Submitted by the expert from Italy

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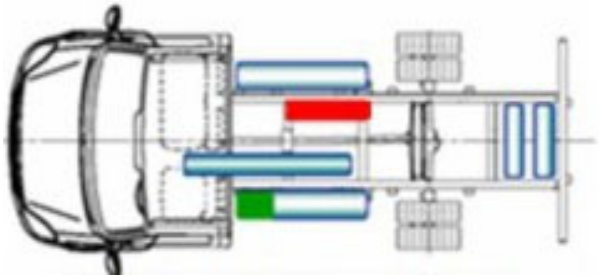
Agenda item 9(b)

CONFORMABLE STORAGE CONCEPT FOR CNG VEHICLES

Motivation for Conformable Storage

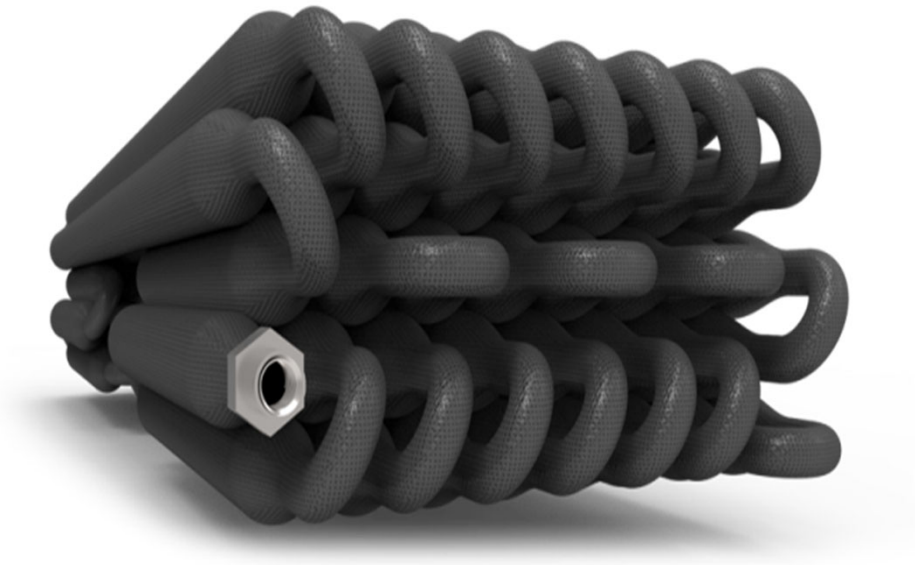
Ram photo at allpar.com:
2012 Ram 2500 with CNG / gasoline capability



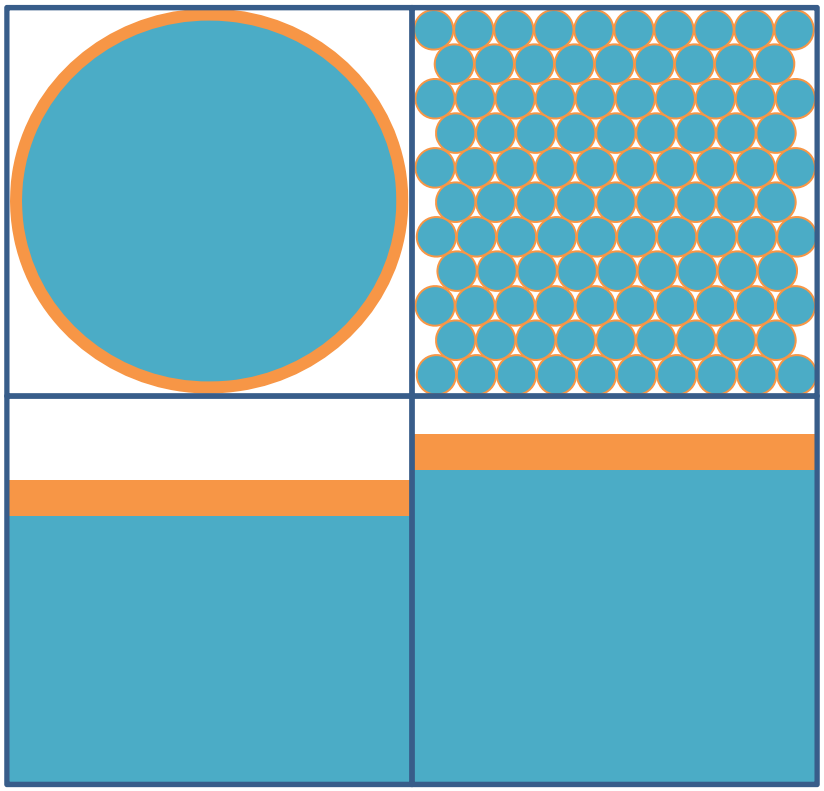
- NGVs offer economic and environmental benefits but bulky CNG cylinders can be difficult to fit around passenger and cargo space
- Multiple tanks are costly and time consuming to install
- This situation applies to vans, non-road equipment, heavy duty trucks and buses

