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Research Article

Design And Engineering Testing Of A Neutral Line Current Eliminator.

Xuxin Zhao[a], Fuman Luo[b].

[a]*College of Chemistry and Environmental Engineering, Shenzhen University, Shenzhen 518060, Guangdong, China.*
[b]*Shenzhen Xinhengji Electric Appliance Co., Ltd, Shenzhen 518000, Guangdong, China.*

Abstract

This paper proposes a device to reduce neutral line current based on the principle of magnetic flux compensation. The device achieves phase shifting through a specially designed magnetic circuit transformer with adjustable coils, generating magnetic fluxes of equal magnitude but opposite direction to counteract the harmonic-induced fluxes, thereby suppressing neutral line current. The circuit design of the neutral line current eliminator is introduced. Measurements conducted on actual engineering loads show that the harmonic current on the neutral line is reduced by more than 90%.

Keywords : *Magnetic flux compensation, Phase shifting method, Neutral line current, Neutral line current eliminator.*

INTRODUCTION

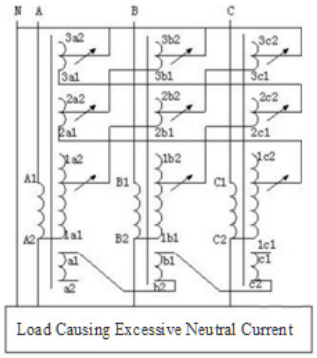
In modern power systems, harmonic pollution caused by the widespread use of nonlinear loads has become a significant factor in the degradation of power quality. Nonlinear loads generate harmonic currents of various frequencies, especially zero-sequence harmonics that accumulate on the neutral line, leading to overheating and, in severe cases, damage or even fire, posing risks to the safe and stable operation of power systems [1]. Therefore, addressing the issue of excessive neutral line current is of great importance.

This paper proposes a device to reduce neutral line current based on the principle of magnetic flux compensation [2]. The device achieves phase shifting through a specially designed magnetic circuit transformer with adjustable coils, generating magnetic fluxes of equal magnitude but opposite direction to counteract the harmonic-induced fluxes, thereby suppressing neutral line current. The circuit design of the neutral line current eliminator is introduced. Measurements conducted on actual engineering loads show that the harmonic current on the neutral line is reduced by more than 90%.

DESIGN OF THE NEUTRAL LINE CURRENT ELIMINATOR

The neutral line current eliminator(NCE), designed with an improved zigzag phase-shifting zero-sequence magnetic flux compensation circuit, is shown in **Figure 1**. It mainly consists of a magnetic circuit three-phase transformer, a sampling unit, a controller, and an actuation unit. The controller is electrically connected to the sampling unit and the actuation unit, the actuation unit is electrically connected to the magnetic circuit three-phase transformer, and the magnetic circuit three-phase transformer is connected to the load [3-6].

Figure 1. Structure of the NCE.



***Corresponding Author:** **Xuxin Zhao**, College of Chemistry and Environmental Engineering, Shenzhen University, Shenzhen 518060, Guangdong, China, **Email:** zhaoxx@szu.edu.cn
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Sampling Unit: Collects the voltages of the A, B, and C phases of the load, the currents of the A, B, C, and N lines, and the voltages and currents of a2 and c1 in the open-delta connection.

Controller: Calculates the collected voltages of the A, B, and C phases, the currents of the A, B, C, and N lines, and the voltages and currents of a2 and c1 in the open-delta connection; calculates the magnetic flux generated by the zero-sequence current of the load and its direction in the core; calculates the required voltage and phase-shifting angle to generate the reverse magnetic flux; outputs control commands to the actuation unit.

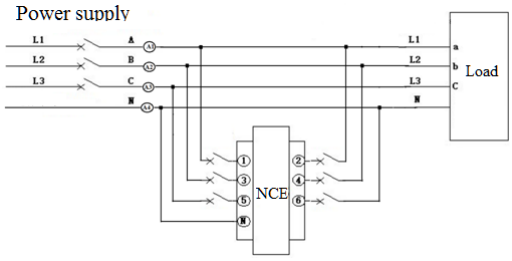
Actuation Unit: Controls the phase-shifting angle and capacity by adjusting the number of turns of three sets of adjustable secondary coils, generating a reverse magnetic flux to counteract the original zero-sequence magnetic flux. The actuation unit adjusts the number of turns of the coils according to the instructions.

Magnetic Circuit Three-Phase Transformer: The capacity of the three sets of adjustable coils is designed based on the magnitude of the neutral line current. Each set is connected in a head-to-tail delta configuration, controlling the magnetic flux direction by adjusting the phase-shifting angle and the capacity by adjusting the voltage.

