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Ultra-Cryopump for High-Demand Transportation Fueling

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Project ID#: IN019

2020 Annual Merit Review Meeting
May 19-21, 2020

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ROTOFLOW
An Air Products Business

Overview

Timeline

Project Start: 2/1/2020

Project End: 5/1/2023

Budget

Total Project Budget:

- Total Recipient Share:
\$418,530
- Total Federal Share:
\$1,674,100
- Total DOE Funds Spent*:
\$3,712

*As of 2/28/2020

Technical Barrier Addressed

C: Reliability and Costs of Liquid Hydrogen Pumping

Partners

- US DOE– project sponsor & funding
- Collaboration between two Air Products business units

Relevance

Objective: design, build, and successfully test a liquid hydrogen pump for heavy duty transportation (truck and bus) refueling

- Scope includes pump design, seal design, heat leak mitigation, and motor configuration

DOE Technical Targets	
Flow Rate	>400 kg/hr
Power	≤0.5 kWh/kg
Inlet Pressure	<10 bar (145 psi)
Discharge Pressure	≥950 bar (13700 psi)
Reliability	>90%

Approach

FY20 Milestones & Status

- Work in Budget Period 1/FY20 will focus on defining requirements and determining feasibility of various possible designs for key subsystems.
- The team will identify one primary design direction, with fallback plans for areas of high risk.

Milestones	Status
Define interface requirements between pump and heat leak mitigation equipment	In progress
Quantify thermal mass cooling requirements	In progress
Determine feasibility of LIN shielding cooling	In progress
Determine preliminary configuration for vacuum jacket	In progress
Determine single vs dual throw pump layout	In progress
Determine motor clutch system requirements	In progress
Go/No-Go decision #1	Expected July 2020

Accomplishments & Progress

- **Feb 2020** – Cooperative agreement signed and project kicked off.
- As of April 2020, all Budget Period 1 tasks are in progress and on schedule.

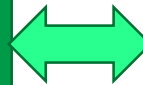
Collaboration & Coordination

This effort is a collaboration between two Air Products business units, **Rotoflow** and **Hydrogen for Mobility**.

- Utilize Rotoflow's product development, testing, and production capabilities.
- Leverage Hydrogen for Mobility's well-established presence in the hydrogen fueling market.

Rotoflow

- Supplier of cryogenic rotating equipment and pumps
- In-house prototyping, testing, and production capabilities
- Product and technology ownership for Ultra-Cryopump



Hydrogen for Mobility

- Owner of Air Products hydrogen fueling stations and associated technology
- 200+ fueling stations installed since 1993
- Business ownership for Ultra-Cryopump

Remaining Challenges & Barriers

Seal performance

- As with any pump, longevity and performance of seals is key.
- Air Products is constructing a dedicated seal test rig to allow offline testing of seals and enable faster design iteration.

Heat leak mitigation

- Minimizing heat leak and controlling heat generation is key to minimizing boiloff.
- Ability to compress 2-phase hydrogen is key to utilizing cryogenic boiloff gas.

Internal pump stresses

- Higher pressure and higher throughput requirements for heavy duty applications require design and material changes to pump
- Not simply a scale-up of our existing pump designs for automotive fueling applications

Budget Period 1 activities focus on addressing these challenges

Proposed Future Work

Remainder FY20:

- Complete BP1 activities
- Go/No-Go decision point to transition to BP2
- Draft Hydrogen Safety plan by April 30, 2020

FY21:

- Begin BP2 activities
 - Refine the design concepts selected in Budget Period 1 into detailed designs that can be prototyped
 - Design tooling for assembly
 - Design test apparatus to characterize performance

**Any proposed future work is subject to change based on funding levels.*

Technology Transfer Activities

Specific technology transfer activities, and any potential patentable features, have yet to be determined.

Summary

- **Objective:** Design, build, and successfully test a liquid hydrogen pump for heavy duty transportation (truck and bus) refueling.
- **Approach:** Work in Budget Period 1/FY20 will focus on defining requirements and determining feasibility of various possible designs for key subsystems.
- **Accomplishments:** All BP1 tasks are in progress and on schedule.
- **Collaborations:** This effort is a collaboration between two Air Products business units, Rotoflow and Hydrogen for Mobility.