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GENETIC SYNTHESIS OF NEW MAGNETIC SEPARATORS STRUCTURES

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Abstract. A necessity of the development of fundamentally new types of unconventional devices in the modern conditions of progressive increase of structural and functional variety of magnetic separators has been grounded. It has been proved that homologous series law is an important methodological instrument of genetic synthesis having the powerful heuristic potential and able to provide the directed search of new separator structures.

Key words: magnetic separators, homologous series law, genetic synthesis, structure, homology, primary field sources.

1. Introduction

In modern conditions a tendency to progressive increase of structural and functional variety of magnetic separators can be observed [1-3]. It is caused by the necessity of creating qualitatively new devices able to provide reliable functioning and required characteristics of the systems in conformity with new operating conditions. In its turn it stimulates the development of principally new types of unconventional magnetic separators.

The problems of search and synthesis of principally new structural types of magnetic separators refer to the complex class of indeterminate problems of search design. The role of these problems in the design of new devices may come up to 80%.

The ambiguity inherent in search problems and the fuzziness of source data result in the fact that most of such problems are solved by means of approximate (heuristic) methods. The results of search problem solution are of a random character and do not guarantee obtaining optimal structural variants. Under these conditions the search directed to the development of methodological design approaches which are able to provide the proper synthesis of required magnetic separator structures is topical.

The homologous series law (HSL) is an important methodological instrument for the genetic synthesis having the powerful heuristic potential and the ability to provide a directed search of new structures and synthesis at an interspecific level.

Homology is a close alliance (similarity) of objects according to particular structural features conditioned by the generality of their electromagnetic symmetry group. The HSL basis is formed by primary field sources (PFS) of genetic classification (GC) [4, 5]. The essence of HSL is the fact that features parallelism is typical of allied basic species synthesized from the sources of one topologically equivalent series. The problem of directed search and synthesis of the structures of the magnetic separator using HSL implies acquisition of information about structural filling of homologous series of both existing and implicit structures of the magnetic separator. The completeness of such series elements is provided by the principle of topological invariance within an arbitrary GC group in accordance with the rules of information transfer and corresponding methods of topological transformations [4].

Thus, the HSL presents the basis for a fundamentally new approach to the methods of solving search problems which is based on the generation of homological structures by topological transformations methods. By means of the HSL and using genosystematics prognostic function results (in particular, macrogenetic analysis results [5]) it is possible to realize the directed synthesis of the magnetic separators, information about which is inaccessible or unavailable at the present moment of the class evolution (Fig.1).

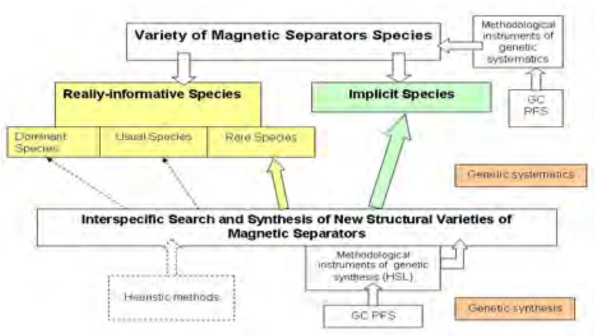


Fig. 1. Interconnection of two main directions of genetic electromechanics: genosystematics and genetic synthesis of new structures

2. Synthesis of homologous series structures

Let us consider the basic structure-prototype S_{p1} of the magnetic separator for bulk material separation (Fig.2) [6], presented in the form of an informational (the claim of the patent specification) and a geometric (see figures explaining the device operation) model as the output information for the statement of the problem of directed search and synthesis of new structures of the magnetic separators.

The analysis of genetic information of the device for bulk material magnetic separation (Fig.2) shows that the device of this type belongs to the subfamily of translational motion magnetic separators, the Species of plain (*PL*) ones and is characterized by electromagnetic asymmetry both in longitudinal (x) and in transverse (y) directions of the electromagnetic field wave propagation. The peculiarity of the structure-prototype consists in the presence of two electromagnetic systems (magnetic field inductors) mounted above the transporting device astride its symmetry axis at an angle of α = 60-90° to the transporter basis (*2 PL 2.2y*).

