§1. Rotational Vibrations of the Rotor Shafts of the Cold Compressors in the Helium Subcooling System for the LHD Helical Coils

Hamaguchi, S., Imagawa, S., Mito, T.

The LHD cooling system has a helium subcooling system to improve the cryogenic stability of the helical coils by lowering the operating temperature.[1] In the system, the liquid helium, which is supplied to the coils, has been subcooled at a heat exchanger in a saturated helium bath. The bath temperature is reduced by a series of two centrifugal cold compressors (CC) with gas foil bearing. After the installation, 3.2 K subcooled helium at the nominal mass flow rate of 50 g/s has been supplied stably to the coils and the total time of the subcooling operation exceeds 13,000 hours. However, several sudden reduction of the rotational speed occurred so far. Degradation of the journal bearings has also been observed in annual inspection. The cold compressors are key technology to subcool helium for the superconducting magnet system of not only the LHD but also fusion reactors. So, the rotational vibrations of the rotor shafts of the cold compressors have been measured to investigate the stability in the present study.

Fig. 1 shows the cross section of the cold compressor. A censor is installed around the upper portion of the rotor shaft to measure the displacement of the rotor shaft. Fig. 2 shows the power spectrum of the rotational vibration obtained by analyzing the measured displacement with the fast Fourier transformation and also is the comparison between the power spectrum in the beginning of the 16th LHD experiment campaign and that in the end. Fig. 2(a) is the result in the waiting operation, fig. 2(b) is that in the rated operation. First-order power spectrum corresponding to the rotational speed showed little change and was less than 10 micro-m 0-P (within normal operating range). Irregular power spectrum (not higher order power spectrum) was also observed and the frequency changed before and after the experiment campaign. It is necessary to analyze the irregular power spectrum in details. Eventually, the measured and analyzed rotational vibration will be stored and applied to the understanding of the operational status of the cold compressors.

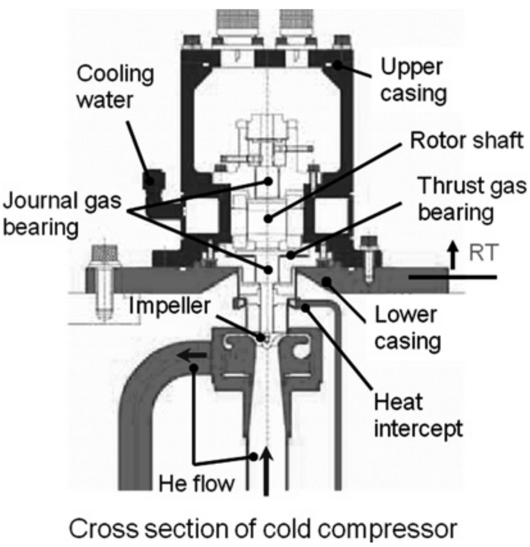
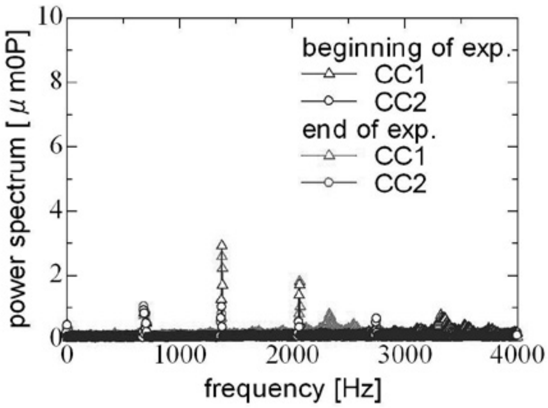


Fig. 1. Cross sectional view of the cold compressor.

(a)



(b)

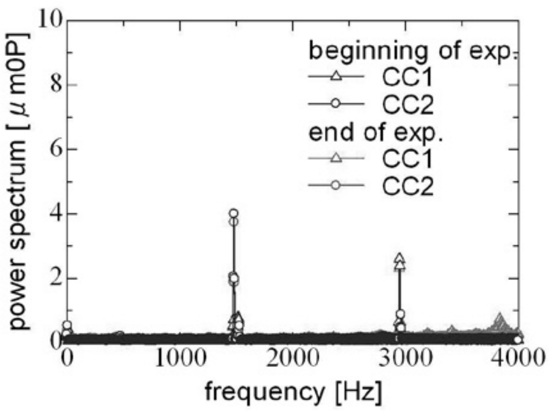


Fig. 2. Power spectrum of the rotational vibrations by FFT analysis of the displacement of the rotor shafts before and after the 16th LHD experiment campaign; (a) power spectrum in the waiting operation, (b) power spectrum in the rated operation.

1) S. Hamaguchi et al., Advances in Cryogenic Engineering, **53B** (2008) 1724-1730.