Operation of the BigRIPS cryogenic plant

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Since the total operation time of the helium compressor unit has reached to 77,680 h in August 2021, the main compressor was shipped to the manufacturer's factory for maintenance. The compressor unit was disassembled, and its interior was cleaned. All the components were checked carefully, and no significant mechanical damage was found.

In addition to maintaining the mechanical components of the compressor unit, we replaced the activated charcoal and molecular sieves in the adsorbent vessel in August 2021. We measured the operation interval of the drain valves of the coalescer vessels in the compressor unit, to evaluate the oil contamination level. We replaced coalescer filter elements five times since 2008. The operation periods of replaced filter elements are from Aug. 2008 to July 2010, Sept. 2010 to July 2012, Sept. 2012 to July 2014, Sept. 2014 to July 2016, and Sept. 2016 to June 2019. Figure 1 shows an estimate of the oil contamination level at the entrance of the third coalescer vessel as a function of the coalescer filter operation time. The navy blue, green, and yellow diamonds represent the estimates for the first, the second, and the third elements, respectively. The fourth, the fifth and the sixth elements are shown with pink, red, and purple diamonds, respectively. The oil contamination values measured using the oil check kit are also shown. The open triangles, squares, and circles represent the results for the first, the second, and the third elements. The results for the fourth and the fifth elements are indicated by the open diamonds and circles, respectively. The cross represents the results of the sixth elements. Both estimations of the oil contamination level are consistent with each other, and the performance efficiency of the sixth filter element is apparently better than that of the others.

At the end of October 2021, we started continuous operation of the BigRIPS cryogenic plant after summer maintenance. This operation was terminated by an incident in the 2021 winter beam time. At 7:35 on December 3, the fire alarm of the RI-Beam Factory (RIBF) building rang, and the cryogenic plant operator found smoke emanating from the compressor unit of the BigRIPS cryogenic plant. After having made necessary emergency contacts, the plant operator stopped the compressor unit safely at 7:50. Evaporated helium gas from the STQ cryostats was transferred to the RIKEN liquid-helium supply and recovery system using a temporary recovery line. We inferred that the smoke was emitted from the coupling side baring unit of the main motor of the compressor unit, since burnt grease was found around the coupling. A sudden increase in the operation current of the motor unit from 30.6 A to 33.6 A, which was measured at 7:28, also indicates a breakdown of the main motor.

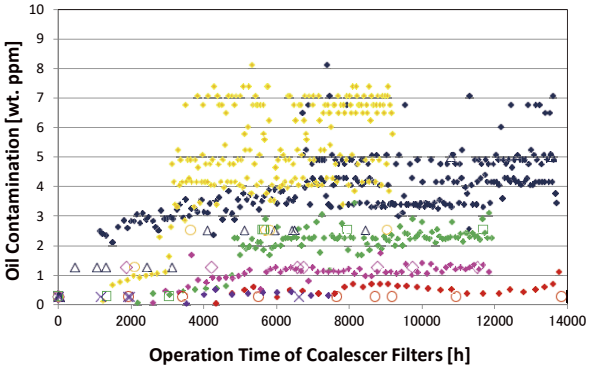

Fig. 1. Oil contamination at the entrance of the third coalescer vessel.

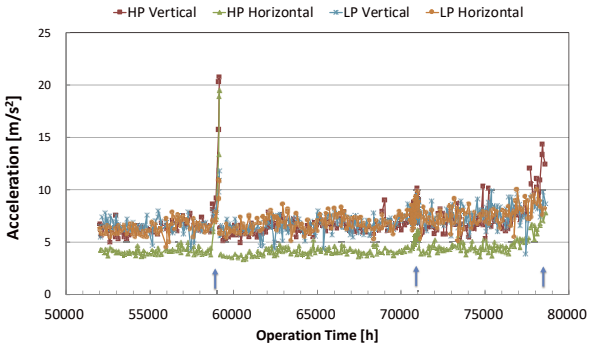

Fig. 2. Vibration acceleration of the compressor unit.

We noticed an unusual noise produced by the main motor of the compressor unit since November 2021. We measured the vibrations of the compressor at the high-pressure and low-pressure sides since 2015. Figure 2 shows the vibration acceleration in the vertical and horizontal directions as a function of the total operation time. Continuous operation started with a total operation time of 77,683 h and the acceleration increased rapidly. The final measurement of the vibrations was performed on Dec. 1. Two additional rapid increases in the vibration acceleration at operation times of 59,000 h and 71,000 h were caused by damage to the bearing unit occurred in Dec. 2016[1] and in June 2019.[2]

The main motor unit was dismounted from the compressor unit and shipped to the manufacturer's factory for repairs in January 2022. The origin of the unusual vibrations is under investigation.

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References

1) K. Kusaka *et al.*, RIKEN Accel. Prog. Rep. **50**, 285 (2017).
2) K. Kusaka *et al.*, RIKEN Accel. Prog. Rep. **53**, 222 (2019).