

Keandalan hasil pengujian tegangan tembus minyak transformator dipengaruhi oleh kondisi sampel dan konsistensi prosedur pengujian. Perbedaan suhu awal minyak dapat menghasilkan nilai tegangan tembus dan tingkat penyebaran data yang berbeda, sehingga pengendalian kondisi suhu diperlukan agar hasil pengujian dapat dibandingkan secara tepat. Selain itu, dibutuhkan sel uji yang dapat mempertahankan posisi elektroda dan menampung sampel minyak selama pengujian. Penelitian ini bertujuan menganalisis nilai dan konsistensi tegangan tembus minyak transformator pada beberapa variasi suhu awal menggunakan sel uji cetak 3D. Pengujian dilakukan dengan memastikan kondisi sel uji memenuhi standar serta suhu ruang nominal 25 °C dengan suhu awal minyak 15 °C, 20 °C, 25 °C, dan 20,5 °C. Pada setiap kondisi dilakukan enam kali penerapan tegangan hingga terjadi tembus. Data dianalisis menggunakan nilai rata-rata, median, standar deviasi, dan rasio standar deviasi terhadap rata-rata. Hasil penelitian menunjukkan bahwa Pengujian I, II, III, dan IV menghasilkan rata-rata tegangan tembus berturut-turut sebesar 15,03 kV, 17,812 kV, 18,174 kV, dan 12,911 kV. Rasio standar deviasi terhadap rata-rata masing-masing pengujian sebesar 0,2852; 0,2654; 0,314; dan 0,1587. Pengujian pada suhu awal 20,5 °C menghasilkan penyebaran relatif paling kecil. Sementara itu, pengujian pada suhu awal 25 °C menghasilkan rata-rata tegangan tembus tertinggi, tetapi disertai penyebaran data yang lebih besar. Hasil tersebut menunjukkan bahwa setiap kondisi suhu awal menghasilkan karakteristik nilai dan penyebaran tegangan tembus yang berbeda. Pada konfigurasi yang diuji, suhu awal 20,5 °C memberikan hasil paling konsisten, sedangkan suhu awal 25 °C menghasilkan rata-rata tegangan tembus tertinggi. Penelitian ini juga menunjukkan bahwa pengendalian suhu awal dan konsistensi prosedur perlu diperhatikan secara bersamaan dalam pengujian tegangan tembus minyak transformator. Sel uji cetak 3D dapat digunakan sebagai perangkat pendukung pada konfigurasi pengujian yang diterapkan dalam penelitian ini.

Kata kunci : minyak transformator, suhu awal, tegangan tembus, konsistensi pengujian, sel uji cetak 3D.

The reliability of transformer oil breakdown voltage testing results is influenced by sample conditions and the consistency of testing procedures. Differences in the initial oil temperature can lead to varying breakdown voltage values and data dispersion levels; therefore, temperature control is essential to ensure that testing results can be accurately compared. Furthermore, a test cell capable of maintaining electrode positioning and holding the oil sample during testing is required. This study aims to analyze the value and consistency of transformer oil breakdown voltage across several initial temperature variations using a 3D-printed test cell. Testing was conducted by ensuring that the conditions of the test cell complied with standard specifications and the ambient temperature was maintained at a nominal 25 °C, with initial oil temperatures of 15 °C, 20 °C, 25 °C, and 20.5 °C. For each condition, six applications of voltage were performed until breakdown occurred. Data were analyzed using the mean, median, standard deviation, and the ratio of standard deviation to the mean. The results indicate that Tests I, II, III, and IV yielded average breakdown voltages of 15,03 kV, 17,812 kV, 18,174 kV, and 12,911 kV, respectively. The standard deviation-to-mean ratios for each test were 0.2852, 0.2654, 0.314, and 0.1587, respectively. Testing at an initial temperature of 20.5 °C produced the smallest relative dispersion. Conversely, testing at an initial temperature of 25 °C resulted in the highest average breakdown voltage, albeit accompanied by greater data dispersion. These findings indicate that each initial temperature condition generates distinct breakdown voltage values and dispersion characteristics. In the evaluated configuration, the initial temperature of 20.5 °C provided the most consistent results, whereas the initial temperature of 25 °C yielded the highest average breakdown voltage. This study also demonstrates that initial temperature control and procedural consistency must be considered simultaneously in transformer oil breakdown voltage testing. The 3D-printed test cell can be utilized as a supporting device in the testing configuration implemented in this research.

Keywords : *transformer oil, initial temperature, breakdown voltage, testing consistency, 3D-printed test cell.*