IMPROVING OF HISTOGRAM PARAMETERS OF MAGNETITE NANOPARTICLES DISTRIBUTION ON SIZE

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Histogram of magnetite nanoparticles distribution on size has been constructed on the base of their vicinity to firing ground frequency. Future parameters of histogram of distribution have been improved by least square method. Constructed histogram of distribution has been applied to calculation of moments of distribution and magnetization curve of system of magnetite nanoparticles. Analysis of obtained result showed, that constructed histogram is more accurate describe disperse system of magnetite nanoparticles.

1. Introduction.

Distribution of particles of disperse systems on size is one of base physical characteristics of these systems. Distribution function is used to determination of physical parameters of disperse systems by its statistical averaging, it allows to analyze mechanism of particle growth and to describe behavior of these systems in external field and etc. Nanoparticle size distribution function has been determined by different physical methods [1-7]. Magnetic granulometry, dynamical laser light scattering, acoustics spectrometry and small X-ray scattering methods have determined size distribution function of magnetite nanoparticles on size. These all methods are based on measurement of intensity of physical parameters, related with the size distribution of nanoparticles. By this methods will obtain distribution functions of nanoparticles on magnetic, brown diameter and etc. In this case, magnetic and brown diameter of nanoparticles is necessary transfer to their geometrical diameter. For this calculations it is necessary value of thickness of nonmagnetite layer, length of stabilizer molecule and etc. [2,3,5,9-12].

At present work histogram of distribution of magnetite nanoparticles on size has been constructed. Parameters of histogram have been improved by least square method. Moments and parameters of distribution, magnetization curve of systems of magnetite nanoparticles has been obtained by experimental and calculated by frequency firing ground and histogram distributions without and with improved parameters. Results of investigation showed, that moments of distribution and magnetization of disperse systems of magnetite nanoparticles calculated by histogram with improved parameters are more near corresponding parameters obtained by frequency firing ground and experimental.

2. Determination histogram of distribution of nanoparticles on size.

One of criterion of construction accurate histogram of some parameter distribution of disperse system may be vicinity of intensity of parameters of disperse systems calculated by statistical averaging with this histogram and frequency firing ground, respectively.

Theorem: If the constructed histogram of distribution and frequency firing ground of some parameters of disperse system are in the vicinity to each other, then characteristics of disperse system determined by this histogram and frequency firing ground will be vicinity each other too.

Proof: The vicinity of two discrete functions (histogram and frequency firing ground) will be estimated by the following formula

$$\rho(P,\ H) = \sum_{i=1}^{n} \left| P(r_i) - H(r_i) \right| \le \delta \qquad (2.1)$$

where $P(r)$ and $H(r)$ the frequency firing ground and histogram of distribution on parameters "*r*", respectively.

We inequality (2.1) will transform in the following way. Both parts of inequality (2.1) multiplied to $G(r,E_j)$. $G(r, E_j)$ is the function "*r*", "*E*" described as one of physical characteristics of disperse system. For all values of arguments "*r*", "E_j" $G(r,E_j)$ J 1. This inequality (2.1) may by generalized to all values of "E_j". Then obtain:

$$\rho(P,\ H) = \sum_{j=1}^{m}\sum_{i=1}^{n} \left| P(r_i) - H(r_i) \right| \cdot G(r_i,\ E_j) \le \delta_1$$

$$\rho(P,\ H) = \sum_{j=1}^{m}\sum_{i=1}^{n} \left| P(r_i) - H(r_i) \right| \cdot G(r_i,\ E_j) =$$

$$= \sum_{j=1}^{m}\sum_{i=1}^{n} \left\{ \left| P(r_i) \cdot G(r_i,\ E_j) - H(r_i) \cdot G(r_i,\ E_j) \right| \right\} =$$

$$= \sum_{j=1}^{m}\sum_{i=1}^{n} \left| P(r_i) \cdot G(r_i,\ E_j) \right| - \sum_{j=1}^{m}\sum_{i=1}^{n} \left| H(r_i) \cdot G(r_i,\ E_j) \right|$$

As $P(r)$, $H(r)$ and $G(r,E_j)$ *i 0* for all values of arguments “*r*”, “E_j” and in definition:

$$I_p(E_j) = \sum_{i=1}^{n} G(r_i, E_j)P(r_i)$$

and

$$I_H(E_j) = \sum_{i=1}^{n} G(r_i, E_j)H(r_i)$$

These last expressions are statistical averaging of $G(r,E_j)$ on parameter “*r*” by histogram ($H(r)$) and frequency firing ground ($P(r)$), respectively. Taking into account last expressions we obtain:

$$\sum_{j=1}^{m} \left| I_P(E_j) - I_H(E_j) \right| \le \delta \qquad (2.2)$$

Thus the inequality (2.2) is condition of vicinity of $I_P(E_j)$ and $I_H(E_j)$, which was to be proved.

