Simulation and experimental investigation on the critical current and AC losses of a hybrid high temperature superconducting fault current limiter (SFCL) with biased magnetic field

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1. INTRODUCTION

A new type of hybrid superconducting fault current limiter (SFCL) with biased magnetic field has been successfully designed and constructed in China Electric Power Research Institute (CEPRI) in 2019.The experimental results of the superconducting current limiting unit show that the critical current reaches 90A and the AC loss reaches 1.93718E-4 J/m/cycle (50Hz&40A) for one unit, which verifies the design of this kind of SFCL.

2. WORKING PRINCIPLE

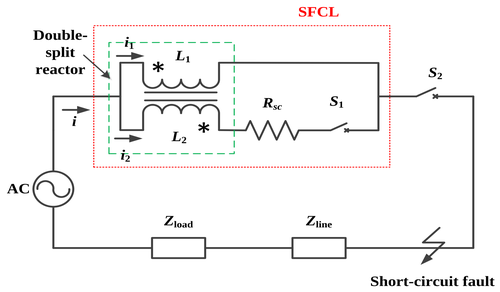


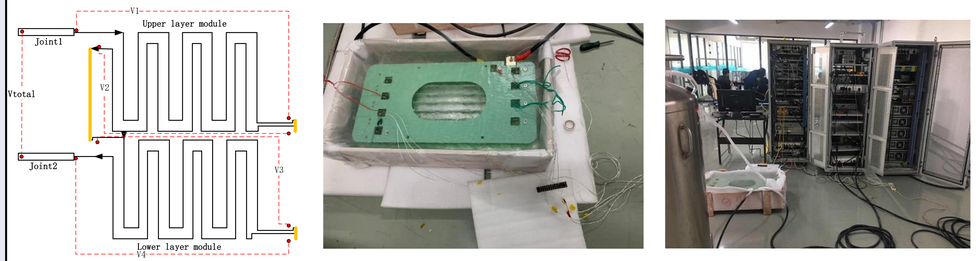
Fig.1 Topology of hybrid HTS SFCL.

The novel SFCL with biased magnetic field consists of three parts: (1) a double-split reactor. It has two branches of L_1 and L_2 (L_1 = L_2 = L) and the two branches have a reverse connection at the same ends. (2) a non-inductive HTS unit R_{sc}. (3) a fast switch S_1.

When the short-circuit fault occurs and i_2 is more than the critical current of non-inductive HTS unit, the resistance of HTS unit makes the impedances of the two branches unequal and most of fault current transfers to L_1 which has less impedance than branch L_2. When the resistance of HTS unit reaches to a certain quench value, S_1 is triggered to open. But L_1 still connects to the circuit and limits the fault current further until the circuit breaker S_2 is open.

3. CRITICAL CURRENT EXPERIMENTS

The critical current testing platform mainly includes: 1 kA DC current source, a shunt with 500 A/75 mV , a nanovoltmeter, a ammeter, a low temperature dewar and a critical current testing system.



(a) (b) (c)

Fig.2 Critical current experiments: (a) P&ID for test of SFCL unit ; (b)SFCL unit; (c)

TABLE I
PARAMETERS OF SFCL UNIT

Superconducting Unit Parameter	Parameter
Manufacturer	AMSC
YBCO Layer Width (mm)	4.8
YBCO Layer Thickness(μm)	1
Superconducting tape width(mm)	0.36-0.44
Superconducting tape length(m)	23.2

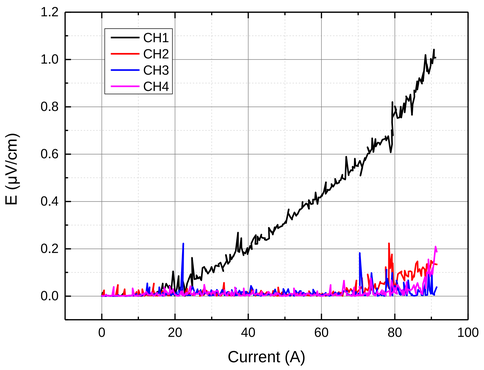
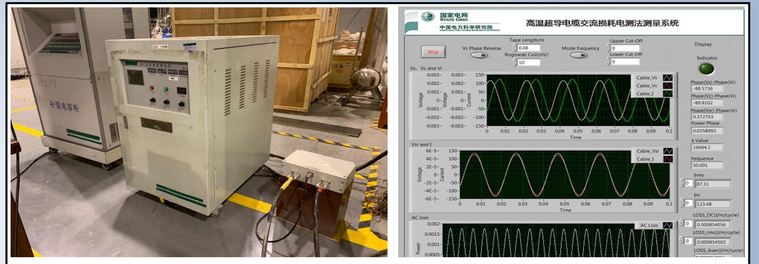


Fig.3 Experimental critical current curves

4. AC LOSS EXPERIMENTS

The experimental platform of AC loss testing system mainly includes: (1) 300A/3000A SFY sinusoidal AC variable frequency current power supply system;(2) Fluke Current Probe; (3) Acquisition and control system.



(a) (b)

Fig.4 Photo of AC loss test system.(a) experiment platform;(b) Acquisition and control system.

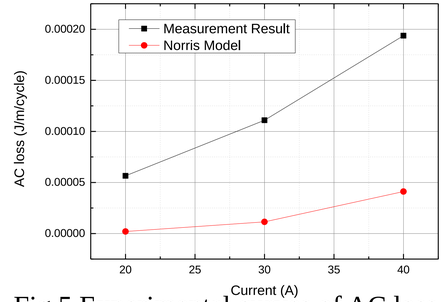


Fig.5 Experimental curves of AC loss

The results show that the AC loss increases with the increase of current, and the measured value is slightly larger than that of the theoretical calculation of Norris model.

5. CONCLUSIONS

This paper proposes a new structure of HT SFCL consisting of HTS fault current limiting module and double split reactor. The critical current of the superconducting current limiting unit and the AC loss performance have been studied according to the characteristic of YBCO coated conductor. The experimental results show that the critical current is 90A and the AC loss reaches 1.937E-4 J/m/cycle (with 50Hz&40A),which meet the calculation results very well.

INFORMATION

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