NEW PROCEDURE FOR ESTIMATION OF THE PHYSICAL VALUES

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ABSTRACT

This paper compares the methods of checking the state of rolling bearing for high-frequency vibration. For more accurate registration of impact loads at low shaft speeds a program was created that allows recording the impact load every millisecond. Multifractal analysis application possibilities in materials properties investigation are considered in the given article. Theory of multifractal analysis being considered in this work can be used as a new procedure for estimation of materials corrosion degree. The technology of calculations given in this work is directed to practical determination of scaling parameter α with the help of Scilab software. Fractal theory provides an effective method to describe the complexity and irregularity of the vibration signals of rolling bearings. In this paper considered formalism of geometric description of multifractal.

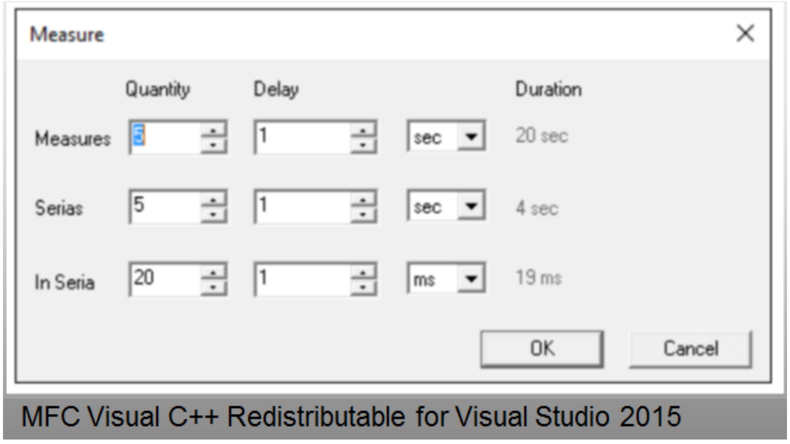
Keywords. Multifractal analysis, the accurate registration oh the physical values, Bearing failure checks, Correlative fractal dimensionality

1. SOFTWARE FOR THE FUNDAMENTAL ANALYSIS OF VIBRATION

The use of vibration parameters (vibration displacement, vibration speed and vibration acceleration) is difficult at small and very high shaft speeds, when there are no shock loads or if the frequency of vibration is too high. Effective use in the analysis of vibration intensity of changes in vibration acceleration and its derivatives. The order of the derivative can be any real number. If the frequency of vibration is not constant, fractional derivatives are used. The intensity of the change in vibration acceleration is estimated using the frequency spectrum of the vibration power [1]. When processing signals that inform about the level of vibration and balance, sometimes an expert-statistical method is applied [2].

To collect diagnostic information, one can use a vibrating stand with the PT 500.04 PC Based Evaluation Software for recognition of equipment node state [3]. When processing experimental data, you can use the graphical interface of the System Identification Toolbox. All the above methods of bearing failure checks are based on the analysis of data recorded with a time interval equal to $\Delta\tau$ = 1s. If the shaft rotates at a frequency of n=200 rpm, then the shaft will make a 3, (3) turns in the time interval $\Delta\tau$ = 1s. At some point in time, the recording equipment does not detect the shock load. If the expected frequency of vibration at a given speed is 11.9 Hz, then the duration of one rotation of the shaft (300 ms) is 3.57 times the vibration signal time. At this sampling frequency of vibration signals, it is difficult to diagnose faults in bearings. For receiving the best estimation of the physical values a program was created that allows recording the impact load every millisecond.

Table 1 .Recording the impact load every millisecond



The bearing was considered as a resonant system, in which its own frequencies were calculated [4, 5]. The efficiency compares the methods of checking the state of rolling bearings for high-frequency vibration.

The power of high-frequency bearing vibration was monitored; analysis of the form of high-frequency vibration excited by short shock pulses; spectral analysis of fluctuations in the power of high-frequency vibration was made too. The relative error in determining the characteristic frequencies of the arising defects at the rotational speeds of the shaft from 200 rpm to 1500 rpm did not exceed 10 % .

2. MULTIFRACTAL ANALYSIS OF THE MATERIALS SUBJECTED TO CORROSION

Theory of multifractal analysis is effective approach to description of the signals with complicated and irregular forms. Just such signals are carriers of information about damages of materials. For determination of the uncertainty parameters multifractal analysis application possibilities in materials properties investigation are considered in the given article. Known methods of materials properties investigation can be divided into destructive and non-destructive testing methods. For example, even non-destructive testing methods do not allow to estimate exactly rate of surface and volume destruction of the materials subjected to corrosion. We use a formalism of the geometrical description of a multifractal, so theory of multifractal analysis being considered in this work can be used as a new procedure for estimation of materials corrosion degree. Let us combine a geometrical fragment with a matrix of numbers which has been made on the basis of characteristics of binding elements, thetrefore the technology of calculations given in this work is directed to practical determination of scaling parameter α with the help of Scilab software. In accordance with scaling factor α and order paramater q, using formalism of geometric description of multifractal, the function forming multifractal is determined. That function, in its turn, will allow to estimate the degree of material corrosion stability and to bind fractal dimensionality with corrosion current density. Modeling of experiments showed that method of multifractal analysis applied for materials corrosion stability estimation is practically suitable.

