Study of power conversion characteristics using multi-phase transformers -Comparison between special winding type and Zigzag type-

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Introduction

In recent years, DC technology, which is highly compatible with renewable energy, has been in the limelight as we move toward a decarbonized society [1]. The authors have developed and conducted various studies on a multiphase transformer with special winding type for AC/DC conversion to utilize grid power for DC feeding and distribution [2]. When configuring a multipulse rectification system, the transformer using special winding type offers the advantage of reducing winding compared to using zigzag type. In this paper, we have studied the case where a distributed power supply such as photovoltaic power generation is connected to the secondary side of the transformer using an actual transformer. Specifically, it compares the DC voltage ripple when using a transformer with Zigzag type and a transformer with special winding type.

Experimental Method

First, the experimental circuit is shown in Figure 1. Using this circuit, we evaluate the DC voltage under two patterns: when the transformer with Zigzag type and when with special winding type. In this study, we used the power supply unit as an alternative to the standalone operation mode of PCS. The power consumption for both DC loads and AC loads in each test shall be 1 kW. Additionally, the transformers used in the experiment have 12 phases at secondary side, a capacity of 5 kVA, and a transformation ratio of AC 200 V/DC 350 V.

Results and Discussion

The DC voltage when using a transformer with Zigzag type is shown in Figure 2, and when using a transformer with special winding type is shown in Figure 3. These data were collected with a sampling frequency of 1 MHz. Next, the ripple ratio was calculated using the voltage's average and peak to peak. The results showed a DC voltage ripple ratio of 2.56 % for the Zigzag type and 2.68 % for special winding type. Therefore, it was found that when supplying power from the transformer secondary side, there is no significant difference in DC voltage ripple whether a transformer with Zigzag type or a transformer with special winding type is used. However, since the AC components of each order contained in the DC voltage differ, further analysis is considered necessary.

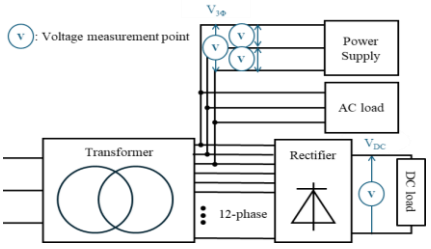

Figure 1 Experimental circuit

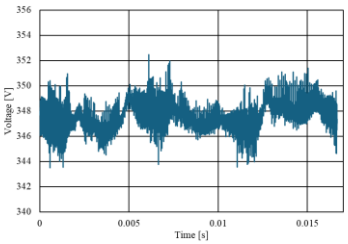

Figure 2 DC Voltage using Zigzag type

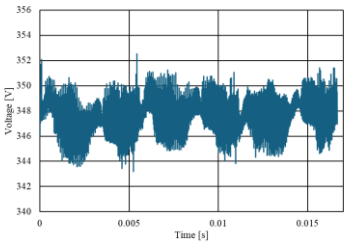

Figure 3 DC Voltage using Special winding

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References

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[2] A. Matsunaga et al. “A Study of Rectifier Circuit Failure with Special Winding Type Twenty-four phase Transformer,” 2024 13th International Conference on Renewable Energy Research and Applications (ICRERA), Nagasaki, Japan, 2024