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Mathematical models of linear random processes in the description of the diagnostic signals of acoustic emission accompanying the work units of electrical equipment

Abstract. *On the basis of elements of the theory of linear random processes, we develop a probabilistic model of acoustic emission signals used for diagnosing unites of electrical equipment. The complete probabilistic characteristics of the signal of acoustic emission as a function of the probability distribution.*

Keywords: linear stochastic process, acoustic emission signal, diagnostics of electrical equipments.

Signals of acoustic emission (AE), which arise in the unites of electrical equipment (EE), can manifest as a continuous or discrete form. The mathematical model of continuous AE many scholars use the model of a Gaussian random process. Pulse model AE signal is a superposition of a large number of pulses generated randomly in time elementary radiators located in the middle of the object.

According to the results of the study of existing models as a model AE signal was chosen to model a linear random process (LRP), which is defined as follows:

$$\xi(t)=\int_{-\infty}^{\infty}\varphi(\tau,t)d\eta(\tau),\ t\in(-\infty,\infty)\ , \qquad (1)$$

where $\{\eta(\tau),\eta(0)=0,\tau\in(-\infty,\infty)\}$- is stochastically continuous random process with independent increments, which is called the generator, $\varphi(\tau,t)$ - a nonrandom function, for which the $\left|\int_{-\infty}^{\infty}\varphi^{p}(\tau,t)d\kappa_{p}(\tau)\right|<\infty,\ p=1,2$, where $\kappa_{p}(\tau)$- the semi-invariant *p*-th order process $\eta(\tau)$.

In constructing a mathematical model of AE signal using the LRP (1) it was assumed that under continuous emissions mean a continuous time generating some source of the fluctuation signal of AE, and a pulse (discrete) - operation of this source at some point in time, resulting in a radiated pulse. On the basis of physical assumptions made by the general model of AE signal can be represented as the sum of independent continuous and pulsed components of the signal

$$\xi(t)=\nu_{1}\xi_{c}(t)+\nu_{2}\xi_{\Pi}(t), \qquad (2)$$

where ν_1 and ν_2 - weighting factors that characterize the magnitude of the contribution of continuous $\xi_c(t)$ and pulsed $\xi_{\Pi}(t)$ components in the AE signal $\xi(t)$ of the form (2).

Using a model of LRP (1) and the proposed model AE signal (2) provide a full probabilistic characteristics of the signal, as LRP is known to the general form of the characteristic function (CF) $f(u;t)$. Distribution law of the process with known CF can be found in two ways:

- the first of these is to identify and study the module $R_{\xi}(u)$ and argument $A_{\xi}(u)$ of the CF study LRP $\xi(t)$;

- the second involves finding and analyzing the spectra of Poisson jumps.

In the present study to determine the probability characteristics of AE signal was used the first method. Along with CF complete probabilistic characterization of the process $\xi(t)$ is its distribution function $F(x)$, which is uniquely determined by the CF using the Fourier - Stieltjes. Using this transformation, an analytical expression for the one-dimensional distribution function $F(x)$ of the process $\xi(t)$, provided that the process is stationary. If a function $F(x)$ is continuous, the process $\xi(t)$ can write an expression for its probability density $p(x)$.

We obtained the dependence of the distribution functions $F(x)$ of the AE. For this purpose the methods of numerical integration.

The distribution functions $F(x)$ constructing assumed that the impulse component $\xi_{\Pi}(t)$, which is included in the model (2), is a simple Poisson process with constant intensity λ and the same amplitude.

Using a model of LRP (1) and the proposed model AE signal (2) provide a full probabilistic characteristics of the AE signal in the form of probability distribution functions $F(x)$. This made it possible to substantiate a number of diagnostic features that characterize the technical condition of EE units.

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