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Prognostication of Residual Ressources of Reducers of Draglines Esh 15.90

OrkhonLkhamjav*, Hyo-SangCHOI**,Buing-IkJUNG***, AriunboldAltankhuyag****
Mongolian National University,Chosun University, Korea
Orkhon_Lkha@yahoo.com;hyosang@chosun.ac.kr;jbi8258@dkc.ac.kr

Abstract: The Results of vibration monitoringof the hoist and drag reducers bearings of draglines, working at Baganuur coal mine (Mongolia) are calculated. There has been made analysis of variation of Hurst exponent. There has been determined the relation between Hurst exponent and operating time of reducers of lifting of excavators draglines. The conclusion is drawn on need of increase of level of reliability and efficiency of operation by vibration diagnostics application.
Keywords: Bearing,Hurstexponent, vibration monitoring, acceleration, dragline

I. INTRODUCTION

In this article the aim is to develop a methodology to assess the technical condition and forecasting residual life of the bearings of the main drives of draglines taking into account the conditions of their mining operation on the cut "Baganur" (Mongolia).

Modern technologies of control and diagnostics of the equipment use the method of vibration diagnostics. The choice of method depends on the structural vibration diagnostics, functional and vibration state of the object. Vibrodiagnostics most widely used for controlling the rotating mechanisms. There are following major fault is determined by analyzing vibration signals [1].

- defects of rolling bearings;
- bearing defectsof slipping;
- defects of mechanical gears.

In fact,comparison of the vibration with the simple process of oscillatory movement is incorrect. The level of vibration of rotating machines and their elements depends on many external and internal factors and is a nonlinear process with widely variable parameters.

There has been conducted a series of measurements of parameters of vibration of the control points on the gearbox bearings move, lift, thrust and rotation draglines ESH15.90 with vibration analyzer VA-412 at Baganuur coal mine (Mongolia). The experimental database contained more than 280 spectra of velocity and acceleration observed during excavators'. The purpose of the measurements was to investigate the level of influence of factors on the technical condition of units of excavators and receiving data to predict their residual life and planning of repairs. [1,4].

As the result of measurements at the control points of bearing gear vibration spectra were recorded in the form of a sequence of amplitude frequency velocity and acceleration. As an example, Fig. 1 shows one of the vibration acceleration spectra of lifting gear of walking excavator ESH-15.90.

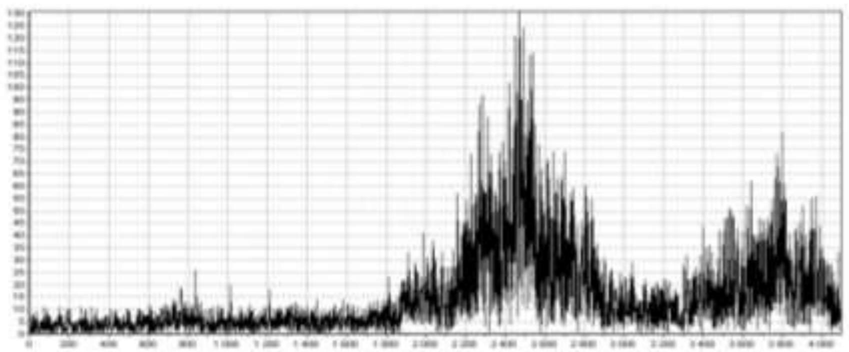

Fig.1. Spectrum of the vibration acceleration of the bearingoflifting gear of walking excavator ESH-15.90

The resulting series of frequency amplitudes are fractal sets, and to describe them in the theory of dynamical systems used Hurst exponent H, which quantifies the extent of randomness amplitudes in the frequency range of the spectrum [1, 2]. As the level of randomness of the vibration signal changes, its fractal characteristics also change. This can be considered as an additional indicator of Hurst diagnostic criterion for assessing the technical condition of bearing reducers draglines, which is determined by the following formula:

$$H = \frac{\log(R/S) - \log a}{\log N}$$

where H - Hurst exponent, which takes values from 0 to 1;
R -fluctuation, which is the difference between the maximum and minimum values of the amplitude of the mean x Mk;
S -standard deviation of the amplitude of the oscillation x from their average value Mx;
a - is a constant;
N -current value of the sample size (the number of periods of oscillation).

To estimate the Hurst exponent applies a normalized scale, determined by the ratio of R / S. Usually, for the series of vibration parameters of many natural processes, the value of the normalized amplitude is described by the following empirical equation:

$$R/S=(a \cdot N)^H,$$

where H - Hurst.

The technical condition of bearings is monitored according to the diagnosis of its defects on the basis of the Hurst exponent changes. Vibration measurements data were analyzed using the program Fractan, whereby for each spectrum was obtained dependence of normalized amplitude R / S on the sample size N. Hurst exponent defined by each spectrum of vibroaccelerations. Example of dependence R / S = f (N) is shown in Fig. 2, for which the Hurst exponent H = 0,386 [1,2,3].

