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Pengaruh Through Fault Current terhadap Health Index Transformator Berdasarkan Perubahan Karakteristik dan Konsentrasi Gas DGA pada Minyak Isolasi
Anindita Singgih Pambudi, Prof. Ir. Tumiran, M. Eng., Ph. D., IPU. ; Ir. Lesnanto Multa Putranto, S.T., M.Eng., Ph.D.,
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

ABSTRAK

Transformator merupakan peralatan listrik tegangan tinggi yang berperan penting dalam menjaga kontinuitas penyaluran energi listrik kepada pelanggan. Gangguan hubung singkat pada jaringan distribusi 20 kV di sisi tegangan rendah transformator daya menyebabkan arus *Through Fault Current* (TFC) mengalir pada belitan transformator. Paparan TFC dapat menimbulkan *stress* termal dan dielektrik yang menurunkan kualitas sistem isolasi transformator serta memicu terbentuknya gas terlarut karakteristik *Dissolved Gas Analysis* (DGA). Kondisi tersebut mengindikasikan terjadinya degradasi sistem isolasi transformator. Namun, penelitian mengenai analisis kuantitatif degradasi minyak isolasi akibat paparan TFC masih relatif terbatas. Oleh karena itu, diperlukan pendekatan metode statistika untuk menganalisis kecenderungan degradasi minyak isolasi serta evaluasi kondisi transformator melalui perhitungan *Health Index* berdasarkan parameter minyak isolasi.

Penelitian ini menganalisis pengaruh TFC terhadap degradasi minyak isolasi dan perubahan *Health Index* transformator berdasarkan data riwayat gangguan dan hasil pengujian minyak isolasi. Analisis dilakukan menggunakan metode statistika *Multivariate Linear Regression* (MLR) dan *Support Vector Regression* (SVR). Metode MLR digunakan untuk menganalisis hubungan linier antara TFC dan degradasi minyak isolasi, sedangkan metode SVR digunakan untuk memodelkan hubungan nonlinier antara keduanya. Evaluasi kondisi transformator dilakukan menggunakan metode *Analytical Hierarchy Process* (AHP) melalui proses *scoring* dan pembobotan parameter minyak.

Berdasarkan evaluasi koefisien determinasi (R^2), metode MLR lebih sesuai digunakan untuk menganalisis pengaruh TFC terhadap perubahan konsentrasi gas DGA, sedangkan metode SVR lebih baik dalam merepresentasikan perubahan karakteristik minyak isolasi. Hasil regresi menunjukkan *Health Index* mulai menurun pada persentase kumulatif TFC sebesar 3,17% dan diprediksi mencapai *end of life* pada 71,76%.

Kata kunci— TFC, *Health Index*, Transformator, Minyak Isolasi

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ABSTRACT

Power transformers are high-voltage electrical equipment that play an important role in maintaining the continuity of electrical power delivery to customers. Short-circuit faults in the 20 kV distribution network on the low-voltage side of a power transformer cause Through Fault Current (TFC) to flow through the transformer windings. TFC exposure can generate thermal and dielectric stresses that reduce the quality of the transformer insulation system and trigger the formation of dissolved gases characterized by Dissolved Gas Analysis (DGA). These conditions indicate degradation of the transformer insulation system. However, research related to the quantitative analysis of insulating oil degradation caused by TFC exposure is still relatively limited. Therefore, a statistical approach is required to analyze insulating oil degradation trends and evaluate transformer condition through Health Index calculation based on insulating oil parameters.

This study analyzes the effect of TFC on insulating oil degradation and transformer Health Index variation based on disturbance history and insulating oil test data. The analysis was conducted using Multivariate Linear Regression (MLR) and Support Vector Regression (SVR) statistical methods. MLR was used to analyze the linear relationship between TFC and insulating oil degradation, while the SVR method was applied to model the nonlinear relationship between the two variables. Transformer condition evaluation was performed using the Analytical Hierarchy Process (AHP) method through scoring and weighting processes of insulating oil parameters.

Based on the coefficient of determination (R^2) evaluation, the MLR method was found to be more suitable for analyzing the effect of TFC on changes in DGA gas concentration, whereas the SVR method better represented changes in insulating oil characteristics. The regression results indicate that the Health Index begins to decline at a cumulative TFC percentage of 3.17% and is predicted to reach end of life at a cumulative TFC percentage of 71.76%.

Keywords— *TFC, Health Index, Transformer, Insulating Oil*