It’s known, that all constructed distribution functions, histograms must have different and non-zero values at all considered values of argument [13]. Thus, numbers of histograms, which may be constructed on the base of conditions [13] and (2.1) are limited.

3. Results and discussion.

Four samples of magnetite nanoparticles have been investigated [14-16]. Improved histogram data, determined by above mentioned method are $(f;x)_I$ =(0,2; 0,203), (0,4; 0,563) , (0,6; 0,194) , (0,8; 0,036) , (1,0; 0,004), $(f;x)_{II}$ = (0,25; 0,664) , (0,5; 0,247), (0,75; 0,08), (1,0; 0,009), $(f,x)_{III}$ =(0,167; 0,121); (0,334; 0,403); (0,54; 0,293); (0,667; 0,123); (0,833; 0,05); (1,0; 0,01), $(f,x)_{IV}$ =(0.2, 0.304); (0.4, 0.46); (0.6, 0.197); (0.8, 0.035); (1.0, 0.004) for samples I-IV, respectively. In fig.1(a,b) there have been presented curve firing ground frequency (curve 1), distribution histograms magnetite nanoparticle samples I without (curve 2) and with improved data (curve 3).

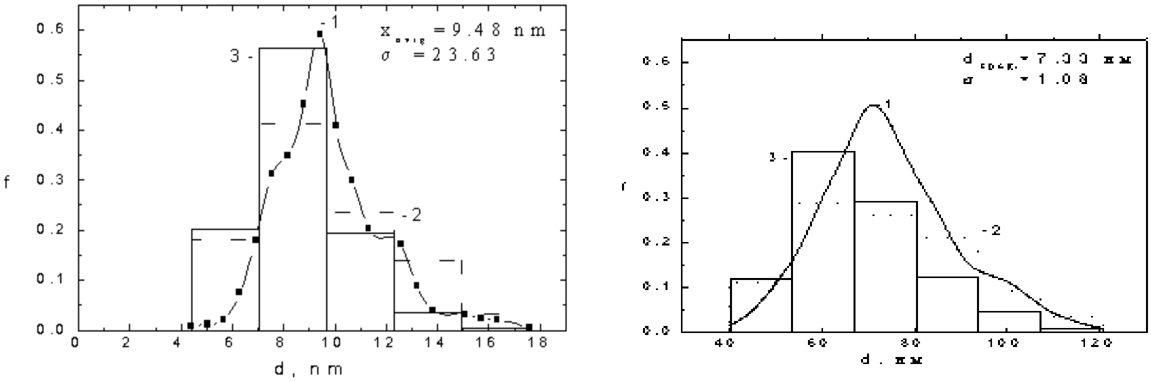

Fig.1(a,b). Curve frequency firing ground (1) [14], distribution histogram without (2) and with (3) improved parameters of magnetite nanoparticle sample –I (a). –II (b).

In table 1 there have been shown moments and parameters of distribution calculated by frequency firing ground, histogram without and with improved parameters and relative errors of calculations. As it is seen from table, moments and parameters of distribution calculated by histogram are more accurate.

In fig.2 there have been shown magnetization curves, obtained by experiment, calculated by Langevan equation using frequency firing ground, histogram, without and with improved parameters. As it is seen from fig.2 magnetization curve, calculated by histogram with improved parameters is closer to experimental magnetization curve and curves calculated by frequency firing ground.

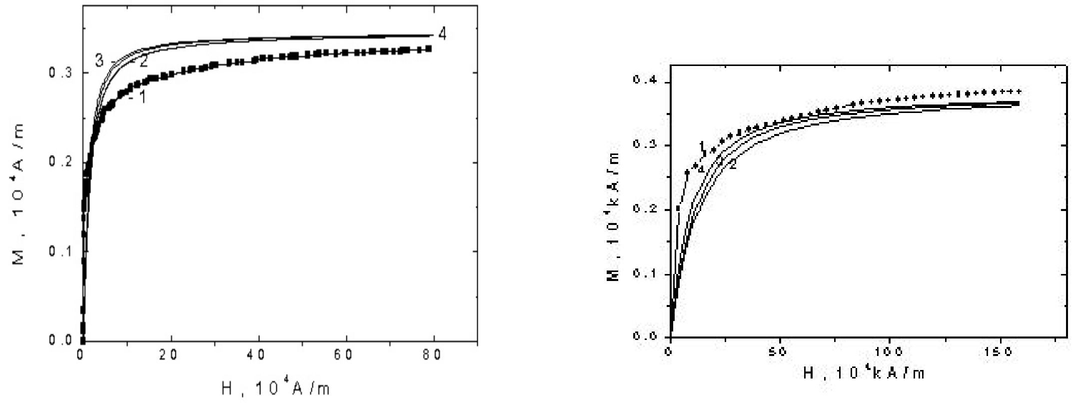

Fig.2 Magnetization curves of magnetite nanoparticle samples –I and –II obtained by experimental (1) [15,16], calculated by equation (4.1) using frequency firing ground (2), distribution histogram without (3) and with (4) improved parameters.

