Contribution ID: **104** Type: **Contributed Oral**

C2Or3C-06: Initiation and suppression of Taconis oscillations in tubes with junctions and variable-diameter tube segments

Tuesday 11 July 2023 17:45 (15 minutes)

Taconis oscillations represent spontaneous, usually unwanted excitation of acoustic modes in narrow tubes going from warm ambient environment into cold cryogenic space. These oscillations can drastically magnify heat leak and create vibrations undesirable for measurement instruments. In this study, modifications of classical constant-diameter tube are investigated. Specifically, variable-diameter tubes are found to have a profound effect on excitation, with wider tube segments in the warm environment strongly encouraging oscillations, while additions of properly chosen pipe network configurations can suppress the oscillations. The low-amplitude thermoacoustic theory, previously developed for thermoacoustic engines and refrigerators, is adapted for modelling Taconis phenomena, accounting for finite-length segments with temperature evolution where thermal-to-acoustic energy conversion takes place. Experiments are conducted with helium and hydrogen as working fluids to validate theoretical predictions. With the rapid development of liquid hydrogen storage and transfer systems, it is expected that Taconis oscillations may become an issue, and this study provides an initial modelling framework to assess this phenomenon in hydrogen systems.

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Session Classification: C2Or3C: Miscellaneous II