Present status of the BigRIPS cryogenic plant

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Periodic maintenance of the oil-removal module in the helium compressor unit is crucial to ensure the long-term continuous operations of BigRIPS[1]. The oil-removal module comprises a bulk oil separator (an oil vessel with a demister), three coalescer vessels, and two adsorbent vessels (4SP and 5SP) that contain activated carbon and molecular sieves. The periodic replacement of coalescer filters and adsorbents ensure low oil contamination in helium gas. We report our studies on oil contamination performed over the past 9 years.

Each coalescer vessel contains four coalescer filters, manufactured by Domnick Hunter,[2] and all the filters were replaced every 2 years since 2008. However, the filters used for 6 years were discontinued and replaced with the successive product of Domnick Hunter in 2014. The drain oil separated from the helium gas is sent to the compressor via a drain line with solenoid valves, depending on the oil level in the vessel. By measuring the operation interval of the solenoid valves, the oil contamination level of the coalescer vessels is evaluated.[3]

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 2008-2009, 2010-2011, and 2012-2013 operations, respectively. The coalescer filters used in those periods were discontinued.[2] The estimate for the 2014-2015 operation with the new coalescer filters is shown with pink diamonds. The oil contamination values measured using the oil check kit are also shown. The open triangles, squares, circles, and diamonds represent the results for the 2008-2009, 2010-2011, 2012-2013, and 2014-2015 operations, respectively. Both estimates of the coil contamination level are consistent with each other and the performance efficiency of the new filter elements seems to be similar to or better than that of the discontinued ones.

In addition to replacing the coalescer filters, we have replaced the adsorbent in 4SP and 5SP to maintain the performance of the oil-removal modules. The 4SP adsorbent vessel contains activated carbon and molecular sieves, and they are replaced with new ones every year. On the other hand, the 5SP vessel contains activated carbon only, which we replaced in 2009, 2011, 2013, and 2016. Used adsorbent was sampled and sent to the adsorbent manufacturer for degradation analysis. Sampled activated carbon was tested and the following items were measured and reported: bulk density, loss on drying, and volatile matter content.

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We show, as an example, results of the volatile matter content, which we consider a good index of the amount of oil adsorbed in activated carbon. Figure 2 shows the volatile matter content of the activated carbon sampled from 4SP. In each analysis, activated carbon was sampled from three different parts of the adsorbent vessel. The results for the sample from the upper, middle, and lower part of the vessel are indicated by blue, brown, and green bars, respectively. The total operation time of each adsorbent is also indicated.

Before summer 2008 only two coalescer vessels were used in the oil-removal module and the whole cryogenic plant suffered from oil-contamination. The volatile matter content of 8.7% indicates that the activated carbon was badly degraded. All the results except that for the sample taken in 2008 are in the range of 2–3% and indicate the degradation of the adsorbent in its early stage. This result suggests that the three coalescer vessels work with sufficient oil-separation efficiency.

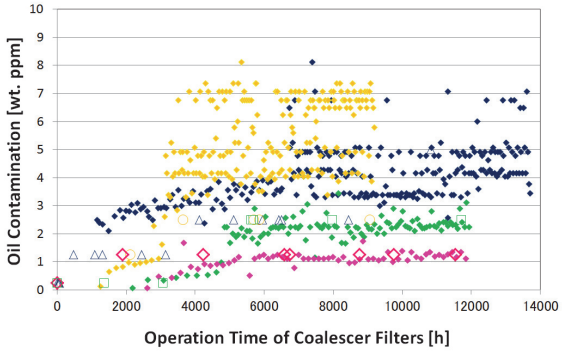

Fig. 1. Oil contamination at the entrance of the third coalescer vessel.

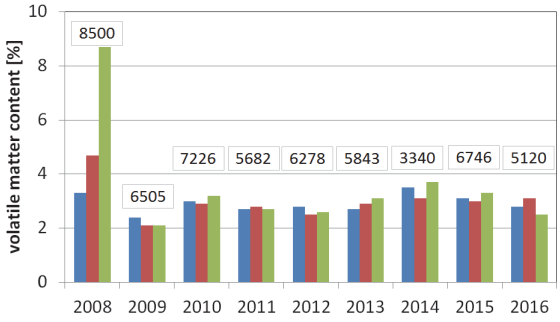

Fig. 2. Volatile matter content of the activated carbon sampled from the 4SP adsorbent vessel.

References

1) K. Kusaka et al., RIKEN Accel. Prog. Rep. **43**, 244 (2008).
2) http://www.parker.com/
3) K. Kusaka et al., RIKEN Accel. Prog. Rep. **41**, 309 (2010).