ABSTRAK

Transformator daya merupakan peralatan penting dalam sistem tenaga listrik yang memerlukan pemantauan kondisi untuk menjaga keandalan operasinya. Salah satu metode yang banyak digunakan adalah *Dissolved Gas Analysis* (DGA), namun hasil diagnosis dari berbagai metode DGA konvensional sering menghasilkan interpretasi yang berbeda sehingga diperlukan suatu pendekatan untuk mengintegrasikan hasil diagnosis tersebut. Penelitian ini bertujuan menganalisis kondisi transformator daya menggunakan metode *fuzzy logic* Tsukamoto dengan mengintegrasikan enam metode DGA konvensional, yaitu *IEC Ratio*, *Rogers Ratio*, *Doernenburg Ratio*, *Duval Triangle*, *Duval Pentagon*, dan *Four Gases*. Hasil diagnosis dari masing-masing metode dikonversi ke dalam nilai numerik berdasarkan tingkat keparahan gangguan, kemudian diproses melalui tahapan fuzzifikasi, inferensi, defuzzifikasi, hingga menghasilkan kondisi akhir transformator. Sistem diimplementasikan menggunakan Python pada Google Colab dan divalidasi melalui perbandingan hasil perhitungan manual, pengujian data historis, data skenario, pengujian sensitivitas, serta validasi menggunakan data penelitian terdahulu. Hasil pengujian menunjukkan bahwa seluruh data historis berada pada kategori Waspada dengan nilai *output* sebesar 50,00–60,26. Selisih antara perhitungan manual dan sistem berada pada rentang 0–0,37, sedangkan hasil validasi literatur menunjukkan bahwa keluaran sistem memiliki tingkat keparahan yang sejalan dengan karakteristik gangguan pada penelitian referensi. Berdasarkan hasil tersebut, metode *fuzzy logic* Tsukamoto mampu mengintegrasikan hasil diagnosis berbagai metode DGA menjadi keputusan kondisi transformator yang lebih objektif, sistematis, dan konsisten.

Kata kunci: *Dissolved Gas Analysis*, *fuzzy logic*, Tsukamoto, transformator daya.

ABSTRACT

Power transformers are essential components in electrical power systems whose operating reliability depends on accurate condition monitoring. One of the most widely used diagnostic techniques is Dissolved Gas Analysis (DGA); however, conventional DGA methods often produce inconsistent diagnostic interpretations. This study aims to analyze power transformer conditions using the Tsukamoto fuzzy logic method by integrating six conventional DGA techniques: IEC Ratio, Rogers Ratio, Doernenburg Ratio, Duval Triangle, Duval Pentagon, and Four Gases. The diagnostic results were converted into numerical values based on fault severity and processed through fuzzification, inference, and defuzzification to determine the final transformer condition. The proposed system was implemented using Python in Google Colab and validated through comparisons with manual calculations, historical transformer data, scenario-based testing, sensitivity analysis, and validation using data from previous studies. The results show that all historical data were classified as Warning, with output values ranging from 50.00 to 60.26. The difference between manual and system calculations ranged from 0 to 0.37, while literature validation demonstrated that the system produced condition assessments consistent with the fault severity characteristics reported in the reference study. These results indicate that the Tsukamoto fuzzy logic method is capable of integrating multiple conventional DGA diagnoses into a transformer condition assessment that is more objective, systematic, and consistent.

Keywords: *Dissolved Gas Analysis, fuzzy logic, Tsukamoto, power transformer.*