INVESTIGATION OF AE PROPERTIES OF THE HOISTS

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ABSTRACT

Possibility of defect growth control in hoists by AE method during operational process was determined. It was shown that crack growth in 10 HSND steel and the welding zones specimens accompanied AE signals, which may by use for evaluation non-destructive testing methods.

KEYWORDS

Acoustic emission, non-destructive testing, crack, subcritical crack growth, Kaiser effect, yield, plastic strain, hoist.

Power units of the hoists are usually made from tough steels 9G2S, 10HSND, St.3 and so on. Their mechanical characteristics are well known (Pustovoy et al., 1990), that witness about great interest of practical engineers and designers. Recently, due to significant amount of such machines and mechanisms and their considerable operational term, the problem of residual resource forecast of their most important elements by means of non-destructive control became very actual. Among the progressive directions there are methods of diagnostics based on the phenomenon of acoustic emission (AE) and the fracture mechanics elaborations, which are widely used in fundamental investigations and manufacturing (Greshnikov and Drobot, 1976; Andreykiv and Lysak, 1989). It is connected with main advantages of the AE method such as the possibility of the defect start control and investigation of the defect dynamics through the entire object volume during operational process (Tripalin and Bujlo, 1986; Andreykiv et al., 1990). It is known from reference that plastic materials in the case of the defect growth have low acoustic activity in comparison with high-resistant steels. Therefore a question arises whether it is possible to detect the growth beginning and subcritical growth by ordinary means of AE detection from the real object and the reveal correlations between AE signals and growing defect parameters. Regarding specific hoists and constructing materials, there not have been found any references. Therefore this investigation was performed to find out acoustic emission characteristics of real materials.

For investigation purposes steel 10 HSND was chosen as a most typical representative of steels that a widely used for different power units. In accordance with GOST 25.506-85 from this steel were made prismatic samples 6x65x170 mm, on which after stress concentrator cutting fatigue cracks were created. Samples were made in such a way, that there were 3 types of constraction materials in the process zone: 1) bulk metal; 2) welding joint metal; 3) metal of welding of welding area. Samples were exposed to three-point bending according to GOST 25.506-85 in the laboratoty unit SVR-1 which provides minimized background noises during sample loading. It allowed to use in experiments a standard equipment.

During investigations it was necessery to determine: 1) whether the Kaiser effect is (Keizer, 1953) fulfilled for this type of steels; 2) what is the relationshop between AE signal parameters (amplitude, cumulative account) and fracture parameters (loading, deformation area, crack growth step); 3) whether the amplitude of the AE signals is sufficient for detection of AE from the real object during procesing. Investigations were performed according the methodology of (Skalsky and Lysak, 1986).

For examination of the Kaiser effect fulfillment for steel 10 XSND were performed following experiments. Sample whith concentrator but without crack has been loaded to the magnitude, (point 3), that was in plastic deformation region (P_3 = 967 N), after afterwards it was unloaded almost to zero (point 3a). During the period of loading and unloading the AE signals were detected. After unloading sample had residual plastic deformation 0,077 mm (see Fig. 1), that had been determined from the crack opening displacement v. Than the sample was reloaded with AE signals recording on the acoustogram. Thus the point 4 was determined - point of repeated appearance of the AE signals, where the loading magnitude P_4 =984 N was greated than P_3. Therefore the Kaiser effect existance was conformed for steels of 10 HSND type.

The AE level was determined in the following way. For investigation the AE tranducer with bandwidth 0.2 ... 0.5 MHz which was installed on the sample by means of contact grease layer CIATIM by a pressing load 1.5 ... 20 N was used. Signals were amplified 34 dB by a preamplifier. After this the sensitivity threshold was determinated by selection of discrimination and sensitivity levels in the AVN - 3 unit. In that way discrimination level was chosen as 0.4 V, and amplifeing coefficient of the unit AVN - 3 was 40 dB with bandwidth Δ f = 380 kHz (120...500 kHz). Period of envelope assess of the AE signals was chosen as 1 ms. Thus the best values for investigation of 10 HSND steel samples were installed and they did not change during experiments. On load opening displacement diagrams (Fig. 1, 2) by points are marced typical segments, where the AE signal characteristics were

obtained, such as summary count of AE signals N, numbers of events in the interval between points n, sum of the signal amplitudes - ΣA, maximum amplitudes in the interval - A_{max} and average signal amplitudes $\bar{A}$, gains of the loading. Below most characteristic acoustograms for each loading segment are presented. The analyses of the results shows that AE signals are presented both in the elastic region near the yield-stress and in the region of plastic deformations. This is illustrated by the table, where numarical results of AE signals and mechanical characteristics are shown.

Analyzing numerical results of the table and figures one can concluded that amplitude parameters of the AE signals and their numbers are in entirely sufficient for utilizing the AE for hoists. as an effective method of the non-destructive control. It is also confirmed by the fact that it is a sensitivity surplus of the AVN - 3 unit both in amplifying coefficient (below 60 dB) and discrimination level. Besides usage of resonance detectors and effective preamplifiers will allow to increase sensitivity of the entire AE measurement channel in spite of background noises and other obstacles.