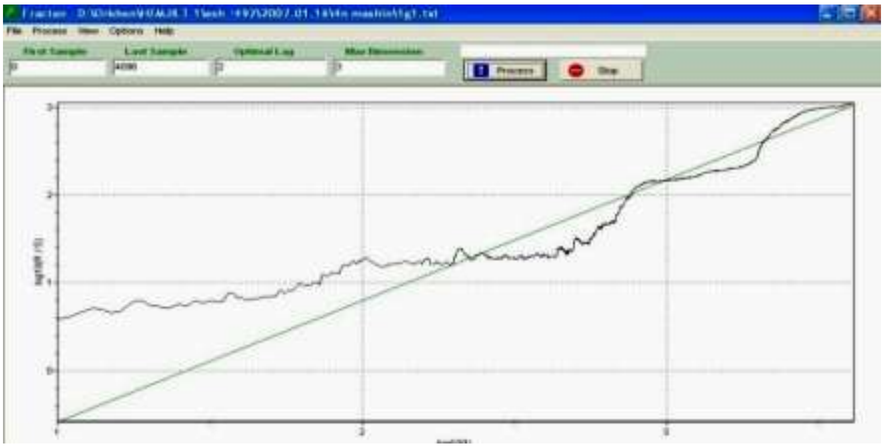

Fig.2. Normalized sweep vibration acceleration of bearingof the lifting gear excavator ESH-15.90

As shown in Fig. 2, according to the changes of the index N for the entire period of work, the bearing of lifting gear is at the stage of development of damage, and reaching a phase of deterioration when there is a noticeable increase in its deterioration.

Practice shows that the Hurst exponent of the working gear is less than 0.5. If the Hurst exponent of the vibration acceleration of bearing lifting ESH is 15.90 equals to 0,386, it means that in the future the vibration acceleration will increase slightly.

The practice of exploitation and analysis of the level of vibration processes of rotation mechanisms (elements) show that, if the Hurst exponent N<0,74 controlled element is functional, and at 0.75 <N<1 occurs emergency deterioration, requiring immediate repair. At the threshold value of the Hurst exponent, which is 0.5, should reduce the frequency of monitoring should be reduced and start preparing for the repairs.

As a result of vibration monitoring there has been found that the value of the Hurst exponent for the most of bearing reducers belong to the region in which most of its value, and arranged for all the natural processes. For them, its limit is 0.75, which indicates immediate replacement of the bearing.

As an example, Fig. 3 shows the evolution of the Hurst exponent for the axial vibration of the bearing of the lifting gear excavator ESH-15.90, and Fig. 4 - curve approximation of its dependence on the operation time of the gear.

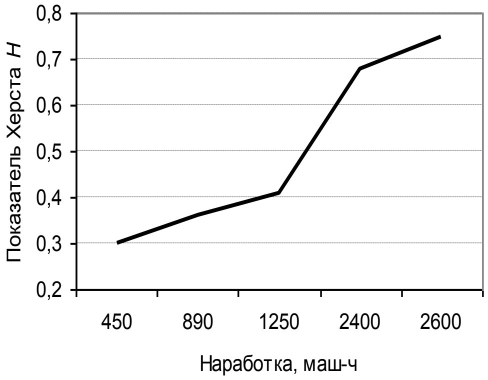

Figure 3. Dynamics of Hurst exponent of the axial vibrations of the bearing of lifting reducer dragline ESH 15.90

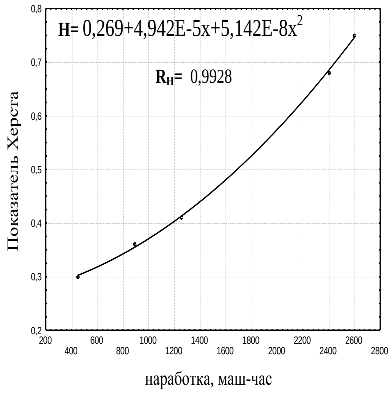

Figure 4. Dynamics of Hurst exponent of the axial vibration of the lifting reducer ESH 15.90 and the curve approximation of its dependence on the operation time

For example, using the following formula which determines the dependence of the Hurst exponent on the operation time, we define the residual life of reducer.

$$H=0.269+4.942E\text{-}5x+5.142E\text{-}8x^2$$

$$t_{rl}=1394 \text{ machine hours}$$

where t_{rl}- residual life

Above method of determination of Hurst exponent of machine units and elements allows us to define the residual life of reducers that ensures the reliability of machines.

II. CONCLUSION

The proposed method of monitoring and calculation of residual life allow 1-2 months ahead to predict the destruction of bearings largest Hurst exponent, which makes it possible to perform maintenance or repair of machinery in their actual state, to maintain the necessary operational reliability of the main drive gear, reduce unplanned downtime in repair, increases the production of draglines and reduce the cost of 1 m3 of overburden.

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