

The logo for Volute, featuring a stylized blue 'V' that resembles a hydrogen tank or a pen nib, followed by the word 'VOLUTE' in a bold, blue, sans-serif font.

VOLUTE

Conformable Hydrogen Tanks

Need for Standards Development

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Volute has invented a conformable hydrogen tank

Folds to fit anywhere

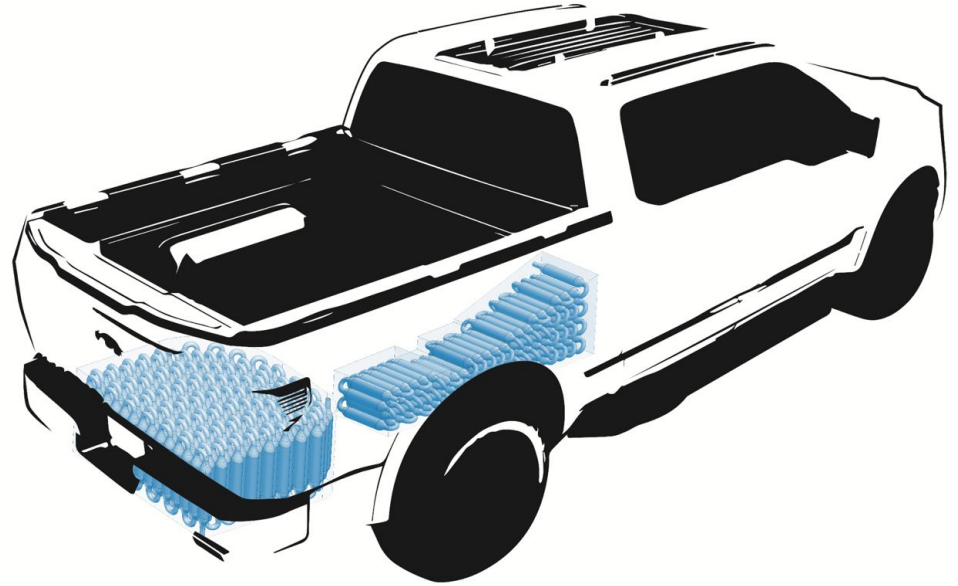
20% lower cost

No pre-cooling during fill

Seamless design

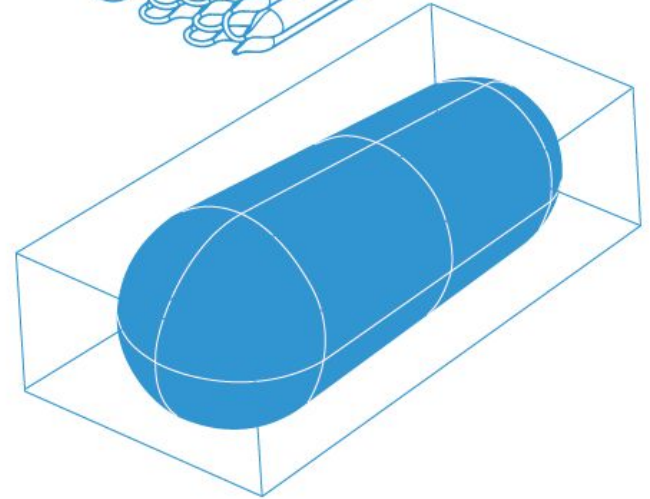
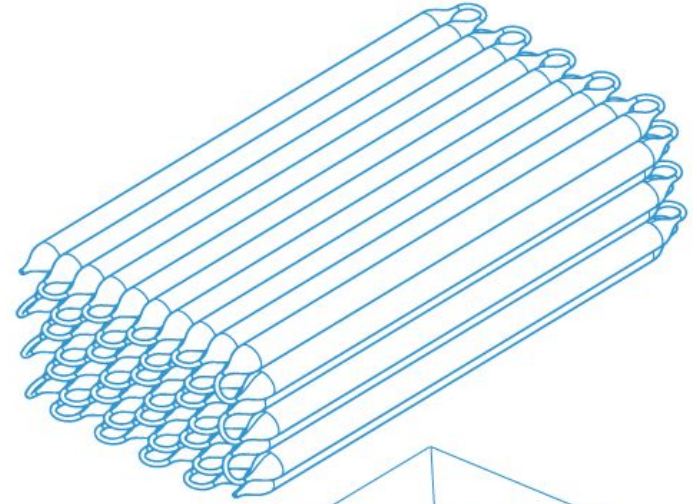
Continuous manufacturing

