The performance of new cryogen-free system to inspect critical current of neutron-irradiated superconductors

Yoshio Okui[1], Kentaro Kominato[1], Takeshi Kamikado[1], Ryoichi Hirose[1], Arata Nishimura[2], Takao Takeuchi[3], Tatsuo Shikama[4]

[1] *Japan Superconductor Technology, Inc., Kobe, JAPAN*
[2] *National Institute for Fusion Science, Toki, JAPAN*
[3] *National Institute for Materials Science, Tsukuba, JAPAN*
[4] *Institute for Material Research: Tohoku University, Oarai, JAPAN*

A new cryogen free system to inspect critical current properties was installed in FY2011 at International Research Center for Nuclear Materials Science (Oarai center), Institute for Materials Research (IMR) of Tohoku University. This system is consisted of a superconducting magnet, a variable temperature insert (VTI) and control units. The entire equipment is operated in cryogen free, since the system is suitable for using in a hot lab. This paper will present the performance and the current status of new cryogen free system.

A superconducting magnet has a 52 mm room temperature bore with overall dimensions of 820 mm in diameter and 680mm in height. The magnet is cooled with a single 1W GM cryocooler. Also, all coils are connected in series and charged with a single power supply. The magnet is charged up to 15.5T in about 30 minutes. An iron shield is installed around the magnet to reduce the fringe field less than 0.5 mT. The VTI has 35 mm sample bore and is fit in the magnet room temperature bore of 52 mm. The VTI has HTS current leads and two sets of GM cryocoolers. The joule heat and the radiation heat are taken out by a high purity aluminum (6N) rod to the second heads of GM cryocoolers. The aluminum rod is sandwiched by the electrodes and the temperature of the sample holder is controlled by a small heater. A control units automatically charge and discharge the magnet to specified magnetic field, and control the heater current to set the sample at the specified temperature. Then the current applied to the sample and the critical current is automatically measured.

The critical temperature, the critical magnetic field and the critical current measurements were carried out using non-irradiated Nb3Sn TF strand for ITER. The system worked successfully. To confirm the performance of this system, the current of 500 A was fed into the strand. Finally the critical current has been evaluated while ramping to 500 A under the 15.5 T by some modification and improvement of measurement system and the programming software of control. Meanwhile, the test results showed the temperature rising of both electrodes and the temperature gap between each electrode during 500 A running. Under the 15.5 T, significant increase in voltage was observed at about 100 A. In the case, the temperature rise was less than 1 K.