



Contribution ID: 498

Type: **Contributed Oral Presentation**

A Cryogen Recycler with Pulse Tube Cryocooler for Simultaneously Recondensing Helium and Nitrogen

Thursday, July 2, 2015 9:15 AM (15 minutes)

Liquid helium cooled NMR magnets often use liquid nitrogen cooled radiation shields. Among these NMR magnets cryogen boil-off rates of 3L/day of liquid helium and 6L/day of liquid nitrogen are common. We have developed a cryogen recycler for closed loop operation of the helium and nitrogen circuits. With these closed loops, the recycler maintains zero boil-off of both helium and nitrogen.

The recycler uses a 4 K pulse tube cryocooler, Cryomech model PT407. The PT407 cryocooler has simultaneous cooling capacities of $>0.7W$ at 4.2 K and $>25W$ at 55 K. The recycler has two liquid return legs for liquid helium and liquid nitrogen respectively, which are inserted into the fill ports of the helium and nitrogen reservoirs. The first stage of the PT407 is used to recondense nitrogen boil-off at 77K. The 4 K stage of the PT407 is used to re-liquefy helium vapor.

The recycler was tested at Cryomech and demonstrated recondensing performance of 7.8 L/day of nitrogen while simultaneously re-liquefying 3.3 L/day of helium. The recycler has been installed in an NMR magnet at the University of Sydney for 6 months, where it is operating smoothly and maintaining zero cryogen boil-off.

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Session Classification: C4OrD - Novel Concepts and New Devices III

Track Classification: CEC-17 - Novel Concepts and New Devices