70 MPa operation



Volute's tank makes better use of space

- Foldable design can be configured to fit irregular spaces in vehicles
- Stores 25% more fuel when compared to a standard cylinder filling the same bounding box

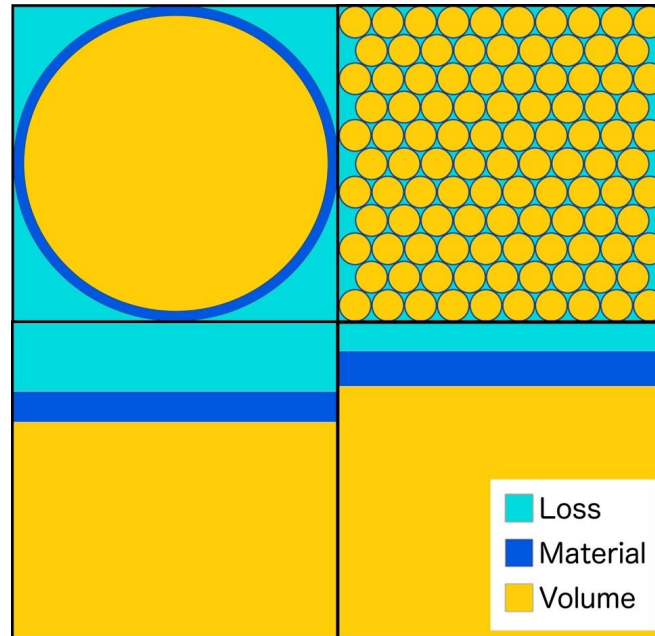


Volute's tank has a smaller radius and thus thinner walls

Carbon fiber strength
Hydrogen pressure

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Tank radius
Tank wall thickness



A subscale tank is currently undergoing UN GTR 13 tests



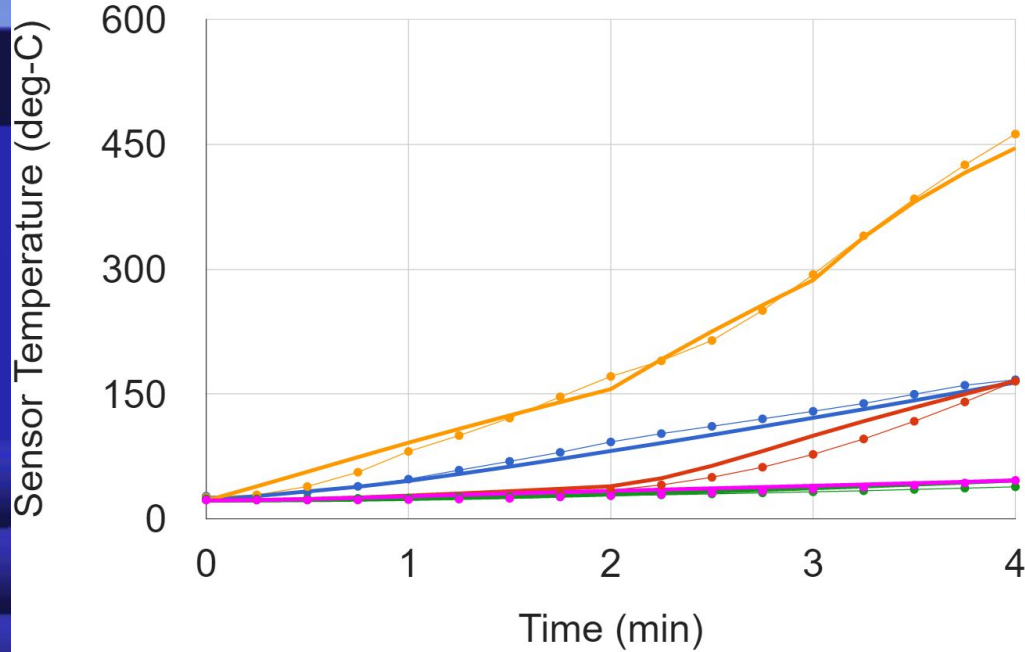
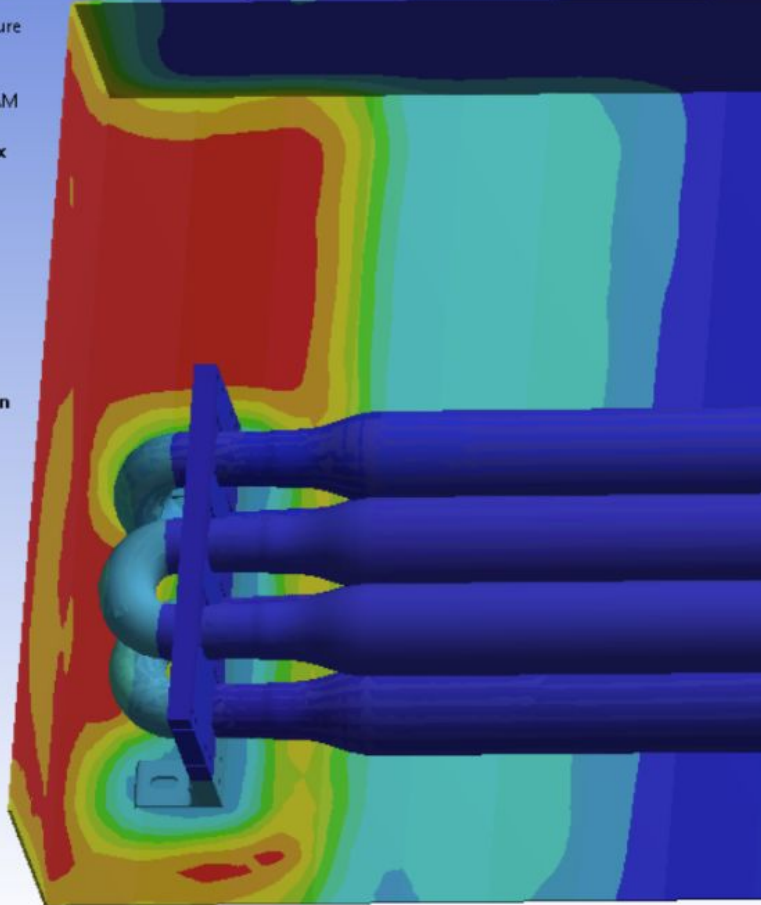
Localized
Fire

