



Contribution ID: 346

Type: Poster

C2Po3D-10: Advances in small scale cryogenic magnetic refrigeration

Tuesday 20 May 2025 14:00 (2 hours)

Existing cryogenic refrigeration systems are both capital cost expensive and extremely energy intensive. Large scale H₂ liquefaction plants achieve, at best, 10-20% of Carnot efficiencies (Carnot is theoretical maximum), while small and medium scale cryogenic systems operate with 5-10% efficiencies. These high costs and poor efficiencies are a major pain point for existing industries requiring cryogenic temperatures, and they create an enormous barrier to entry for private investment into H₂ infrastructure for fuel cell electric vehicles (FCEV).

Magnetic refrigeration is a promising technology, and likely the only technology, with the potential to significantly improve cryogenic refrigeration. Model predictions indicate >50% efficiencies in the cryogenic temperature regime (sub 80K) are possible. A major hurdle inhibiting the advancement of at-scale magnetic refrigeration systems is the assumption that these systems can only be operational with expensive and energy intensive superconducting magnetic fields, thus, limiting the application solely towards large scale systems (i.e. >\$50million dollar, 30 ton per day hydrogen liquefaction plants).

General Engineering & Research (GE&R) is on the cutting edge of magnetic refrigeration technology development. We manufacture and sell our own patented line of high performance low cost magnetocaloric materials which can be used to build high efficiency systems for all refrigeration applications, and these are the only known compositions that will meet both cost and performance requirements to be viable in mass production of magnetic refrigeration systems for residential and commercial refrigeration and air conditioning applications, as well as cryogenic applications (cryocooling and gas liquefaction). Further, GE&R has built an at-scale cryogenic magnetic refrigeration system and successfully demonstrated sustained sub 80K (-193C) magnetocaloric cooling using a Halbach permanent magnet. The successful demonstration of cryogenic magnetic refrigeration using a permanent magnetic field with ZERO energy input requirements, validates this technology, and opens the door for its use in small and medium scale industrial applications, as well as fueling station infrastructure for fuel cell electric vehicles (FCEV). This presentation will provide an overview and status update of GE&R's magnetic refrigeration technologies.

Author: Dr IHNfelDT, Robin (General Engineering & Research LLC)

Presenter: Dr IHNfelDT, Robin (General Engineering & Research LLC)

Session Classification: C2Po3D - New Devices, Novel Concepts, and Miscellaneous II