To obtain fractal set matrix of numbers of brightness of images (got by microscope VHX Keyenc-2000) of the investigated materials subjected to corrosion were used. The images were exported in JPG format into the environment Scilab 5.5.2 to get tone pattern of $m \times n$ format.

The idea is that it is necessary after grey background to convert numbers of image brightness into the matrix of numbers [6]. That matrix should be converted by the rules of matrixes transformation. The first matrix is initial one. It is necessary to find the sum of the matrix numbers, then to carry out element wise division of all numbers by that sum. In the result the matrix of probabilities $P_i = l_i^{\alpha}$ will be obtained. Each element of the matrix should be raised to the q degree and added by elements. Now the most important. It is necessary to find the rows of a new matrix joining the elements of the initial matrix by four. Then in a similar way to determine the sum of the matrix elements, dividing all numbers element wise by the sum and to obtain a matrix of another size and etc.

Software module implementing the described algorithm is given below.

```
end
// -- 21/02/2017 10:03:06 -- //
a=imread('C:\Users\loca\Desktop\pin.jpg')
grayim=rgb2gray(a)
b=double(grayim)*0.5
[M,N]=size(b)
B=matrix(b,M,N)
C=[]
for i=1:393
for j=1:512
C(i,j)=(B(i+i-1,j+j-1)+B(i+i-1,j+j)+B(i+i,j+j-1)+B(i+i,j+j))/4
end
[M,N]=size(C)
```

The fractal set is obtained by sequential partition of an image into i squares with a side of l_i, equal to numbers of pixels 2, 4, 6, 10, 12, 16, 32. This is a common scheme of geometric description of an arbitrary fractal set. Such geometric method [7] is reduced to the sequence $n \to \infty$ of the steps of initial set division, leading to the formation of N_n·fragments of length $l_i \to 0, i = 1,2, \dots,$ where N_n- is a current parameter by all partitions.

The values of probabilities of each fragment realization allows to determine the function $M_n(q) = \sum_{n=1}^{N_n} l_n^{q\alpha - f(\alpha)}$forming the fractal. That function, in its turn, permits to estimate corrosion stability of the materials subjected to corrosion. The materials have been treated by sulphuric acid H_2SO_4 and potassium chloride KCl. By the data of Table 1 it is seen that special alloy $Ni_{20\%}Co_{20\%}Fe_{20\%}Cr_{20\%}Ga_{20\%}$ has got the lowest rate of corrosion and the lowest correlative fractal dimensionality $\Delta D_{q=2}$.

Table 2

Material	Composition	Indices of corrosive resistance, $\frac{mm}{year}$	$\Delta D_{q=0,5}$	$\Delta D_{q=2}$
Special alloy	$Ni_{29,5\%}Fe_{39,8\%}Cr_{20\%}Mo_{6\%}W_{4,\ 7\%}$	2,916797021	0,18	0,22
Special alloy	$Ni_{38,33\%}Fe_{36\%}Cr_{13,88\%}Mo_{6,66\%}W_{5,15\%}$	3,315641896	0,19	0,21
Special alloy	$Ni_{20\%}Co_{20\%}Fe_{20\%}Cr_{20\%}Sn_{20\%}$	3,436499298	0,28	0,27
Special alloy	$Ni_{20\%}Co_{20\%}Fe_{20\%}Cr_{20\%}Ga_{20\%}$	2,504523815	0,17	0,15
Special alloy	$Ni_{20\%}Co_{20\%}Fe_{20\%}Cr_{20\%}Ge_{20\%}$	4,038578422	0,27	0,26

The obtained result points out to the tendency of linear relation between fractal dimensionality and rate of corrosion [8]. Random value α is bound with the function of its distribution $f(\alpha)$. Change of mechanical properties of the materials subjected to corrosion is characterized by generating function of fractal measure $M_n(q)$.

3. CONCLUSION

In the given paper has shown that the measurement of any physical quantity can be simulated. The measuring complex can be presented as linear multiples. The statistical analysis will allow to receiving the best estimation of measuring quantity. In the given paper the probabilistic nature only is used and geometrical features of a multifractal are not used. Taking into account the fact that the length l_n of a finite element aspires to zero, it is possible to make fragment numbering different, considering, that the probability of a corrosion of a whole object equals to one. Dependence of a course-of-value on dimension of a multifractal allows estimating the character of Indices of corrosive resistance

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