

ASSESSMENT OF THE OXIDATION DEGREE OF TRANSFORMER OILS BASED ON MULTIPLE NON-LINEAR REGRESSION MODELS

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Assessment of insulation condition, especially in the area of permissible values of indicators, is an actual and practically important task, the solution of which gives an opportunity to pass to repair and maintenance of equipment not by calendar period, but by technical condition, as well as to perform forecasting of technical condition. For description of oil oxidation processes it is suggested to use regression model of the form:

$$\hat{t} = \sum_{i=1}^p f(x_i)$$

where \hat{t} is the transformer oil service life, determined by regression model; p is the number of oil quality indicators (regressors); $f(x_i)$ means the dependences of the oil's service life on the values of the oil's quality indicators.

As shown in [1] there is a statistically significant relationship between the oil indicators values and the operating time. At the same time it is shown in [2] that the dependences of transformer oil values on operating time have a complex, non-linear character. The carried out analysis has shown, that the greatest reliability of approximation can be received using the quadratic polynomial. At model training regressors were substituted in the equation in descending order of inverse correlation ratio value – indicators value on operating time [3]. The indicators were substituted into the equations until the global maximum of the goodness-of-fit measure – \bar{R}_p^2 – was reached [3]. For transformers with 60-70 % loading, filled with T-1500 oil, the regression model is as follows:

$$t = -4,559 + 240,952 p_1 - 1456,033 p_1^2 + 2,467 p_2 - 0,264 p_2^2 + 5,472 p_3 - 0,0456 p_3^2$$

where t is the calculated ageing time; p_1 is the current value of the oil's acid number; p_2 is the current value of the oil's colour; p_3 is the current value of the oil's dielectric loss tangent at 90°C.

References:

1. Shutenko O., Ponomarenko S. Reliability assessment of the results of periodic monitoring of the transformer oils condition. *2020 IEEE 4th International Conference on Intelligent Energy and Power Systems (IEPS)*, Istanbul, Turkey, 7–11 September 2020. P. 77–82. DOI: <https://doi.org/10.1109/ieps51250.2020.9263141>.
2. Shutenko O., Ponomarenko S. Analysis of ageing characteristics of transformer oils under long-term operation conditions. *Iranian Journal of Science and Technology, Transactions of Electrical Engineering*. 2022. Vol. 46, no. 2. P. 481–501. DOI: <https://doi.org/10.1007/s40998-022-00492-7>.
3. Shutenko O., Ponomarenko S. Development of a multiple regression model for early diagnosis of transformer oil condition. *Arabian Journal for Science and Engineering*. 2022. DOI: <https://doi.org/10.1007/s13369-021-06418-5>.