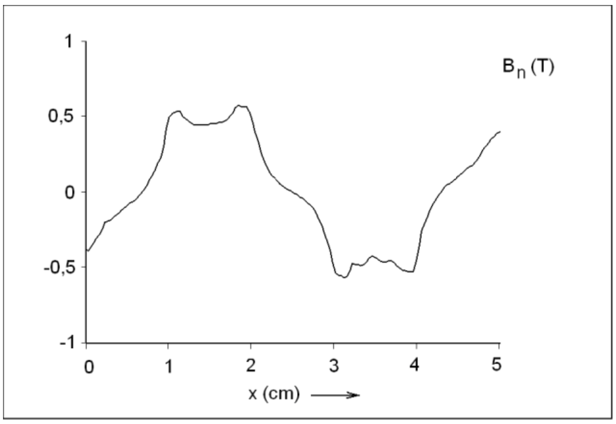

Fig.9. Magnetic flux density normal part value along line A-A´

Lines A-A´ and C-C´ are in the distances 1 mm from every array. In Figs. 9 and 10, there are presented magnetic flux density normal and tangential parts. In the Fig. 11, there is presented magnetic flux density absolute value along line B-B´.

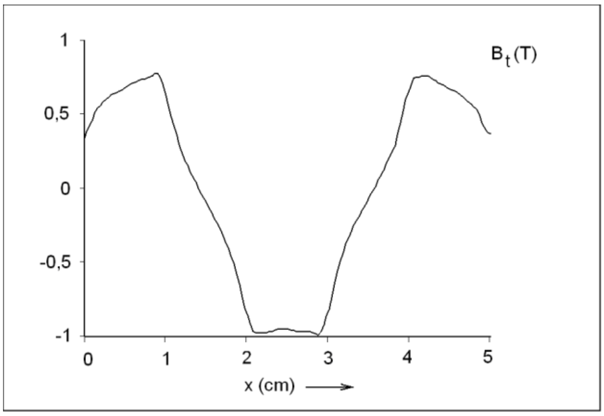

Fig.10. Magnetic flux density tangential part value along line A-A´

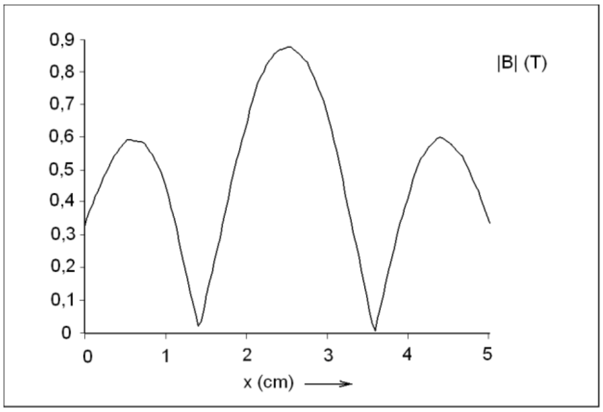

Fig.11. Magnetic flux density absolute value along line B-B´

III. CONCLUSION

Magnetic flux density values in the working parts of separators can be reviewed from presented Figures. In the case of one Halbach array, magnetic flux density values have been verified by measurement.

In the case of use bonded NdFeB magnets, the inferior magnetic flux density values and forces (approximately one half) acting to the separated particles are obtained. The computations have been realised by 2D programme FEMM based on finite elements method.

Acknowledgements

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