Thus, analysis of carried out investigations shown, that for monodisperse systems it may be constructed one and accurate histogram describing distribution of nanoparticles on size. Physical parameters (moments, parameters of distribution, magnetization of disperse systems of magnetite nanoparticles) of disperse systems may be calculated more accurately and rapidly by this histogram. Thus, it is established, that histogram of distribution with improved parameters more convenient and more exactly describes distribution of magnetite nanoparticles.

Table 1.

Initial moments of distribution magnetite nanoparticles samples I-IV, calculated by firing ground of frequency, histogram without and with improved parameters

N	Moments and parameters of distribution calculated by firing ground frequency (1)	Relative error of calculation of moments by histogram without (2) and with (3) improved parameters		Moments and parameters of distribution calculated by firing ground frequency (1)	Relative error of calculation of moments by histogram without (2) and with (3) improved parameters	
	1	2	3	1	2	3
I sample				**II sample**		
$\overline{x}$	.94807E+02	.1406	.0413	.77570E+02	.1706	.0375
$\overline{x^2}$	.95468E+04	.3035	.0625	.65486E+04	.3402	.0516
$\overline{x^3}$	.10200E+07	.4885	.0634	.60048E+06	.5031	.0526
$\overline{x^4}$	.11541E+09	.6924	.0457	.59517E+08	.6551	.0491
$\overline{x^5}$	.13788E+11	.9094	.0135	.6328E+10	.7949	.0461
$\overline{x^6}$	.173224E+13	1.1322	.0286	.715167E+12	.9239	.0453
$\overline{x^7}$	.227792E+15	1.3529	.0756	.851209E+14	1.0452	.0466
$\overline{x^8}$	.311936E+17	1.5651	.1234	.105799E+17	1.1617	.0492
$\overline{x^9}$	.442499E+19	1.7644	.1691	.136342E+19	1.2752	.0523
$\overline{x^{10}}$	.646957E+21	1.9488	.2106	.181099E+21	1.3862	.0556
III sample				**IV sample**		
$\overline{x}$	.733193E+02	.095	.024	.54401E+02	.108	.048
$\overline{x^2}$	.566779E+04	.190	.031	.30949E+04	.222	.077
$\overline{x^3}$	.461060E+06	.281	.023	.18391E+06	.344	.087
$\overline{x^4}$	.393497E+08	.367	.004	.11395E+08	.474	.080
$\overline{x^5}$	.350948E+10	.447	.023	.73457E+09	.612	.058
$\overline{x^6}$	.325578E+12	.518	.055	.491326E+11	.755	.024
$\overline{x^7}$	.312638E+14	.582	.087	.339946E+13	.901	.018
$\overline{x^8}$	.309242E+16	.640	.118	.242519E+15	1.047	.064
$\overline{x^9}$	.313672E+18	.693	.147	.177805E+17	1.190	.119
$\overline{x^{10}}$	.324975E+20	.742	.171	.133542E+19	1.329	.159

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NANOÖLÇÜLÜ MAQNETİTLƏRİN ÖLÇÜLƏRƏ GÖRƏ HİSTOQRAM PAYLANMASININ PARAMETİRLƏRİNİN TƏKMİLLƏŞDİRİLMƏSİ

Nanoölçülü maqnetitlərin ölçülərə görö histoqram paylanması onun tezliklər poliqonuna daha yaxın olması şərti əsasında təyin olunmuş və daha sonra onun parametrləri ən kiçik kvadratlar metodu ilə dəqiqləşdirilmişdir. Təyin olunmuş histoqram paylanması paylanmanın momentlərini və nanolçülü maqnetitlər sisteminin maqnitləşmə əyrisinini hesablanmasında istifadə olunmuşdur. Alınmış nəticələr bu üsülla təyin olunmuş histoqramın dispers sistemlərin paylanmasını daha düzgün xarakterizə etdiyini təsdiq etdi.

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УЛУЧШЕНИЕ ПАРАМЕТРОВ ГИСТОГРАММЫ РАСПРЕДЕЛЕНИЯ НАНОЧАСТИЦ МАГНЕТИТА ПО РАЗМЕРАМ

Гистограмма распределения наночастиц магнетита по размерам была построена на основе его близости по полигону частот. Параметры гистограммы улучшены методом наименьших квадратов. Полученная гистограмма распределения использована для определения моментов распределения и намагничивания дисперсных систем наночастиц магнетита. Анализ полученных результатов доказали, что полученная таким способом гистограмма более точно описывает распределение дисперсных систем.

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