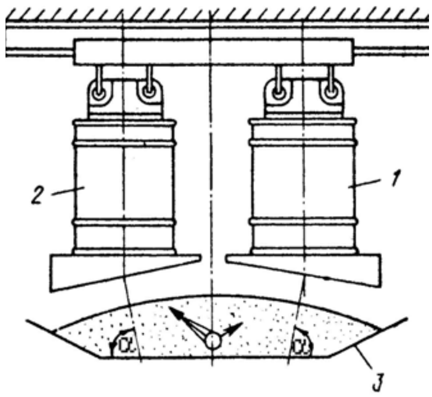


Fig.2. Device for bulk materials magnetic separation (2 PL 2.2y): 1,2 – electromagnetic systems; 3 – transporting device (α - angle of electromagnetic systems installation)

To determine structures homologous series Species composition Q_T it is necessary to single out structure-prototype S_p essential features meeting the synthesis objective function

$$F_S = (p_{S1}, p_{S2}, p_{S3}, p_{S4}) \quad (1)$$

Structure-prototype essential features determining invariant properties of homologous series structures include: p_{S1} – presence of two magnetic field static inductors which can be mounted above the transporter astride its symmetry axis; p_{S2} – possibility of mounting a movable nonmagnetic unloading screen in the space between the inductor and the transporting device; p_{S3} – y-orientation of the field traveling wave; p_{S4} – field source electromagnetic asymmetry (electromagnetic symmetry group 2.2).

To solve the synthesis problem correctly the following limitations $L=f([x)$ are imposed on domain Q_T:

The synthesis is performed within the GC first big period ($P^I \subset < S_0 >$, where $<S_0>$ – the required set of primary sources of the electromagnetic field in GC periodic structure).

Electromagnetic systems with a movable inductor and complicated variants of combined systems containing multi-element and hybrid structures are not being considered at the present stage of solving the synthesis problem .

Taking the above stated into account, the problem of directed search and synthesis of new structural varieties of magnetic separators can be formulated in the following way: to determine the domain of existence Q_T according to known basic structure (structure-prototype) S_p belonging to basic prototype *PL2.2y* with the known objective function of the synthesis $F_S = (p_{S1}, p_{S2}, p_{S3}, p_{S4})$ and the assigned totality of limitations $L=f(x_1, x_2)$, and to synthesize a finite set of structures belonging to other species of homologous series *T* and meeting function F_S.

The domain Q_T of directed search and synthesis of homologous series structures can be presented in the following form (Table 1).

Table 1

Domain Q_T of directed search and synthesis of homologous series structures

Domain Q_T		
Basic level generative structures	Generative structures built on resources-isotopes	
PL 2.2y	*PL 2.2y₁* → $PL\ 2.2y_1$	$PL\ 2.2y_2$
CL 2.2y	$CL\ 2.2y_1$	$CL\ 2.2y_2$
CN 2.2y	$CN\ 2.2y_1$	$CN\ 2.2y_2$
TP 2.2y	$TP\ 2.2x_2$	$TP\ 2.2y_2$
SPH 2.2y	$SPH\ 2.2y_1$	$SPH\ 2.2y_2$
CL 2.2y	$TCL\ 2.2x_2$	$TCL\ 2.2y_2$

The following designations are adopted in Table 1: ***2PL 2.2y … 2SPH 2.2y*** – basic level structures; $2PL2.2y_{1...}2CPH2.2y_2$ – twin structures.

Table 1 illustrates the fact that to obtain the domain of directed synthesis of allied structures it is necessary to single out the series whose structure is allied to the structure-prototype and which can meet the objective function of the synthesis F_S, from the domain Q_{MC} of the class existence of magnetic separators [5].

