#Po2.07-06 •Experiment Study on an Inductive Superconducting Fault Current Limiter Using No-Insulation Coils

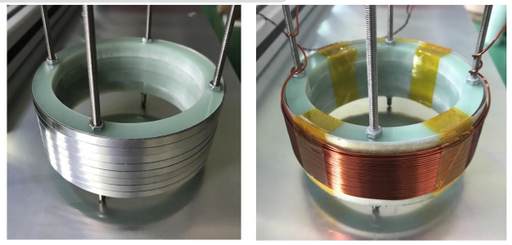
D. Qiu[1], Z.Y. Li[1], Z. Huang[1], A. Zhao[1], D. Hu[1], Z. Hong[1, 2], and Z. Jin[1]

Shanghai Jiao Tong University[1], China; Shanghai Superconductor Technology Co. Ltd[2], China

Introduction

- A novel **inductive superconducting fault current limiter** (iSFCL), using **NI coils** as the **secondary shielding winding**, is fabricated and tested, which is based on that the NI coil can shield alternating magnetic field [1].
- The **impedance variation test** is conducted using a current source. And the **fault current limiting** is conducted on a **40 V / 3.3 kA** short circuit platform, whose voltage can be adjusted from 0 to 40 V.
- This research is aimed to verify the **feasibility of applying the NI coils into iSFCL**, which is a trial on the AC power area of NI coil.

Experiment Setup



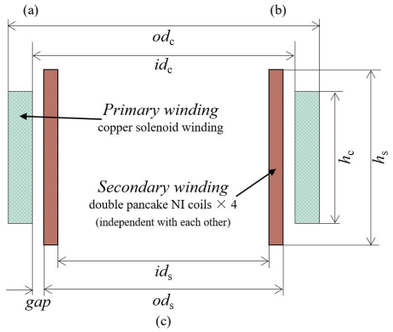


Fig. 1. Photos of the iSFCL prototype, (a) the secondary shielding winding and (b) the copper winding. (c) Diagrammatic sketch of the iSFCL prototype.

Table 1. Specifications of YBCO tape and NI coil

Item	Specifications	Values
YBCO tape	Tape width	4.8 mm
	Thickness	0.25 mm
	I_c / n-value (@77 K, Self-field)	40 A / 28
Double pancake NI coil	i. d. / o. d.	110 mm / 113 mm
	Height	9.6 mm
	No. of turns	10
	$I_{c\text{-coil}}$ (@77 K)	28 A
	Time constant	1.49 s
	Equivalent turn-to-turn resistor	0.015 mΩ

Table 2. Dimensions of the iSFCL prototype.

Item	Specifications	Values
Secondary shielding winding	Height, h_s	40 mm
	i. d. / o. d., id_s / od_s	110 mm / 113 mm
	No. of NI coils	4
	Total no. of turns, N_s	40
Primary copper winding	Height, h_c	30 mm
	i. d. / o. d., id_c / od_c	115 mm / 118.5 mm
	No. of turns, N_c	50
Total	Gap between primary winding and secondary winding, *gap*	1 mm

Impedance Variation Test

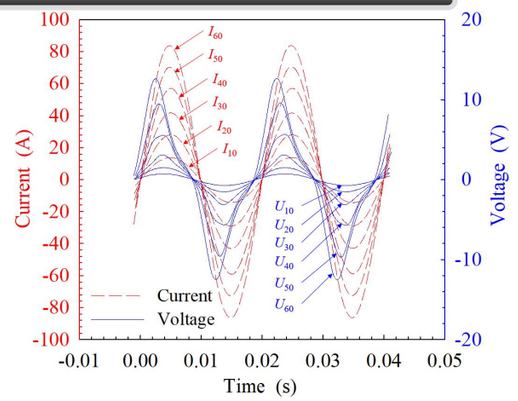


Fig. 2. Waveforms of current and voltage of the iSFCL prototype under different currents (50 Hz) in two cycles.