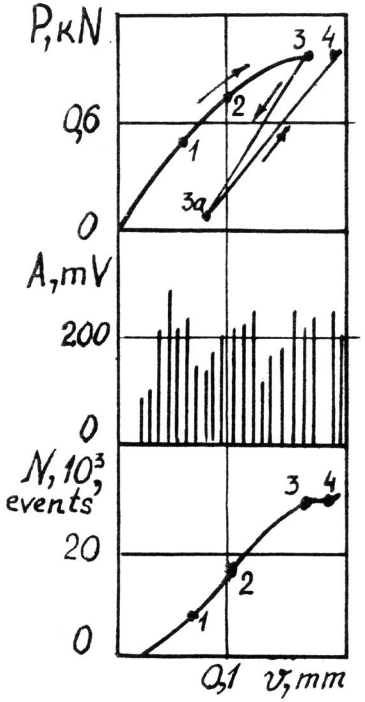


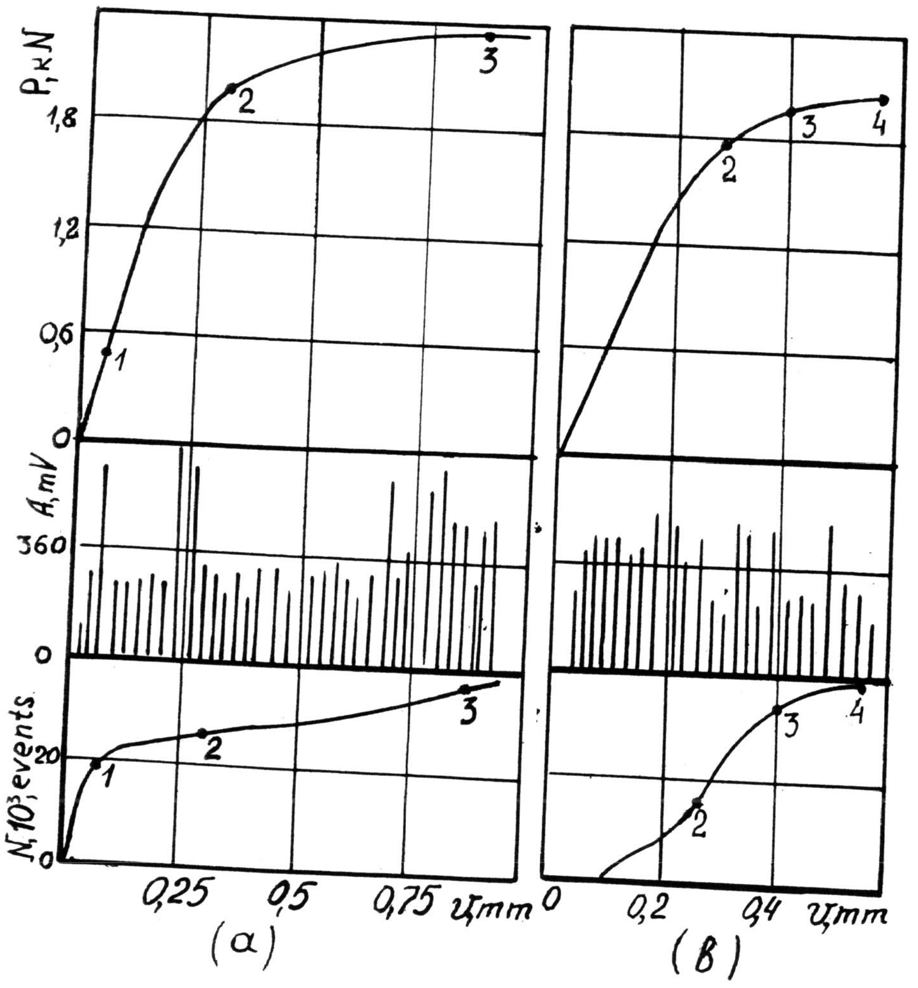
Fig. 1 Relationship between AE signals and loading level for 10 HSND steel.

CONCLUSIONS

1. The Kaiser effect is fulfilled to steels of 10 HSND type that are widely used for manufacturing of hoists.

2. Material operational areas differ in acoustic activity. The most active generation of AE signals takes place under defect formation in the welding zone, the next are bulk metal and the metal of welding joint.

3. The amplitude and numbers of events are different for different deformation zones, but sufficient for AE detection in the object. For example in the interval 0 - 1 (see Fig. 1,2) average amplitude of the AE signals is 360 mV for the samples



(a)

(b)

Fig. 2 Characteristic of variations of P, A effect by v for metal of welding zone (a) and for metal of welding joint (b).

from welding zone 240 mV for the samples from bulk metal and 160 mV for the samples from the metal of welding joint.

4. For effective detection of AE signals from defect formation in 10 HSND steel the measurement unit amplification magnitude 75 dB and discrimination level of 0,3 - 0,5 V are sufficient that allows to use AE directly during the mechanism operation.

Table. Dependence of the loading increment characteristics and sample surface changes on the AE signals.

Sample type	Point on the curve	Event count in the interval, n	Deflection magnitude, δ, mm	Amplitude sum in the interval, ΣA, V	Observation on the lateral surface in the crack tip (microscope magnification x 4,65)
I. Bulk metal. Fig. 1	1	45	0,2	12,5	No changes
	2	50	0,37	18,8	No changes
	3	116	0,57	48,1	The crack opened. Plastic effects are not observed
	4	25	0,8	5,1	Further crack opening
II. Welding zone. Fig. 2a	1	52	0,2	18,9	No changes
	2	162	0,8	54,2	The crack opened, distinctively is seen it outline
	3	96	1,7	34,6	Crack tip rounded slip planes are formed
III. Metal of welding joint. Fig. 2b	2	11	0,53	1,8	No changes
	3	6	0,9	2,1	Considerable opening displacement. Slip planes are formed
	4	6	1,28	2,3	Evolution of slip planes. Crack do not move

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