Contribution ID: **153**

Type: **Contributed Oral**

C1Or2A-01: Modelling and optimization of cryogenic mixed-refrigerant cycles for the cooling of superconducting power cables

Monday 10 July 2023 11:00 (15 minutes)

For the green energy transition, the transport of large amounts of electrical energy is needed both in densely populated areas and over long distances. Superconducting power cables represent one possible solution, requiring energy-efficient liquid nitrogen re-cooling stations for an economical operation at cable lengths longer than about 1 km to 2 km.

In this contribution, a model for simulating cryogenic mixed-refrigerant cycles (CMRC) based on the Joule-Thomson effect and an associated optimization algorithm are presented. The distinctive feature of CMRC is the combination of good scalability of the cooling capacity, adaptability of the mixture to the specific application and an inexpensive process design. While the process is relatively simple, the identification of ideal operating conditions and mixture compositions requires complex modelling. In order to optimize these characteristics for CMRC processes, the Differential Evolution algorithm is adapted to a model built in Mathematica. Thermodynamic property data is calculated with the Peng-Robinson Equation of State as part of CoolProp, an open-source thermophysical property library. First simulation results are presented and further improvements are being discussed.

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Session Classification: C1Or2A: Non-Aerospace Coolers I: Brayton and JT Coolers