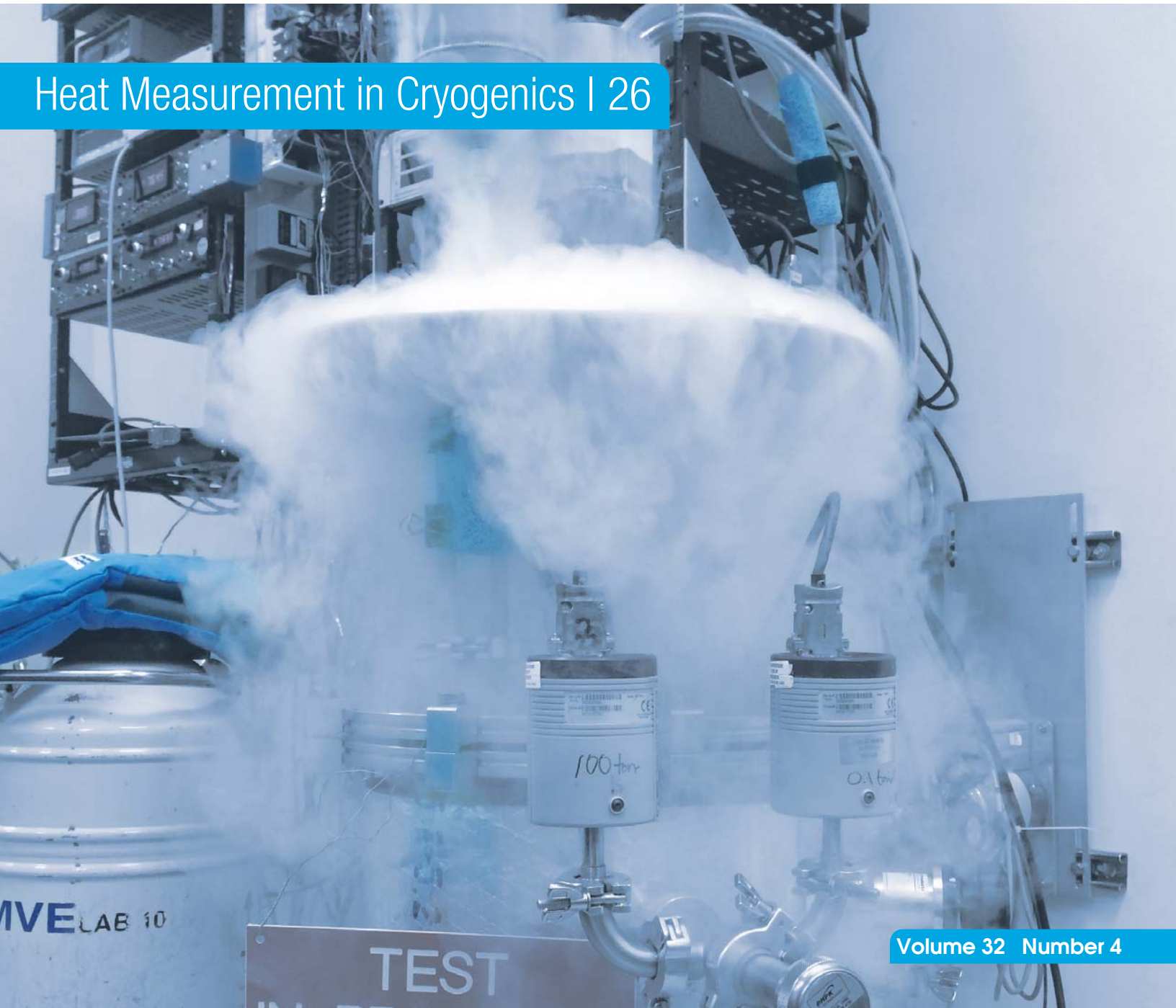
Cold Facts

The Magazine of the Cryogenic Society of America, Inc.

INTERNATIONAL



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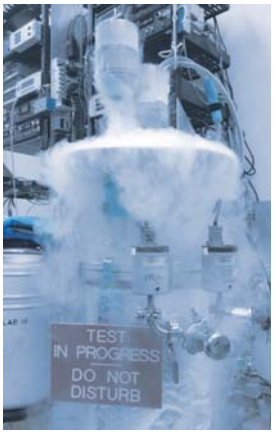


ON OUR COVER

The Cryostat-500 instrument shown here is undergoing tests at the Cryogenics Test Laboratory at NASA Kennedy Space Center. CSA President James Fesmire is the senior principle investigator there, and in this issue he begins a four-part series on boiloff calorimetry for the measurement of very low heat flows. Part 1 begins on page 26 and provides a short history of heat measurement in cryogenics.

In all instances, "CSA CSM" indicates a Corporate Sustaining Member of CSA.

DID YOU KNOW?

Publication of the *2017 Buyer's Guide* is just around the corner, so now is the time to review your company's listing at **https://csabg.org/**. Please contact Jo Snyder (jo@cryogenicsociety.org) by Oct. 28 with any updates you would like to make.

The issue will feature editorial content on insulation, information on handling expansion and contraction and personal accounts exploring relationships with mentors. Please contact Brian Dudley (editor@cryogenicsociety.org) with any questions or story ideas. Content is due by Oct. 28.

Large Pulse Tube Coolers Deliver 1,280 W at 77 K

by Alan Caughley, Callaghan Innovation, Alan.Caughley@callaghaninnovation.govt.nz

Callaghan Innovation and Fabrum Solutions, in collaboration with Absolut System, have produced a range of large pulse tube cryocoolers based on Callaghan Innovation's metal diaphragm pressure wave generator technology (DPWG). The metal diaphragms in a DPWG separate the clean cryocooler working gas from the oil-lubricated reciprocating mechanism.

