Degradation of Critical Current in an HTS Tape with Combined Bending and Torsion Considering Curvature of Elliptical Shape

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1. Introduction

The rotating flax pump is a suitable device for charging the excitation coil of an HTS synchronous motor while reducing heat loss.

If the HTS tape is connected in series to reduce joint resistance and increase charging speed.

Therefore, the HTS tape is wound in a shape in which bending and torsion are applied together.

The strain that occurs when the HTS tape is wound causes a degradation of critical current.

Therefore, this paper investigated the degradation of critical current according to the winding shape and strain of HTS tape.

If the strain exceeds the irreversible strain limit, the normalized critical current decreases sharply.

The deformation of critical current due to the reversible strain occurs within the 95 % critical current retention, but the critical current decreases sharply to the irreversible strain region.

2. Experimental Procedures

1) Winding shape and bending diameter

2) Bending strain without torsion

3) Maximum bending strain with torsion

3. Experimental Results

1) HTS tape with winding pitch

2) Normalized critical current

3) N value

4) Conclusion

➢ The rotating flax pump is a suitable device for charging the excitation coil of an HTS synchronous motor while reducing heat loss.

➢ An HTS tape must be connected in series to reduce joint resistance and increase charging speed.

➢ Therefore, the HTS tape is wound in a shape in which bending and torsion are applied together.

➢ The strain that occurs when the HTS tape is wound causes a degradation of critical current.

➢ Therefore, this paper investigated the degradation of critical current according to the winding shape and strain of HTS tape.

➢ If the strain exceeds the irreversible strain limit, the normalized critical current decreases sharply.

➢ The deformation of critical current due to the reversible strain occurs within the 95 % critical current retention, but the critical current decreases sharply to the irreversible strain region.

➢ The normalized critical current decreases sharply according to position.

➢ The critical current decreases sharply in the irreversible strain region.

➢ If the strain exceeds the irreversible strain limit, the normalized critical current decreases sharply.

➢ The irreversible strain limit of semicircle is lower than that of tall prolate ellipsoid, resulting in a sharp degradation of normalized critical current in smaller strains.

➢ The average strain of tall prolate ellipsoid, oblate ellipsoid and semicircle is similar, but the difference of bending strain according to position is large.

➢ In the reversible-strain region, there is little change in \( J_c \) and \( n \)-value degradation. However, in the irreversible-strain region, abrupt \( J_c \) and \( n \)-value degradation were observed.

➢ At the same winding diameter, the semicircle has the smallest maximum bending strain but a low irreversible strain limit. Thus, when winding at the same winding diameter, winding with tall prolate ellipsoid results in low \( J_c \) and \( n \)-value degradation.