Compressor-less Hydrogen Refueling Station using Thermal Compression

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PD 126

Instead of relying on expensive and maintenance-prone compressors, this approach would store liquid hydrogen in cryogenic capable pressure vessels where pressurization would occur through heat transfer. This thermal compression filling station concept would present cost and reliability advantages and offer capacity adjustment and flexibility (wide range of pressures and temperatures available).

Time & Budget

Start date: June 2015
End date: June 2017
Federal funds: \$ 500,000
Cost-share: \$ 125,000
Total budget: \$ 625,000

Partners

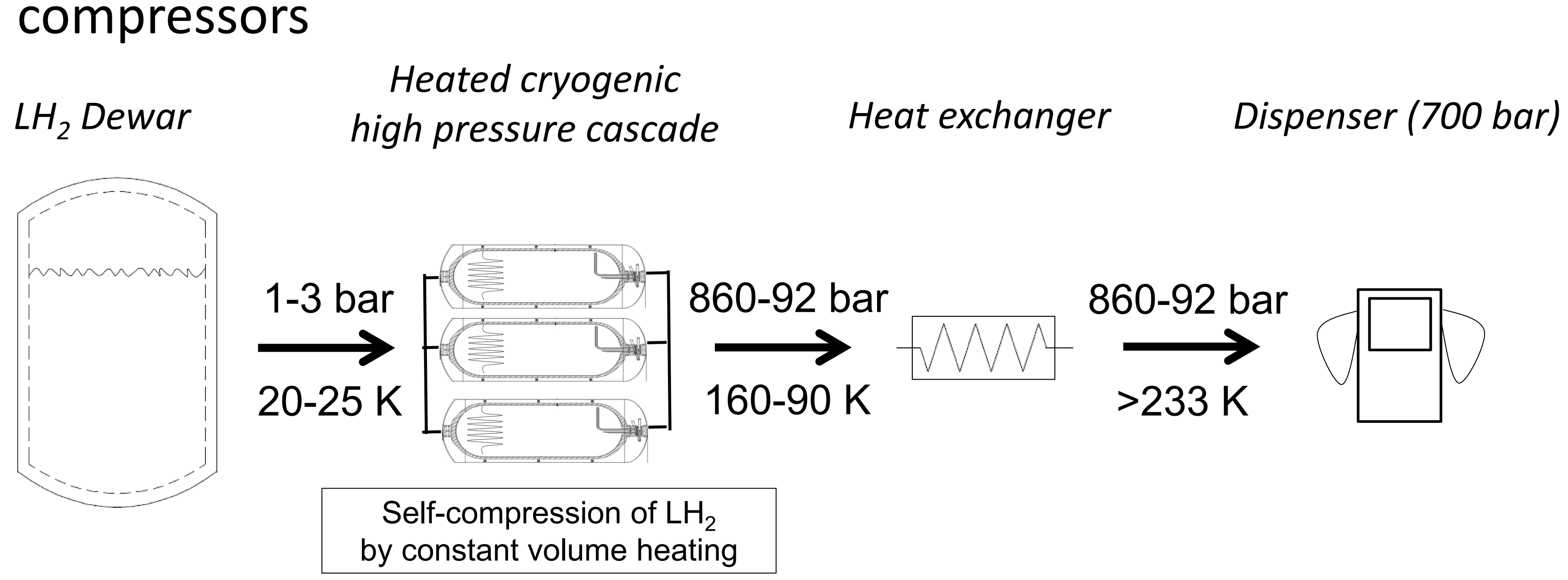
GTI: Lead, fueling station design, BOP specification
LLNL: Thermodynamic modeling and experimental proof of concept
ORNL: Cost-effective stationary storage
SHELL: OEM perspective

Barriers

A. Lack of Hydrogen/Carrier and Infrastructure Options Analysis
B. Reliability and Costs of Gaseous Hydrogen Compression
I. Other Fueling Site/Terminal Operations

Overview/Context

- Station cost reduction is a priority to enable H_2 infrastructure
- Up to 50% of fueling station cost is due to compressors
- Thermal exergy of liquid H_2 could be efficiently used to compress H_2 through insulated high pressure vessel
- Concept would avoid need for expensive and maintenance-prone compressors