The obtained domain Q_T contains 18 generative structures (including six basic level generative structures and 12 structures-isotopes). In the obtained domain Q_T of the directed synthesis there is a structure of one symmetry group and six spatial forms.

Applying the method of the information transfer to the assigned structure-prototype, we get a species composition of structures homologically similar to the chosen structure-prototype and meeting the objective function of the synthesis F_S. The results of structure synthesis are presented in the form of the information database (Table 2).

The analysis of the presented information (Table 2) shows that the homologous series includes 18 structures, three (or 16.7%) of which belong to really-informative Species (in Table 2 the boxes containing generative structures with certified novelty are coloured).

Table 2

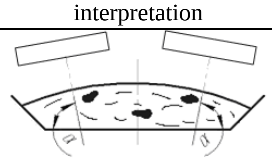
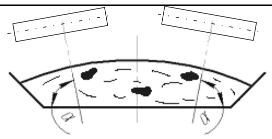
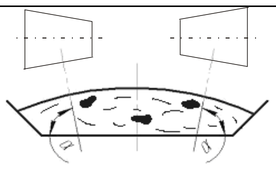
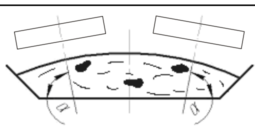
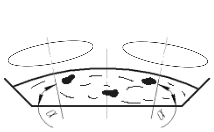
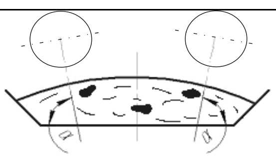
Information database of homologus series *T* structures

Symmetry group	Structures geometric classes					
	PL	*CL*	*CN*	*TP*	*TCL*	*CPH*
2.2	***2PL2.2y***	***2CL 2.2y***	***2CN 2.2y***	***2TP 2.2y***	***2TCL2.2y***	***2CPH2.2y***
	2*PL2.2*y_1	2*CL2.2*y_1	2*CN2.2*y_1	2*TP2.2*y_1	2*TCL2.2*y_1	2*CPH2.2*y_1
	2*PL2.2*y_2	2*CL2.2*y_2	2*CN2.2*y_2	2*TP2.2*y_2	2*CL2.2*y_2	2*CPH2.2*y_2

15 structures (83.3%) define the implicit domain (potentially possible) of the species existence.

Table 3

Visualization of genetic synthesis results (homologus series *T)*

Genetic code	Synthesis results graphic interpretation
2 PL 2.2y	
2 CL 2.2y	
2 CN 2.2y	
2 TP 2.2y	
2 TCL 2.2y	
2 CPH 2.2y	

Graphics provide perfectly clear and concise presentation of information about synthesized structures. In this case genetic particularities of the synthesis objects comprise the core of their graphic interpretation. The visualization of synthesis results for basic level homologous structures is given in Table 3.

It should be mentioned that out of three structures belonging to really-informative species (Table 2) two structures (*2CN2.2* и *2TP2.2y*) were synthesized using HSL. In this case structure *2CN2.2* refers to the rare species domain (Fig. 3) [7] and structure *2TP2.2y* was obtained from the implicit species domain (Fig.4) [8].

The main advantage of synthesized structure *2CN2.2y* as compared with structure-prototype *(2PL 2.2y)* is the new structure enabling the continuity of the removals and subsequent unloadings of ferromagnetic objects. In this case there is no necessity of periodic move of electromagnetic systems into unloading area and their disconnection from electric mains. Besides, the conic form of the electromagnetic systems contributes to the less contamination of extracted ferromagnetic inclusions with nonmagnetic materials.

In its turn, the synthesized structure *2TP2.2y* has certain advantages in comparison with both the structure-prototype (*2PL2.2y)* and the homologically similar structure *2CN2.2y*. In the device for bulk material magnetic separation (Fig.4) electromagnetic systems 1 and 2 are made in the form of static half-disks under with rotating nonmagnetic disks 3 and 4 located under them; they provide the continuity of the removals and subsequent unloadings of the ferromagnetic objects.

