Motivation

• In liquid helium infrastructures the highest potential of efficiency optimization lies within the transfer process
• By use of conventional transfer lines up to 30% of transferred liquid evaporates
• Generated gas undergoes demanding recovery, purification and reliquefaction
• Using a pump in combination with a dual flow transfer system, transfer losses down to 2% or less are possible [1]

Goal: Development of a flexible transfer system with high-efficiency pump

Liquid helium pump

• Submersible centrifugal pump (design adapted from first TU Dresden prototype [2]):
  • Shrouded impeller with 18 blades (including 9 splitter blades)
  • Radial-axial stator with 22 blades
  • Impeller and stator additively fabricated (binder jetting method)
• Brushless three-phase DC-motor:
  • Dry running hybrid ball bearings
  • Sensorless commutation

Concept of dual flow transfer system

• Pump transfers liquid helium from reservoir to target dewar through liquid line, in steady state: cold gaseous helium flows back in counterflow
• Cool down: warm helium gas is bypassed to recovery and warms up
• Flexible horizontal section (two corrugated tubes in parallel for more flexibility)
• Rigid vertical section (coaxial tubes at both sides)
• All tubes in one common vacuum
• Several layers MLI applied in horizontal section
• Aluminum tape applied in vertical sections to reduce radiation
• Use of PTFE spacers to fix internal tubes

System characteristics

• Pressure loss dominated by liquid line $\Delta p_{\text{LHe}}$
• Target dewar at medium pressure
• Assuming 7 W static heat leak, subcooled liquid enters target dewar at design flow rate of 1200 l/h
• Total evaporation loss depends on cool down losses (corresponding to cold mass)

Outlook

• Installation of the entire system at filling station
• Experimental testing of cool down and steady state operation
• Evaluation of system performance, especially evaporation losses and cavitation performance of the pump

Literature