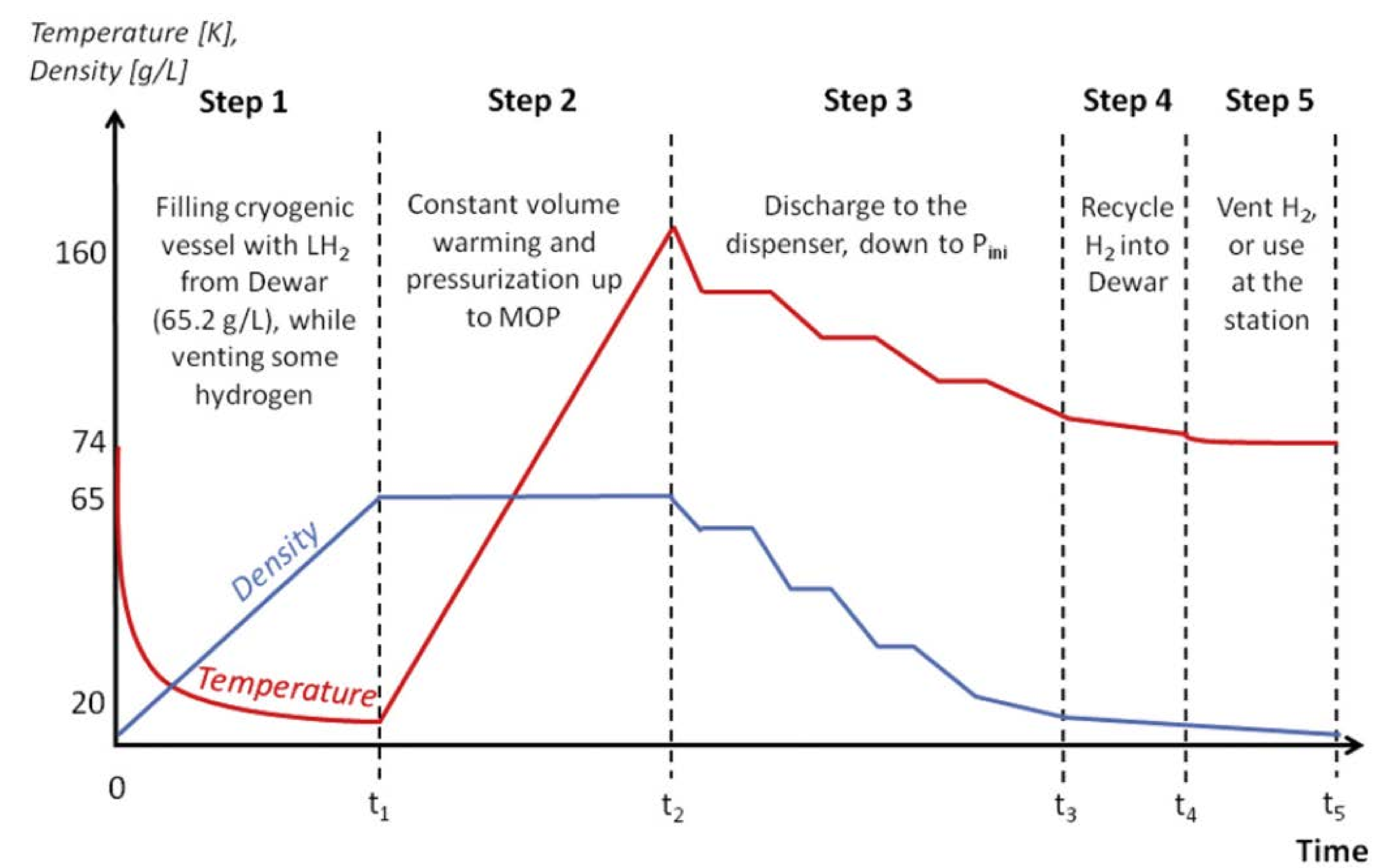


Conceptual design of a 700 bar *compressor-less* fueling station

Objectives

Demonstrate technical and economic feasibility of the thermal compression concept for 700 bar fueling stations

- Build transient simulation models for station design
- Carry out a preliminary full scale system design
- Validate key concepts with small scale demonstration



Notional cycle for an insulated high-pressure vessel

Approach

- HDSAM typical fueling station utilization and assumptions will be used
- Transient model with real gas EOS and 2 phase flow
- Compact heat exchanger designs for high pressure and cryogenic H_2 will be developed
- Technical analysis of large scale cost effective insulated stationary pressure vessel designs
- Station design including Process Flow Diagram (PFD) and gap analysis
- Both capital and operating costs will be included in the levelized H_2 station cost estimate

Critical Assumptions

- Insulated pressure vessel cost and design, boil-off from transferring cryogenic H_2

Quarter	Milestones
Q1	Draft Hydrogen Safety Plan submitted to DOE for review by H_2 Safety Panel
Q2	Proof-of-Concept Thermodynamic Transient Model (real gas EOS, 2 phase flow)
Q3	Completed Model for optimization (minimum venting and cost as a function of daily demand, vessel specs.)
Q4	Completed Preliminary PFD and Energy Balance
Q5	Complete analysis of cost-effective stationary insulated pressure vessels for thermal compression
Q5	Go/No-Go: Cost analysis should demonstrate 15% overall cost reduction over a \$8.72/kg levelized baseline
Q6	Complete analysis of technological gaps
Q7	Small scale demonstration testing with < 3 hours pressurization to 700 bar and 1.5 k/min dispensing rate