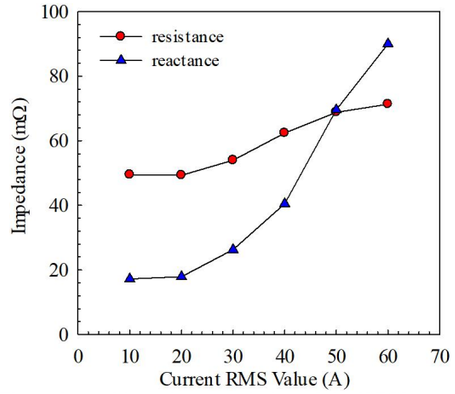


Fig. 3. The estimated impedance variation of the iSFCL prototype under different currents (50 Hz).

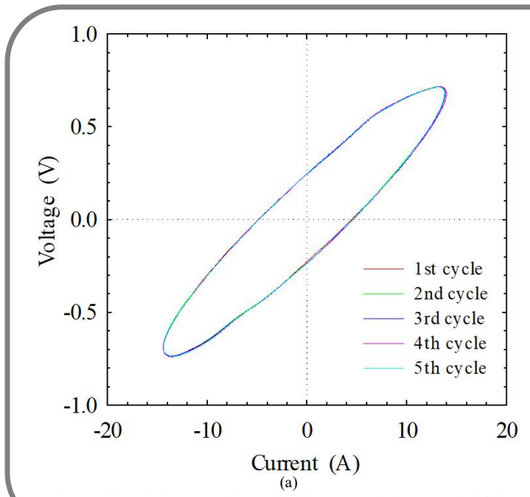


Fig. 4. The U-I curve of the iSFCL under (a) current of 10 A and (b) current of 60 A.

Fault Current Limiting and Recovery

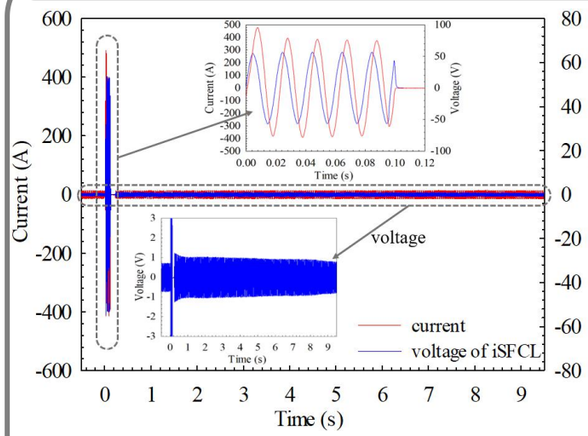


Fig. 5. Fault current limiting. The peak fault current of 3.3 kA is limited to 478 A. After 100 ms recovery, the circuit is reclosed to simulate the auto-reclosing in actual power grid.

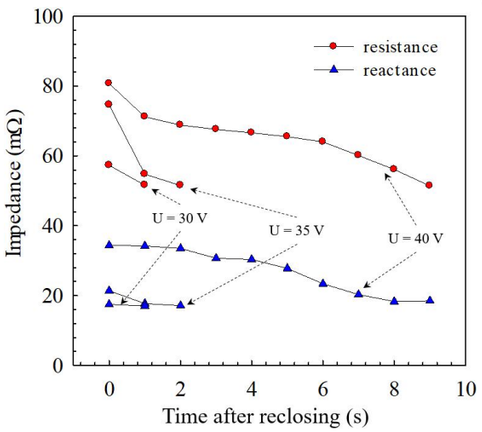


Fig. 6. Recovery of the iSFCL under different voltage of the short circuit experiment platform.

Conclusion

- The result shows that the iSFCL **impedance** is very sensitive to the operating current. It can rise from **49.5+17.2j mΩ** to **71.3+90j mΩ** when operating current rises from **10 A** to **60 A**.
- The iSFCL can successfully **limit the fault current from 3.3 kA to 478 A** in the first peak. Also, the recovery of the iSFCL is tested. The recovery speed of the secondary winding is very fast, while that of the copper winding is much slower. An improvement of adding another primary superconducting winding will be carried on in the next step.

[1] D. Qiu, J. Zhang et al., "Feasibility Study of Closed-Loop No-Insulation Coil to Shield Alternating Magnetic Field," IEEE Trans. Appl. Supercond., vol. 27, no. 6, pp. 1-5, Sep. 2017.

上海交通大學 SHANGHAI JIAO TONG UNIVERSITY