Mechanism and Calculation of Multipoint Grounding Current of Converter Transformer Core

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Abstract

This paper presents mechanism and calculation of multipoint grounding current of converter transformer core. Firstly, the core multipoint grounding equivalent circuit and the circuit impedance calculation method are given and the analytical calculation under harmonic and DC bias is carried out. Secondly, the anisotropic resistivity matrix based on the homogenization modeling theory is given and the FEM calculation under harmonic and DC bias is carried out. Then, the core multi-point grounding test based on the converter transformer model was carried out under harmonic and DC bias is carried out. Finally, the mechanism of multipoint grounding current of core is given, and correctness of the calculation method is verified.

1 Introduction

Converter transformer as one of the core equipment of HVDC transmission system, its core must be grounded at one point [1-2]. If insulation fault, process failure or internal impurities cause electrical contact between core and clamp, the core will be grounded at multipoint. The main harm of multipoint grounding of the core is that it will form a loop inside the converter transformer and generate a large current, which may cause high temperature hot spots. In [3], the defect of multipoint grounding fault of a 500kV transformer clamping piece is found through the power failure inspection and corresponding measures are taken to successfully eliminate the fault. There are only qualitatively stated that the loop induced current will be much larger than the normal grounding current, with few detailed analysis.

This paper presents mechanism and calculation of multipoint grounding current of converter transformer core. As shown in the Fig.1, analytical methods, FEM and experiments are carried out. Firstly, the core multi-point grounding equivalent circuit and the circuit impedance calculation method are given and the analytical calculation under harmonic and DC bias is carried out. Secondly, the anisotropic resistivity matrix based on the homogenization modeling theory is given and the FEM calculation under harmonic and DC bias is carried out. Then, the core multi-point grounding experiment based on the converter transformer model was carried out under harmonic and DC bias is carried out. Finally, the mechanism of multi-point grounding current of converter transformer core is given, and the correctness of the calculation method is verified by experiment.

2 Calculation and experiment on the multipoint grounding current of core

In Fig.1, I and II are the analytical calculation and FEM calculation process. Fig.1, Ⅲ is the experimental platform. Conduct multipoint grounding experiments on the converter transformer model shown in Fig.1 by forming a faulty grounding point and a faulty loop through metal wires. Programmable AC/DC power supplies provide complex excitation (harmonic and DC bias) to simulate the actual working conditions of converter transformers. Randomly select six fault grounding points and conduct analytical calculations , FEM calculaton and experiments under multipoint grounding faults.

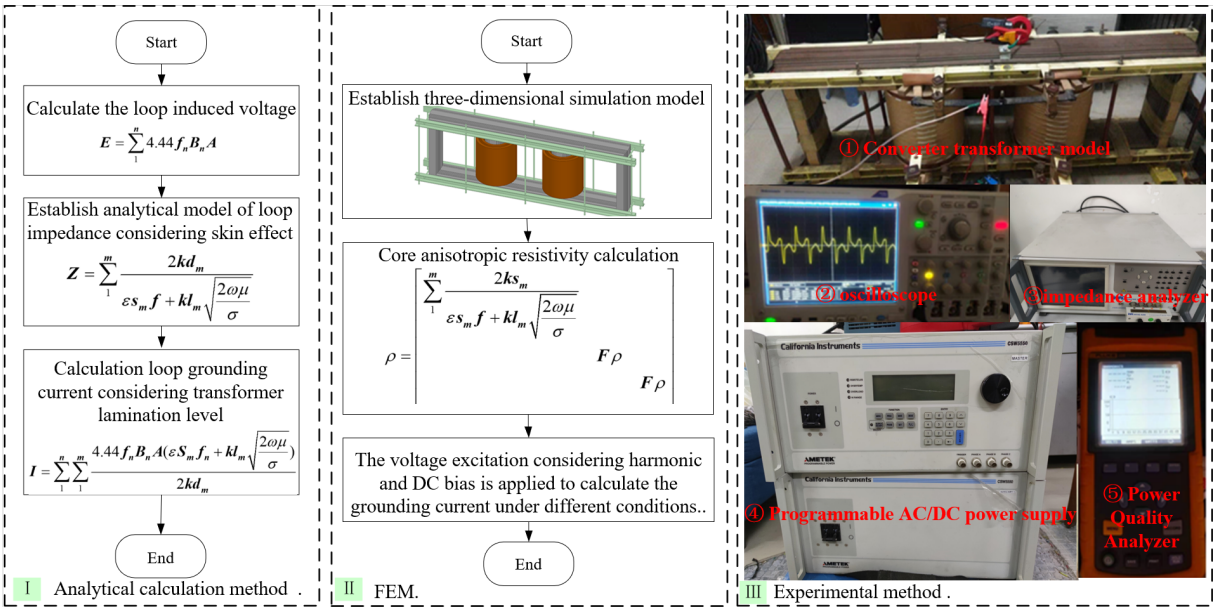
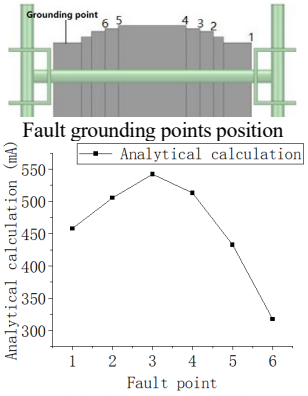
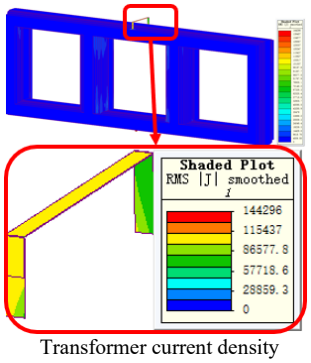
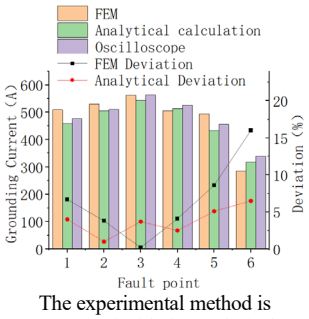


Fig.1 Reserch process flowchart

Table 1 The analytical calculation and experiment results

Transformer parameter		Analytical calculation	FEM	Experiment comparison
Capacity	160kVA			
Core style	Single-phase			
Lamination factor	0.96			
Silicon steel sheet brand	30ZH120			
Voltage ratio	2/0.4kV			

Multipoint grounding value

Transformer current density distribution

The experimental method is compared with the analytical method and FEM.

3 Conclusion

This paper investigates the mechanism of multipoint grounding current in converter transformer core by three methods. The factors and effects of the multipoint grounding current of the converter transformer core were clarified. Loop induced voltage mainly depends on the main magnetic flux area enclosed by the loop, and secondary affected by the leakage magnetic flux area enclosed by the loop; The loop impedance depends on the distance between the fault point in the direction of the core lamination and the grounding point, as well as the insulation performance of the insulation paint film. The correctness of the proposed method was verified through experiments. Due to space limitations, details such as harmonic and DC bias have been omitted, detailed process and result will be shown in full paper.

References

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