Ac Losses of Rebco Pancake Coils Measured by a Calorimetric Method

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Introduction

During a field ramp of a ReBCO magnet, the heat dissipated by conductor AC losses may affect the magnet operation temperature, and significantly increase the liquid helium consumption [1]. Therefore, the calculation and measurement of AC losses of ReBCO coils is very important. Understanding the AC losses behavior of ReBCO coils will allow prediction of the AC losses for future ReBCO magnets.

Experimental

Calorimetric AC losses measurement was performed in the 200 mm bore resistive magnet at cell 4 of the NHMFL. The test coil-set is 6 ReBCO double-pancakes with 40 mm ID and 140 mm OD. The open-circuit test coil-set of is completely immersed in liquid helium in a cryostat. A Hastings HMF-201 mass flow meter (range 0 – 2.0 slps) is used to measure the rate of helium boil-off.

Results and Discussion

Fig. 1 shows helium mass flow rates during a field ramp cycle measured at different field ramp rates. The total helium boil-off for each field cycle is obtained by integration of each curve in Fig. 1. The total boil-off is then converted to AC losses and plotted in Fig. 2 versus field ramp rate.

Conclusions

The AC losses of a set of pancake coils have been measured using a calorimetric method. The majority of the measured AC losses are ramp rate dependent and likely from the turn-to-turn coupling loss due to the imperfections in the coil insulation. We found the AC losses are much smaller than we previously estimated. The discrepancy is attributed to the strong magnetic shielding in radial direction.

Acknowledgements

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References

[1] J. Lu, et al., IEEE Transactions on Applied Superconductivity, v 23, no. 3, pp 8200804, June 2013.

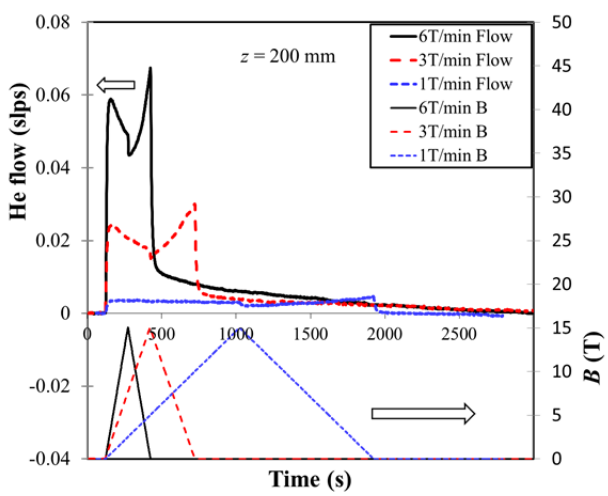

Fig.1 The helium boil-off during field ramp at different ramp rates and z = 200 mm. The background boil-off has been subtracted.

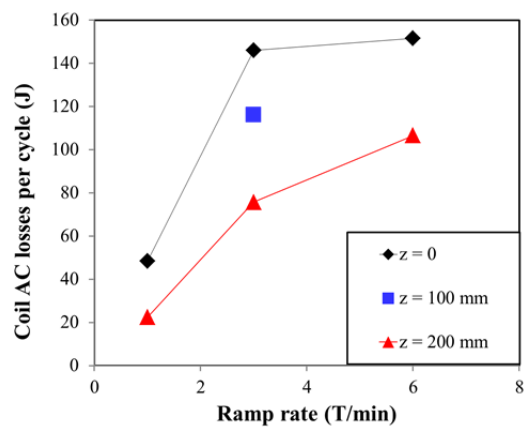

Fig.2 AC losses of the coil per field cycle as a function of field ramp rate.