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Analisis Limitasi Tegangan Surge Arrester Berbasis Pengujian Tegangan Impuls Petir
DHARMA ADYAN PINANDHITO, Ir. Bambang Sugiyantoro, M.T.; Mochammad Wahyudi, S.T., M.T.
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INTISARI

Sistem tenaga listrik di Indonesia memiliki tingkat kerentanan yang tinggi terhadap gangguan petir akibat intensitas sambaran petir yang besar. Kondisi ini menuntut penerapan sistem proteksi yang andal, salah satunya menggunakan *surge arrester*, untuk melindungi peralatan listrik dari lonjakan tegangan lebih. Oleh karena itu, pemahaman terhadap karakteristik limitasi tegangan *surge arrester* menjadi aspek penting dalam perancangan dan koordinasi proteksi sistem tenaga.

Penelitian ini bertujuan untuk menganalisis karakteristik limitasi tegangan *surge arrester* melalui pengujian tegangan impuls petir serta mengevaluasi keterbatasan pembentukan kurva karakteristik berbasis *volt–time*. Pengujian dilakukan pada dua sampel *surge arrester*, yaitu *surge arrester rating* 15 kV (Ultrasil) dan 24 kV (SWE), menggunakan tegangan uji *full lightning-impulse* 1.2/39 μs. Tegangan impuls dihasilkan menggunakan generator impuls Ogawa Seiki 200 kV di Laboratorium Teknik Tegangan Tinggi DTETI FT UGM, dengan variasi tingkat tegangan *charging* dan penyesuaian jarak *spark gap*. Data gelombang impuls yang diperoleh direkam menggunakan osiloskop dan diolah menggunakan pemrograman Python untuk menentukan parameter gelombang serta karakteristik tegangan residual.

Hasil pengujian menunjukkan bahwa tegangan impuls yang dihasilkan hanya membentuk karakteristik limitasi tegangan pada bagian *front* gelombang impuls. Kurva *volt–time* yang terbentuk dari hasil pengujian tidak menunjukkan karakteristik lengkap sebagaimana kurva koordinasi isolasi, melainkan hanya menyerupai garis linear yang merepresentasikan respons *surge arrester* terhadap satu nilai *front time*. Selain itu, *surge arrester* 24 kV menunjukkan tingkat limitasi tegangan yang lebih tinggi, yaitu pada kisaran 45–48 kV, sedangkan *surge arrester* 15 kV hanya sekitar 28–32 kV, sejalan dengan perbedaan *rating* tegangannya. Temuan ini menegaskan bahwa pembentukan kurva proteksi *surge arrester* secara utuh memerlukan pengujian dengan variasi *front time* dan *tail time* impuls, sehingga penggunaan satu jenis gelombang impuls saja tidak cukup untuk merepresentasikan karakteristik *volt–time* dari *surge arrester* secara komprehensif.

Kata kunci: *surge arrester*, tegangan impuls, *front time*, tegangan residual, kurva karakteristik *volt-time*.

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ABSTRACT

The electric power system in Indonesia has a high level of vulnerability to lightning disturbances due to the country's high lightning strike density. This condition necessitates the implementation of reliable protection systems, one of which is the use of surge arresters to protect electrical equipment from overvoltage conditions. Therefore, understanding the voltage limiting characteristics of surge arresters is an important aspect in the design and coordination of power system protection.

This study aims to analyze the voltage limiting characteristics of surge arresters through lightning impulse voltage testing and to evaluate the limitations of forming arrester's characteristic curves based on the volt-time approach. The tests were conducted on two surge arrester samples, namely a 15 kV-rated surge arrester (Ultrasil) and a 24 kV-rated surge arrester (SWE), using a full lightning impulse voltage of 1.2/39 μs. The impulse voltage was generated using a 200 kV Ogawa Seiki impulse voltage generator at the High Voltage Engineering Laboratory, Department of Electrical Engineering, Universitas Gadjah Mada. The test voltage levels were varied by adjusting the charging voltage and the spark-gap spacing. The resulting impulse waveforms were recorded using an oscilloscope and processed using Python-based programming to determine waveform parameters and residual voltage characteristics.

The test results show that the generated impulse voltage only forms voltage limiting characteristics in the front region of the impulse waveform. The volt-time curve obtained from the test results does not exhibit a complete characteristic similar to insulation coordination curves, but instead resembles a nearly linear relationship representing the surge arrester response to a single front-time value. Furthermore, the 24 kV surge arrester exhibits a higher voltage limiting level, with peak residual voltages of approximately 45-48 kV, compared to approximately 28-32 kV for the 15 kV surge arrester, which is consistent with the difference in their voltage ratings. These findings confirm that the formation of a complete surge arrester protection curve requires impulse testing with variations in front time and tail time, and that the use of a single impulse waveform type is insufficient to comprehensively represent the volt-time characteristics of surge arresters.

Keywords : surge arrester, impulse voltage, front time, residual voltage, volt-time characteristic