Conformable Storage Concept

- Lightweight and fuel storage that is shaped to fit in available spaces within the vehicle
- An integrated network of, connected, optimally sized chambers creating CNG fuel storage modules in shapes similar to liquid fuel tanks and battery packs.
- The concept uses conventional composite materials to produce a space efficient, tough, lightweight and low cost storage solution for CNG vehicles
- Potential applications include
  - Light commercial vehicles (pick up trucks and vans)
  - Heavy commercial vehicles (buses, vocational and highway trucks)
  - Agricultural and other off-highway vehicles



Underlying Principles



CNG Storage Space

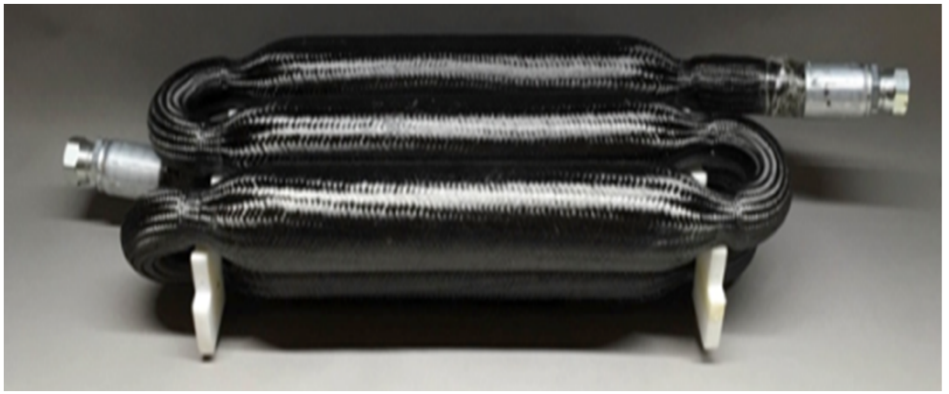
Pressure Vessel Wall

Unused Space

- The technology builds on 3 main underlying principles
  1. Hexagonal packing of small diameter, thin-wall chambers. Hexagonal packing is used to significantly reduce the amount of lost space compared to square packing.
  2. There is a constant optimal stress in the pressure vessel wall. When a single large diameter pressure vessel is replaced with many small diameter vessels, the walls can become thinner and maintain the optimal stress. The overall amount of material stays constant.
  3. Wrapping of a continuous pressure vessel tube to form an arbitrary shape. In the case of FiT PACK, interconnected quasi-cylindrical chambers are folded into the desired shape to suit the vehicle application.

Construction

- The pressure vessel is formed of a continuously molded liner supported by a braided carbon fibre composite skin



- The liner has long chambers and connected flexible elbows to allow it to be folded
- The liner elbows are flexible before the carbon-resin composite is cured
- Tanks are “folded” prior to curing to form the shape needed for the vehicle
- A protective, non-pressure bearing and gas permeable enclosure supports and protects the carbon composite structure on the vehicle

Current Materials Used

- Liner
  - Polymer liner (various options available)
- Composite
  - Braided carbon fibre over-wrap
  - Fibres run continuously from end to end of each string of chambers
  - Epoxy resin matrix