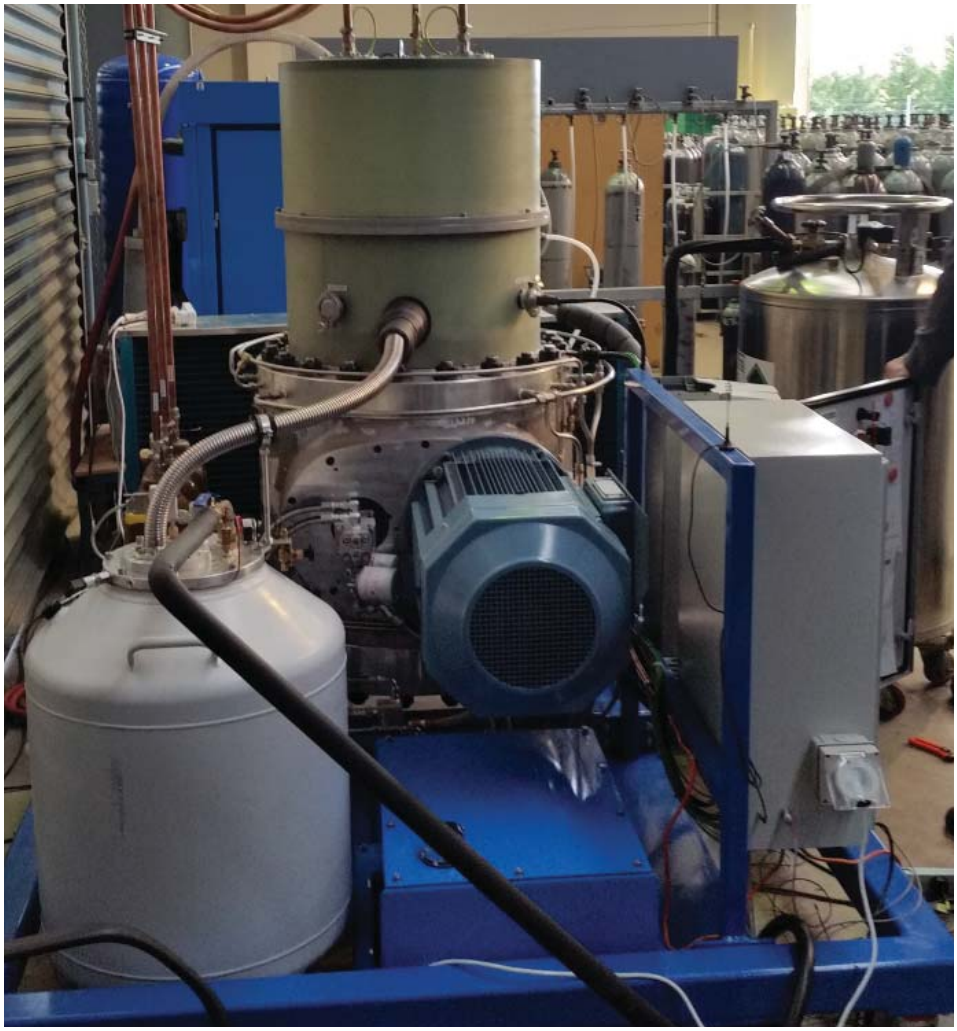
These industrially robust cryocoolers are suited to cooling High Temperature Superconductor (HTS) applications such as transformers, power cables and fault current limiters, or for on-site production of industrial liquid nitrogen.

The largest cryocooler, the PTC1000, consists of three in-line pulse tubes working in parallel sharing a 1,000 cc swept volume DPWG. A test unit demonstrated 1,280 W of refrigeration at 77 K—from 24 kW of input power—during an 11-month test run at a liquid nitrogen liquefaction plant.

The gas company provided an industrial environment, real duty cycles and a commercially viable use for the liquid nitrogen produced. Its location was close to the development team, providing enough proximity to aid monitoring but also enough separation to ensure that operation of the liquefier was conducted by the gas company and therefore provided a real-environment test.

The test began in July 2015, accumulating 3,338 hours of run time with a duty cycle of 42 percent and 67 stop-start cycles. Over 30,000 liters of liquid nitrogen were produced for sale. The pulse tubes produced consistent performance, liquefying at a rate of approximately 11 l/hr. The radiator-based cooling system proved itself over a wide temperature range through a summer and winter in an uninsulated factory building.

The DPWG motor power input was steady at 24 kW and when combined with the 2.5 kW of electricity consumed by the cooling system's circulation pump and radiator fans the energy cost for the nitrogen liquefied was 2.5 kWh/liter. Engineers replaced the alpha-prototype DPWG with a production DPWG in June 2016.



The PTC1000 liquefier in commercial operation. *Image: Callaghan Innovation and Fabrum Solutions*

Development of the pulse tube has continued with the PTC330, a single in-line pulse tube direct mounted to a 330 cc DPWG. The pulse tubes on the large cryocooler each produced 450 W of refrigeration at 77 K. Further optimization of the PTC330 has increased the cooling power to 500 W at 77 K, with no change in input power. The PTC330 has been incorporated into a liquefier and has been producing 4.7 l/hr of liquid nitrogen.

The next step is to continue running the PTC1000 liquefier alongside the liquefier featuring the PTC330. The reduced cost of liquid nitrogen production, made possible by the pulse-tube-based liquefiers, has allowed the gas company used by Callaghan Innovation and Fabrum Solutions for endurance tests to secure more customers and to meet increased demand for liquid nitrogen.

The two liquefiers will be joined by three more in the coming months, making a total of five units producing commercial liquid nitrogen. A paper presenting the experiences of running these tests was presented at ICC19 and is available online here: **http://2csa.us/g9.** ■