We also develop analytics to better understand tank performance

E: Steel Enc Empty Chambers (Linear Shells) - Calibration

Temperature
Type: Temperature
Unit: °C
Time: 240
2/1/2017 10:07 AM

698.05 Max
617.1
536.14
455.19
374.23
293.28
212.32
131.37
50.411
-30.543 Min



CSA N/HGV2 committee has proposed revisions for conformables

Proposed Design Qualification Tests For Conformable Tank Designs:

	Type A – Direct Conformable	Type B – Protective Shell Conformable (non-load bearing)	Type C – Protective Shell Conformable (load bearing)
DEFINITIONS NOTE: Conformable tank definition assume CNG only (without adsorbents)	Pressure vessel or assembly consisting of a non-cylindrical or non-spherical (i.e. irregular) shape.	Pressure vessel or assembly of possibly irregular shape contained within a conformable protective shell that is <u>not</u> under any stress associated with the application of gas pressure.	Pressure vessel or assembly of possibly irregular shape contained within a conformable protective shell that is under stress associated with the application of gas pressure

EXISTING NGV2 QUALIFICATION TEST MODIFICATIONS FOR CONFORMABLE TANKS

Ambient cycling (Section 16.3)	No change	If pressure cycling causes damage to the protective shell, then this is considered a test failure. A shell failure is defined as cracks or fractures in the shell, or	Cycle testing requires a minimum 2 second hold at the maximum and minimum pressure of each cycle, to ensure pressure equalizes in the pressure containing
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NEW NGV2 QUALIFICATION TESTS FOR CONFORMABLE TANKS

Vibration Test	Not Required	Pressurized to 100% of service pressure and prepped for test by placing it in its proposed design position. Conduct vibration sinusoidal form with frequency Range: 5 to 200 Hz with TBD load profile (max. 5g). Change of Frequency at 1 octave per min. Duration per Axis (X, Y, and Z) of 8 h (24 h in total). No leakage during or at the completion of the test. If protective shell is gas-tight (able to hold 50 psi), measurement samples must be taken from annular space within shell (to ensure no CNG build-up within a sealed shell).	Pressurized to 100% of service pressure and prepped for test by placing it in its proposed design position. Conduct vibration sinusoidal form with frequency Range: 5 to 200 Hz * s with TBD load profile. Amplitude (at 5 Hz): 10 mm. Change of Frequency: 1 Octave per min. Duration per Axis (X, Y, and Z): 8 h (24 h in total)
Mechanical Shock Test	Not Required	Pressurized to 100% of service pressure and prepped for test by placing it in its proposed design position. Conduct a shock half-sine pulse	Pressurized to 100% of service pressure and prepped for test by placing it in its proposed design position. Conduct a shock half-sine pulse for

This is currently undergoing discussion for incorporation into NGV2 in 2018
(meeting next week)

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