УДК 62.787

ASSESSMENT OF LIFETIME DATA OF EQUIPMENT

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ОЦЕНКА ДАННЫХ О СРОКЕ СЛУЖБЫ ОБОРУДОВАНИЯ

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Аннотация. *Основной целью анализа данных о сроке службы является прогнозирование надежности и частоты отказов на определенный период времени с использованием параметров функции плотности вероятности. В результате важно описать предыдущие данные о неисправностях и ремонте, тип данных и способы получения информации от экспертов. В статье представлены этапы анализа данных за весь срок службы.*

Introduction. Plant production can be increased while operating costs are greatly decreased with proper equipment maintenance [1]. Professionals in maintenance and dependability can decide on maintenance procedures, inspection procedures, and failure patterns with the help of historical data. A system reliability can be calculated, for instance, by assigning a likelihood of failure to an event and using some probability calculations. To obtain the most precise estimate of the component reliability and, as a result, the system reliability, it is crucial to correctly model the chance of failure [2]. The failure rate plays a key role as a planning parameter for risk-based maintenance optimization [3], optimal maintenance planning [4], and reliability-centered asset maintenance [5].

Methodology. To determine reliability of different components, life data analysis is essential. The lifespan data analysis typically entails the following steps [6]:

1. Collecting and identifying the data sample. The data sample can either be grouped or not grouped data.
2. Choosing the data type. The data type can either be complete, right censored, left censored or multi censored.
3. Performance of goodness of fit test. The most common methods are the plot method, Cramer-von mises, rank regression, likelihood method, Komogorov-Smirnov and Chi-square method.
4. Choosing the probability density function (PDF). Exponential, normal, logistic, lognormal, Weibull, gumbel, gama, rayleigh, and gama g functions are used in mathematics to represent PDFs for reliability engineering. For our research, the Weibull distribution was chosen. The next step will be to define probability density function parameters.
5. Index prediction. This involves PDF function, reliability function, failure rate function, and unreliability function.

Case study on a pump. The initial step in the analysis is to gather failure time data over a 5-year period and separate the many failure types connected with this pump. The pump failure history card is where you may find the history of pump failures. Data from the collection was found to be complete. The best fit analysis is the next stage, which determines which distribution best matches our data. In our case it was found to be 2-parameter Weibull distribution. The estimation method used was ranked regression. Weibull parameters were calculated using the median ranking approach, which employed Bernard's approximation. To perform analysis, Relyence software was used. The calculation results for shape and scale parameters for bearing, mechanical seal and impeller of the centrifugal pump are shown in Table 1. With the parameters, it is possible to calculate reliability and failure rates at any moment using equations presented in Table 1. Figures 1, 2 and 3 show the probability plots of mechanical seal, impeller and bearing.

Table 1

Results from Relyence software

Component	Shape (β)	scale (η(Eta))	Reliability	Failure Rate
Bearing	1.9146	1561.091	$\boldsymbol{R(t) = e^{-\left(\frac{t}{\eta}\right)^{\beta}}}$	$\boldsymbol{\lambda(t) = \frac{\beta}{\eta}\left(\left(\frac{t-\gamma}{\eta}\right)\right)^{\beta-1}}$
Mechanical Seal	1.189	1222.409		
Impeller	1.6448	1147.377		

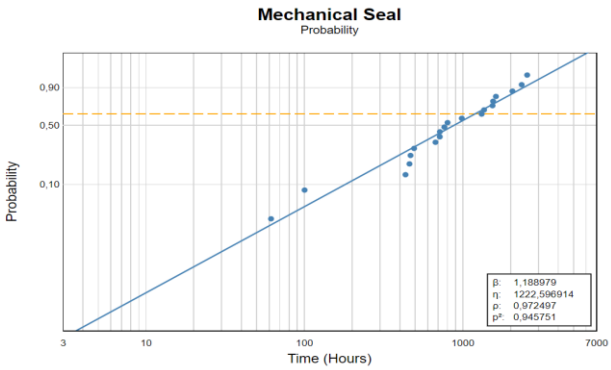

Fig. 1. Probability plot of the mechanical seal

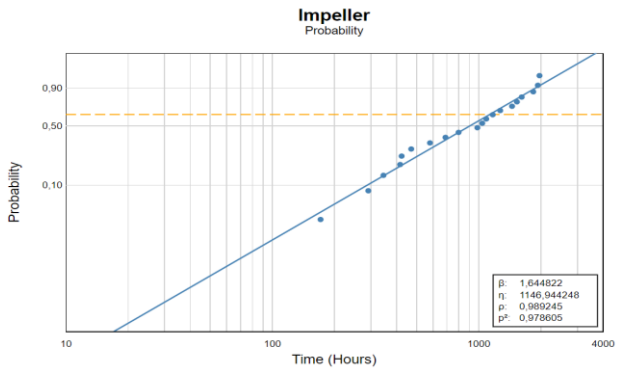

Fig. 2. Probability plot of the impeller

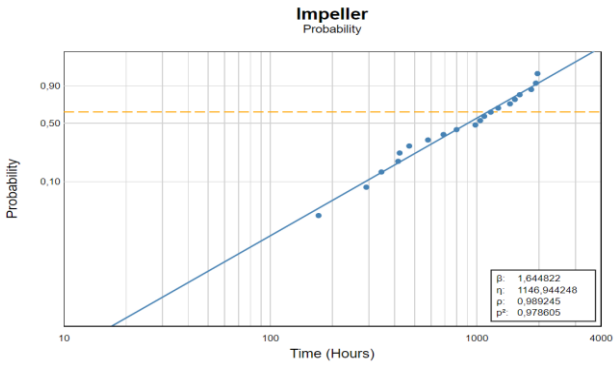

Fig. 3. Probability plot of the bearing

Conclusion. An important tool for performing maintenance and ensuring the reliability of equipment is provided by the availability indicators in equipment monthly report. The system reliability value can be modified by a number of factors depending on the findings of the analysis that is done in the case study. In order to define such indexes as failure rate, reliability, availability, and mean time to failure (MTTF) to support decisions in finding the best time for inspection, maintenance, to see if the equipment has met a reliability requirement, and to provide information to new projects, it is necessary to first understand how failures occur over time. Historical data on failure modes are required to undertake lifetime data analysis. Exponential, normal, logistic, lognormal, and Weibull functions are used in mathematics to represent Probability Density Functions for reliability engineering. By using any probability distribution function for analysis, industries will be able to set priorities for any equipment based on their availability or order of importance to operations.

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