The angle α of the installation of magnetic systems 1 and 2 in relation to the transporter 5 basis can be changed by means of rotators 6 and 7 depending on the natural slope angle of the material and assumes an intermediate position in the range of 60-90°.

The rotators 6 and 7 can also be used to adjust the distance between the electromagnetic systems 1 and 2 and the surface of transported material. Thus, the main advantage of structure *2TP2.2y* as compared with previously synthesized and homologically similar structures (*2PL 2.2y, 2CN 2.2y*) is the improvement of the extraction conditions of ferromagnetic inclusions, as the distance between the electromagnetic system surfaces and the surface of the material transported by the conveyor is approximately equal when the angle of the material natural slope changes.

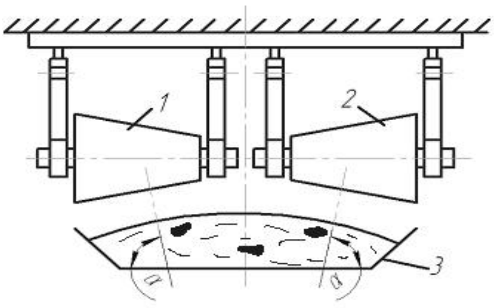


Fig. 3. Device for bulk material magnetic separation 2(CN2.2y), synthesized using HSL: 1,2 – electromagnetic systems; 3 – transporting device (α – angle of electromagnetic systems installation)

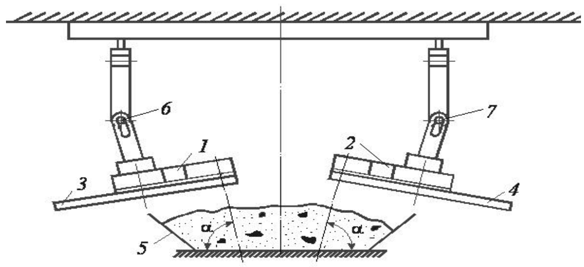


Fig. 4. Device for bulk material magnetic separation (2TP2.2y), synthesized using HSL: 1,2 – electromagnetic systems; 3,4 – nonmagnetic unloading disks; 5 – transporting device; 6,7 – rotators (α – angle of electromagnetic systems installation)

The reliability of the performed synthesis procedure is confirmed by comparative analysis of the patent data retrieval and the results of the synthesis. Belonging of a number of homologous series structures (Table 2) to really-informative species as well as the possibility of the directed generation of new structures (in particular, structures *2CN2.2y*, *2TP2.2y*, whose novelty has been confirmed by the granted patents) testifies to the adequacy of the performed synthesis procedure. In this case, meeting the following condition can be considered: the condition of genetic synthesis adequacy is

$$(2PL\ 2.2y,\ 2CN\ 2.2y,\ 2TP\ 2.2y) \subset T\ , \qquad (2)$$

where *2PL 2.2y, 2CN 2.2y, 2TP 2.2y* – the subset of the really-informative species of structures *T* of the homologous series.

Conclusion

Thus, the presence of the parallelism of structural features in the allied species of electromagnetic systems and the existence of the corresponding series of structural varieties of magnetic separators, invariant to the operating principles and the complexity of their structure, provides the possibility of the realization of directed search and synthesis of new structures. The structures, synthesized as a result of research, are operable and recommended for the industrial application.

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ГЕНЕТИЧНИЙ СИНТЕЗ НОВИХ КОНСТРУКЦІЙ МАГНІТНИХ СЕПАРАТОРІВ

Загірняк М.В., Шведчікова І.А.

Обгрунтовано необхідність розвитку фундаментально нових варіантів нетрадиційних конструкційних пристроїв у сучасних умовах прогресивного зростання структурної та функціональної різноманітності магнітних сепараторів. Показано, що закон однорідних рядів є важливим методологічним інструментом генетичного аналізу, що має потужний евристичний потенціал та здатен забезпечити цільовий пошук нових конструкцій сепараторів.