Thermo-acoustical oscillations in cryogenic systems

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Thermoacoustics: the interaction between temperature, density, and pressure variations of acoustic waves - Wikipedia


“Thermoacoustic Oscillations” article courtesy Meyer Tool & Mfg., Inc.
**TADOPTR**

TADOPTR (ThermoAcoustic Driver/Orifice Pulse Tube Refrigerator)
- R. Radebaugh, NIST

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*Figure 5. Schematic of ThermoAcoustically Driven Orifice Pulse Tube Refrigerator (TADOPTR)*

*Figure 12. TADOPTR natural gas liquefier (600 L/day, 2.0 kW at 120 K)*

[Image of schematic and experimental setup]

[Link to LANL Thermoacoustics website: www.lanl.gov/thermoacoustics]
Liquid Helium Level Measurement

From the Oxford Instruments “Cryogenic Spares & Accessories” website:

“This simple, yet effective dipstick provides accurate indication of liquid helium depth. Stainless steel construction with a fine rubber diaphragm, held in place by an ‘O’ ring over the cup-shaped upper end of the dipstick.

The thermal gradient created in the tube leads to thermal oscillations, which are felt by the vibration of the membrane. The frequency of the oscillation with the lower end in liquid helium is noticeably lower in comparison to that when in cold gas, allowing the liquid level to be easily determined (in most cases).

The dipstick should not be left in the cryostat when it is not in use because it introduces a large amount of heat.”
discontinuous temperature jump

Parameters:
- Temperature ratio $\alpha = T_{\text{warm}}/T_{\text{cold}}$
- Length ratio $\xi = (L-l_h)/l_h$
- $Y_c$ relates radius and Stokes BL thickness
  - Lower asymptote: choose $\alpha$, calculate $Y_c$ using eq. 18
  - Upper asymptote: choose $Y_c$, calculate $\alpha$ using eq. 28
  - Curve: calculate $Y_c$ and $\alpha$ using eqs. 9 & 12
BR refrigerator, FNAL 1990
Youfan Gu and K. D. Timmerhaus
March 27, 1991

Dear Dr. Fuerst,

We have just learned that you have presented a paper entitled "AN INVESTIGATION OF THERMAL ACOUSTIC OSCILLATIONS IN HELIUM SYSTEMS" at the Low Temperature Engineering and Cryogenic Conference held in Southampton, England, on July 17-19, 1990. We are interested in the research work you have performed on the thermal acoustic oscillations in liquid helium systems, particularly, the experimental verification of such oscillations since we are working on a study of thermal acoustic oscillations in liquid hydrogen and helium systems. We would greatly appreciate it if you could send us a copy of the above paper.

Yours Sincerely,
Youfan Gu
Mitigation

- Reduce driving force
  - Change temperature ratio
  - Change length ratio
- Increase viscous damping
  (Reduce tube radius)
- Increase inertial damping
  - Increase tube radius
  - Change temperature gradient
- Block line
  - Check valve
  - Filter
- Connect fill with vent
- Resonator/ballast volume

- **Tube Inserts**


Expander pressure taps: ballast volumes
Dewar neck insert: warm end vent