A TOOL TO ESTIMATE THE BENEFITS OF TUBE-TRAILER CONSOLIDATION FOR STATION BUILDERS

Providing station builders a tool to foresee the benefits of pressure consolidation

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PROJECT OVERVIEW

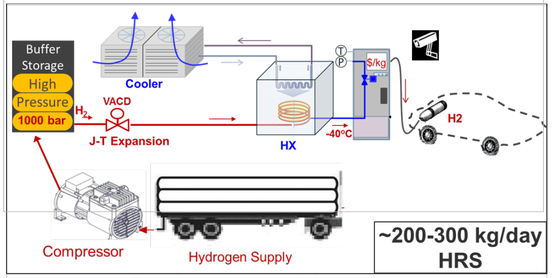
We will provide a tool to station builders to help them quantify the benefits of the pressure consolidation hydrogen refueling technology developed by Argonne National Laboratory, and to compare these benefits to typical baseline station operation. The tool will:

- Provide a variety of options for users to input the station size, supply storage pressure, compressor flow curve, hourly refueling profile, and dispenser-rated vehicle fill pressure;
- Simulate pressure consolidation and use economic analysis to determine the levelized cost of hydrogen refueling;
- Optimize station components and simulate its operation for a given set of design parameters; and
- Output the levelized cost of hydrogen refueling, capital cost of the refueling station, number of fueled vehicles with corresponding state of charge, and supply storage utilization.

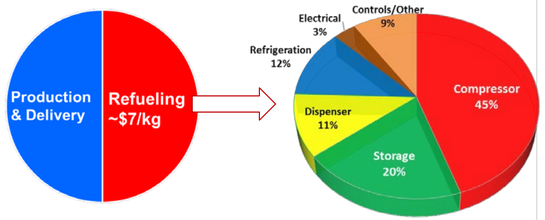
TASK OBJECTIVE

Develop a tool for station developers to estimate the performance of a station using pressure consolidation hydrogen refueling

RELEVANCE

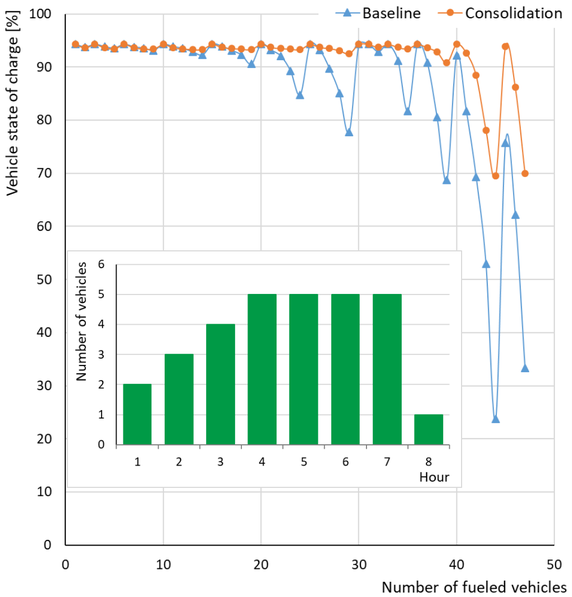


Typical Gaseous Hydrogen Refueling Station



➢ Together, compression and storage make up 2/3 of the total station capital cost

RELEVANCE



- ❑ Pressure consolidation enables consistent high-state-of-charge fueling, which is crucial for customer satisfaction
- ❑ By operating the station with pressure consolidation, simulations show that the equipment capital cost of the station can be reduced by up to 25–30%; alternatively, the station's refueling capacity could be increased by a factor of 2–3
- ❑ The pressure consolidation refueling algorithm allows significant utilization of the tube trailer (or supply storage), which means that deliveries to the station could be less frequent, thereby reducing the cost of hydrogen to customers
- ❑ Operating the compressor continuously with fewer starts and stops should improve its operational reliability, resulting in less downtime/maintenance

ACKNOWLEDGEMENT

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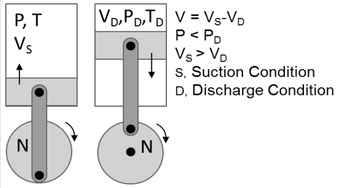
APPROACH

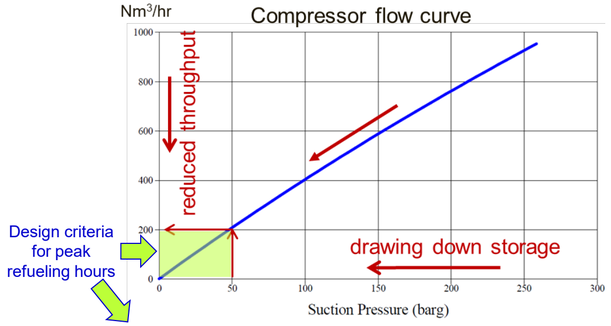


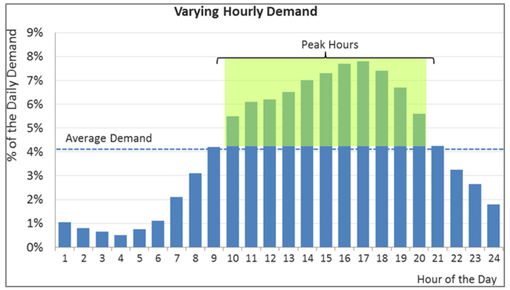
Compressors are typically sized to provide the required compressor throughput to meet station demand at the lowest possible supply working pressure

Mass flow rate = volume displacement × r.p.m. × density

Mass flow rate = volume displacement × r.p.m. × $[P/ZRT]_s$

Mass flow rate ~ suction pressure

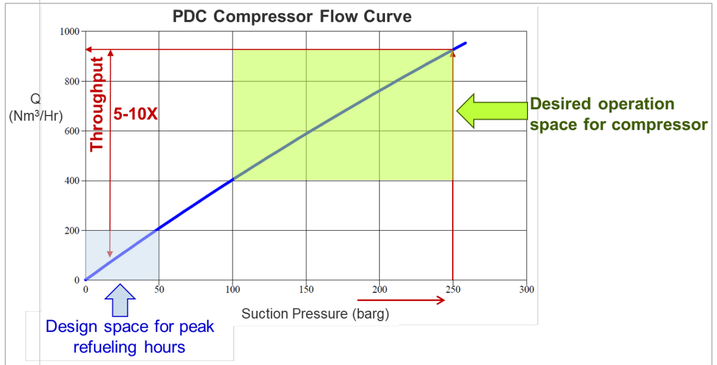




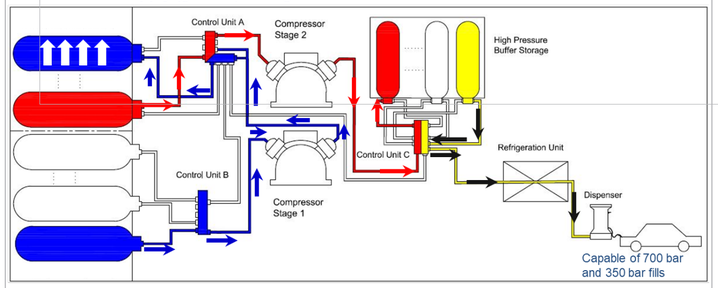
➢ Oversized for better utilization of hydrogen supply storage

➢ Underutilized during off-peak hours

APPROACH



Tube-trailer or supply (ground) storage



SUMMARY

Pressure consolidation allows more efficient utilization of the compressor. Moving hydrogen within the supply pressure vessels during idle refueling periods ensures higher pressure at the compressor suction, which increases its throughput. This increases the station's refueling capacity.

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