

RINGKASAN

ANALISIS SUSUT UMUR TRANSFORMATOR TENAGA AKIBAT SUHU OPERASIONAL DI GARDU INDUK 150 kV KALIBAKAL PURWOKERTO

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Transformator merupakan peralatan listrik yang berfungsi untuk menaikkan atau menurunkan tegangan listrik pada sistem tenaga dengan memanfaatkan prinsip induksi elektromagnetik serta berperan penting dalam menjaga keandalan penyaluran energi listrik. Dalam pengoperasiannya, transformator mengalami pemanasan akibat pembebanan dan kondisi lingkungan yang memengaruhi suhu minyak dan belitan, sehingga berdampak pada penuaan isolasi dan umur pakainya. Penelitian ini menganalisis pengaruh suhu operasional terhadap susut umur transformator tenaga dengan studi kasus Transformator 4 dan Transformator 5 di Gardu Induk Kalibakal menggunakan metode perhitungan berdasarkan standar IEC 60076-7. Parameter yang dianalisis meliputi suhu *top oil*, suhu *hotspot*, Faktor Percepatan Penuaan (FAA), dan *Loss of Life* (LOL), serta didukung oleh sistem pakar berbasis Microsoft Excel. Hasil penelitian menunjukkan bahwa meskipun transformator beroperasi dalam kondisi suhu yang normal dan aman, akumulasi suhu *hotspot* tetap memberikan pengaruh signifikan terhadap susut umur transformator, yang ditunjukkan oleh estimasi sisa umur Transformator 4 sebesar sekitar 10,9 tahun dan Transformator 5 sebesar sekitar 19,9 tahun. Nilai sisa umur tersebut bersifat indikatif, karena diperoleh berdasarkan data suhu operasional pada periode pengamatan tertentu dan asumsi umur desain transformator, sehingga dapat berubah apabila kondisi pembebanan dan suhu operasional mengalami perubahan.

Kata kunci: transformator tenaga, suhu operasional, suhu *hotspot*, *loss of life*, sisa umur.

SUMMARY

ANALYSIS OF POWER TRANSFORMER LIFE LOSS DUE TO OPERATIONAL TEMPERATURE VARIATIONS AT 150 kV KALIBAKAL SUBSTATION PURWOKERTO

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Transformer is an electrical apparatus used to step up or step down voltage in power systems based on the principle of electromagnetic induction and plays a crucial role in maintaining the reliability of electrical energy distribution. During operation, transformers experience heating due to load variations and ambient conditions, which affect oil and winding temperatures and consequently influence insulation aging and service life. This study analyzes the effect of operating temperature on transformer loss of life, using Transformer 4 and Transformer 5 at Kalibakal Substation as case studies, based on calculations in accordance with IEC 60076-7. The analyzed parameters include top oil temperature, hotspot temperature, Aging Acceleration Factor (FAA), and Loss of Life (LOL), supported by an expert system implemented in Microsoft Excel. The results indicate that although the transformers operate under normal and safe temperature conditions, the cumulative effect of hotspot temperature significantly contributes to transformer aging. This is reflected in the estimated remaining life of approximately 10,9 years for Transformer 4 and 19,9 years for Transformer 5. These remaining life values are indicative rather than absolute, as they are derived from operating temperature data over a limited observation period and are based on design-life assumptions; therefore, they may change with variations in load and operating conditions.

Keywords: power transformer, operating temperature, hotspot temperature, loss of life, remaining life,