METHODS FOR COLLECTING AND PROCESSING BASELINE INFORMATION ON THE RELIABILITY OF MINING MACHINE COMPONENTS

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As a source of information for assessing the reliability of the underground mining machines under study, in particular Atlas Copco and Sandvik, statistical data was collected on site in the necessary amounts and according to the above mentioned methodology for collecting information on the performance of the most important components of underground mining machines. Data were obtained and analysed on component running times, failure times and locations, repair times, machine productivity, component replacements and repairs, as well as their operating costs and the labour required for maintenance and repair.

Obtaining reliable information is fraught with a number of difficulties caused by the specifics of operation of underground mining machines in specific conditions of mining enterprises in various industries - coal, non-metallic, iron ore, etc. At estimation of reliability of hydraulic system of underground mining machines in conditions of the Republic of Uzbekistan both reporting data of a number of mining enterprises, namely: reports of dispatching and mechanical services, information of hydromechanical services of mine about replacement of parts and units of underground mining machines, reports of planning departments, etc., and data of operational services of Atlas Copco and Sandvik were used as such information. This information served as the basis for assessing machine reliability while validating its reliability with continuous automated machine observation data.

When planning the volume of determinative amount of data, we used indices numerically characterizing reliability of results: confidence probability - γ related to limiting absolute error - ε condition $\gamma = P(x_0\text{-}x_0)$, and accuracy (relative limiting error $\sigma=\varepsilon/x_0$), where ho is general average value of studied attribute (for example, average MTBF of general totality of homogeneous objects);

x_0 - estimate of feature xo according to the results of observation for the totality of the same objects).

When assessing the reliability of new prototype equipment, the recommended values are $\gamma \geq 0{,}8$; $\sigma \leq 0{,}2$, while for serial equipment these values must be in the range $\gamma \geq 0{,}9$; $\sigma \leq 0{,}1$.

The minimum required sample size [n] depends not only on the values of γ and σ adopted, but also on the type of distribution law,

degree of variation (coefficient of variation) of random variables used to determine reliability indicators (tab. 1).

In the present paper, for the hydraulic equipment as a whole for the investigated machines, a reliable amount of data about failures was determined on the assumption of the exponential law of distribution of operating time between failures (that is true for the complex systems) at γ≥0.9; σ≤0.1.

Thus estimates of reliability indicators of separate hydraulic elements were received with confidence probability γ not less than 0,8 and magnitude of relative error σ not more than 0,15 ... 0,2, and at γ = 0,9 and σ = 0,1 ... 0,15.

Table 1

Volume of sample data required

Law of distribution of random variables (RV)	Coefficient of variation RV	$\gamma = 0,8$		$\gamma = 0,9$	
		$\sigma =$ 0,2	$\sigma =$ 0,15	σ = 0,15	$\sigma =$ 0,1
normal	0,3	6	10	15	31
exponential	1,0	25	45	90	200

A total of 10 underground mining machines from Atlas Copco and Sandvik operating in the Republic of Uzbekistan were analysed.

The level of reliability of the raw data is quite sufficient to be used as a basis for evaluation of machine reliability. When calculating resources (operating time to failure) of separate units and assemblies and other reliability indicators we used methods of mathematical statistics and probability theory. As a result of processing a set of random quantities, we determined the type of their empirical distribution and their characteristics, estimated the law of distribution of random quantities, determined the mathematical expectation, dispersion, and confidence intervals of the average time of no-failure operation.

The reliability of Atlas Copco and Sandvik underground mining machines was determined for the machine as a whole as well as for the main components: the working equipment, the running gear, and the electrical equipment. Particular attention was paid to the hydraulic system and its individual functional groups: high-pressure hoses (hoses), hydraulic cylinders and their fittings, valves, pumps, hydraulic motors, etc. In this case the underground mining machine was presented as a system with a series connection of groups.

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