Contribution ID: **26** Type: **Oral**

Closed-cycle mixed-refrigerant Joule-Thomson (MRJT) cryocoolers for InfraRed (IR) detectors

Wednesday 29 October 2025 15:45 (15 minutes)

Most IR detectors are currently cryocooled by Stirling type coolers, where long mission durations are required. Stirling cryocooling is a matured technology with proven capabilities by many manufacturers who suggest a wide variety of tactical coolers. System engineers learned how to integrate Stirling coolers and managing their disadvantages, mainly their size, the vibration and noise they induce, and the heat which must be removed from the warm side of the cold head and the compressor.
Closed cycle mixed-refrigerants Joule-Thomson (MRJT) cryocoolers, were first suggested in the 1970's, and went through a long research and development process, to be suggested for tactical applications. MRJT coolers do not compete with the high efficiency of Stirling coolers (low power consumption), and the small size of the compressor; however, they benefit other major advantages.
MRJT coolers suggest the smallest cold heads, among other technologies, which allow miniaturization of the complete system. Furthermore, JT cold heads can be designed in different structures, rather than cylindrical cold fingers only, allowing new approaches for Dewar designs. The absences of moving parts at the JT cold head make it free of vibrations and noise emission. A vibration-free cold head is a well appreciated feature which already yielded the development of the Pulse-tube version of Stirling coolers, that doesn't have moving parts in the cold head, at the expense of efficiency and size. Additional advantage of MRJT coolers is the ability to locate the compressor far from the cold head (tens of meters), allowing high reliability, availability and maintainability.
The secret of MRJT is in the mixed refrigerant that holds the cooling potential, and the cold head that is designed to realize this potential. The composition of the mixed refrigerant is determined to comply with several requirements, mainly: the required cooling and ambient temperatures, and the operating pressures which are dictated by the compressor. High efficiency recuperator is essential for obtaining the desired cooling performances (temperature and power), where both high- and low-pressure streams are two-phase blends experiencing condensation and evaporation, respectively. The recuperators' effectiveness is defined by the heat transfer between the streams, while the pressure drop of the streams must also be taken into consideration. These two characteristics usually contradict each other, and a proper compromise must be accomplished. Miniature finned-tube heat exchangers are usually used in the recuperator, and the ability to make them from different raw materials and with different dimensions is crucial for obtaining efficient recuperators; and therefore, attractive JT cold heads.
At CryoR we develop state-of-the-art MRJT coolers, having the ability to design and manufacture mixed refrigerants, oil-free compressors, finned-tubes, miniature cold heads, and complete cooling systems. The ability to control every component of the cooler enables attractive integration in the system. In the current presentation we demonstrate the ability to design different MRJT coolers to comply with various system requirements.

Submitters Country

Israel

Are you a student?

No

Author Affiliations & Email Addresses

I confirm that valid email addresses and affiliations have been added for all co-authors.

Co-Author Affirmation

By clicking here, I, the submitting author, affirm that all co-authors know of and concur with the submission of this abstract.

Author: TZABAR, Nir (CryoR ltd.)

Presenter: TZABAR, Nir (CryoR ltd.)

Track Classification: Cryocoolers