WIRING DIAGRAM OF THE NEUTRAL LINE CURRENT ELIMINATOR

The connection of the neutral line current eliminator to the load equipment is shown in **Figure 2**. The current measurement points in the test are A1 to A4. A1, A2, and A3 record the line currents on the power supply side, while A4 records the neutral line current on the power supply side.

Figure 2. Wiring Diagram of the NCE.



4. Test Results and Discussion

Based on preliminary tests of the LED load characteristics at a commercial plaza in Shenzhen, the neutral line current eliminator designed in this paper was tested in an engineering trial. The test results are shown in **Figures 3** to **6**.

Figure 3. Neutral line current before the operation of the NCE.

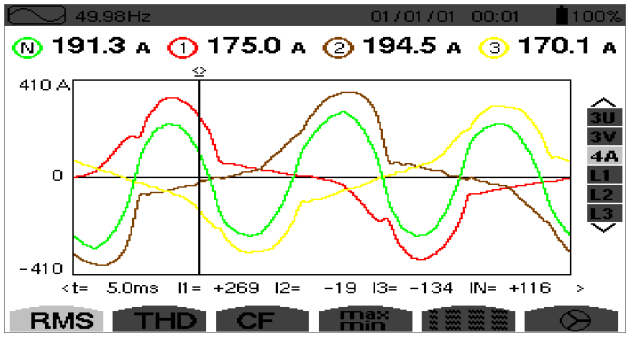
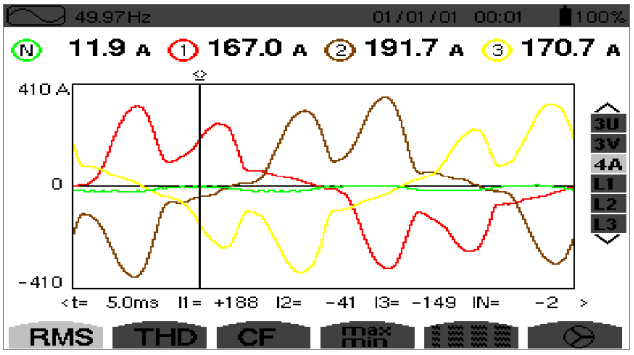


Figure 4. Neutral line current after the operation of the NCE



From **Figures 3** and **4,** it can be observed that the neutral line current decreased from 191.3 A to 11.9 A, achieving a neutral line current reduction rate of 93.8%. This indicates that the neutral line current eliminator has a significant effect on reducing neutral line current in engineering trials.

Figure 5. Harmonic current before the operation of the NCE.

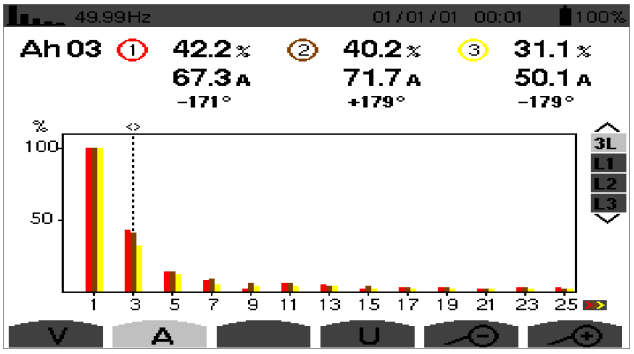
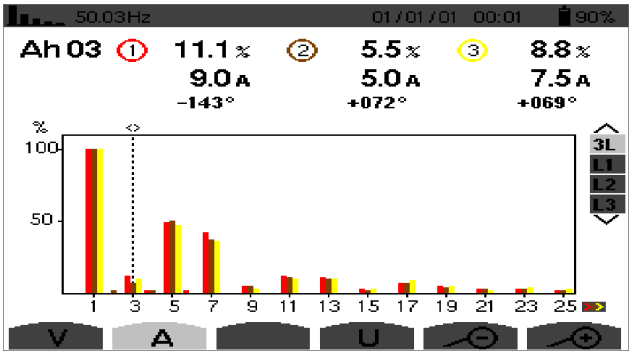


Figure 6. Harmonic current after the operation of the NCE.



From **Figures 5** and **6**, it can be seen that the 3rd harmonic current content in the three phases decreased from 42.2%, 40.2%, and 31.1% to 11.1%, 5.5%, and 8.8%, respectively. This demonstrates that the neutral line current eliminator has a high removal rate for the 3rd harmonic.

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