§10. Investigation of Feasibility of Remountable Superconducting Magnet for Helical Reactor

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Remountable high-temperature superconducting magnet, whereby parts of the magnet are mounted and demounted iteratively, was proposed as a design to solve engineering problems of a helical fusion reactor. [1] And this concept is one of designs for a superconducting magnet in a helical DEMO reactor, FFHR. Feasibility of the remountable high-temperature superconducting magnet has been investigated in this study since 2006. In this year, structural analysis is performed to evaluate gap distance and contact pressure distributions on joint surface in mechanical butt joint of a stacked BSCCO 2223 cable with copper jacket. The purpose of the evaluation is optimization of joint structure in the mechanical joint. After the analysis, some experiments of mechanical butt joint are carried out to confirm an effect of the optimization on joint resistance.

Fig. 1 shows schematic views of a stacked BSCCO 2223 cable with copper jacket and mechanical butt joint of the cable. In this method, a joint surface inclined at a 90-degree angle to the cable length direction and the cable is jointed mechanically only with perpendicular joint force. The joint structure is expressed as a 2D FEM model and gap distance and contact pressure distributions are evaluated by using FEM code, ANSYS.

Fig. 2 shows the gap distance distribution changing with an increase in the perpendicular joint force. The horizontal axis, *t*, indicates position along the joint surface as shown in Fig. 1. In this case, only half the region of the joint surface can contact its opposite surface under high joint forces. From this result, joint resistance becomes at least twice as large as in the ideal case. In addition, excessive stress is imposed on the upper side of the cable at the joint region, which can cause plastic deformation and fracture. The following results are also obtained by the structural analysis. The combination of parallel and perpendicular joint forces is effective in obtaining relatively uniform contact pressure distribution at the joint surface in the case of the 45-degree joint surface. To use a broader rod giving joint force and to apply joint forces not only from upper direction but also from bottom direction can also contribute to obtain relatively uniform contact pressure distribution.

Based on the above results and discussion, two experiments are performed. One experimental set-up, Model 1, is the same as the joint structure shown in Fig. 1. Another set-up, Model 2, has both upper and bottom rods, whose contact areas to the cable are twice larger than that in Model 1. Fig. 3 shows experimental results, a relationship between joint stress and joint resistance obtained by two experiments obtained at 300 A. From these results, achieving relatively uniform contact pressure with proposed joint structure is effective to reduce joint resistance.

From mentioned above, contact pressure distribution is an important factor to reduce joint resistance. This should be taken into account when the mechanical joint section of a larger high-temperature cable is designed and developed for the remountable high-temperature superconducting magnet.

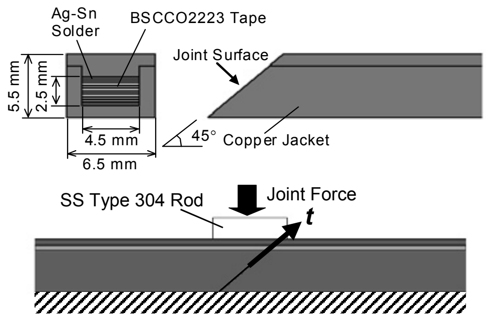

Fig. 1. Schematic views of a stacked BSCCO 2223 cable with copper jacket and mechanical butt joint of the cable.

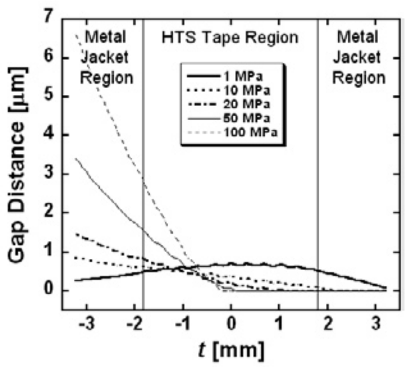

Fig. 2. Gap distance distribution on joint surface when mainly perpendicular joint force is applied to the cable.

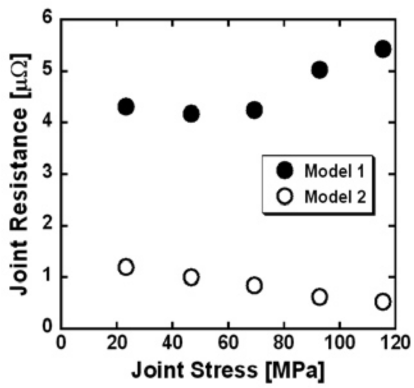

Fig. 3. Relationship between joint stress and joint resistance obtained by two experiments obtained at 300 A.

1) Ito, S., Hashizume, H.: Fusion Eng. Des. **81** (2006) 2527