## §2. Study of Composite Electrical Insulation at Cryogenic Temperature for Superconducting Magnet

Nagao, M., Hozumi, N., Muramoto, Y. (Toyohashi University of Technology),
Hara, M., Suehiro, J. (Kyushu University),
Kosaki, M. (Gifu College of Technology),
Shimizu, Y. (Meijo University),
Mizuno, Y. (Nagoya Inst. of Technology),
Minoda, A. (Matsue College of Technology),
Yamada, S., Satow, T.

The world's largest class superconducting coil is used for the "Large-scale Helical Device". Its electrical insulation system might be exposed to considerably severe multiple stresses including cryogenic temperature, large mechanical stresses and strong magnetic fields. It is therefore very important to study its insulation performance in order to establish the reliability of the coil. If superconductor quenches from superconducting state to normal state, the liquid coolant vaporizes very easily and turns into high-density gas at cryogenic temperature, which may reduce its withstanding voltage. Furthermore, it is very difficult to completely remove foreign particles out of the insulated space. So it is required to clarify the influence of foreign particles and electrification on the insulation performances.

1. Effect of foreign particles on breakdown characteristics of spacer surface in cryogenic liquid

This research was conducted using electrode system that simulated the insulation system in order to investigate the behavior of foreign particles and it's relation with the breakdown characteristics of insulation. The breakdown voltage when conductive particles were introduced between electrodes was lower than that with non-conductive foreign particles. The breakdown voltage with dielectric foreign particles retained nearly the same value as that with non-dielectric particles. The behavior of particles in the electrode system was observed. Under dc voltage, the position of conduction particles could take only three conditions, i.e., the original position; standing upright in the early position; reaching an upper electrode. The position of dielectric foreign particles was unmoved, or moved randomly between the electrodes after breakdown. When the dielectric foreign particles are in cryogenic liquid, the breakdown voltage does not lower. From these results, as shown in Fig.1, if there are the dielectric foreign particles in cryogenic liquid, the breakdown voltage of electrode system does not affect.

2. Electrification of cryogenic liquid flowing electrical insulating pipe

It has been considered that liquid nitrogen in not electrified because it is an inert liquid. However, electrification of liquid nitrogen flowing through a straight insulating pipe was confirmed by the present experiments. The results obtained are summarized as follows: (1) The amount of charge produced by electrification depended on the material of the insulating pipe, as shown in Fig.2. (2) The amount of charge increased with increase of flow rate of liquid nitrogen and length of the pipe, and then showed saturation. (3) The amount of charge was about 0.1% of that observed in the case of insulating oil circulating in a transformer. (4) Electrification of liquid nitrogen was also observed when an elbow-type insulating pipe was used.

Reference

1) Hirahata, Y., Muramoto, Y., Hozumi, N, Nagao, M., Minoda, A., Kosaki, M. & Satow T., 2002 National Convention Record I.E.E. Japan, No. 1-036 (2002)
2) Sakane,W., Mizuno Y. & Minoda, A. , 2002 National Convention Record I.E.E. Japan, No. 2-014 (2002)

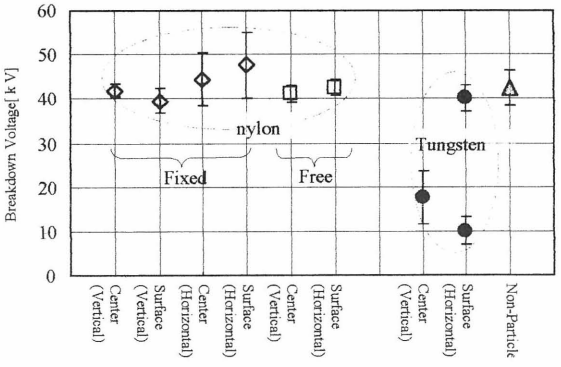


Fig.1 Breakdown voltage by entering foreign particle (2mm) in Liquid $N_2$

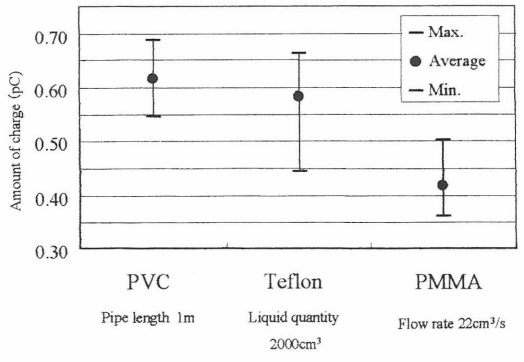


Fig.2 Effect of dielectric materials on electrification