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Composite fuel tanks lightweight vehicles allowing alternative fuels to be carried onboard

plastics & autos

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- Alternative fuel vehicles using gaseous material (i.e., compressed natural gas [CNG], hydrogen, etc.) require strong, safe, lightweight tanks to maintain "normal" vehicle size, weight, and driving ranges.
- Traditional alternative fuel tanks are made of common grade steel and, over time, the gas can migrate into the metal. This makes the metal brittle, fatiguing it to the point that gas, such as hydrogen, can leak from the tank.[1]
- Higher quality steel can prevent embrittlement, but can raise the cost and the weight of the tank. A premium steel tank holding 3 kg (6.61 lbs) of hydrogen would itself weigh 400 kg (881.85 lbs), obviously cutting into fuel economy.[1]
- In addition, because both natural gas and hydrogen are stored in gaseous form, larger fuel tanks are required to achieve practical driving ranges—otherwise, alternative fuel vehicles may not be able to compete with driving ranges of gasoline-powered vehicles. However, "with a conventional tank, increasing size [can] also increase weight."[2,1]
- The benefit to using materials such as plastic and fiber carbon composites for alternative fuel tanks is that they keep weight to a minimum, while offering high shock resistance and a long life.[2]
- According to the International Association of Natural Gas Vehicles, "One perception that often arises is that you can't carry enough CNG because the cylinders weigh too much or take up too much space. However, if lightweight cylinders are used and the actual fuel needs of the vehicle are taken into account, weight is often not an issue at all."[3]
- In 2003, Japan-based Toyoda Gosei Co., Ltd. successfully developed an all-composite compressed natural gas tank that is 60% lighter than the average metal CNG tank.[4]

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Alternative fuel vehicles, such as this natural gas bus, can use composite tanks to keep weight to a minimum, while offering high shock resistance and a long life.[2]

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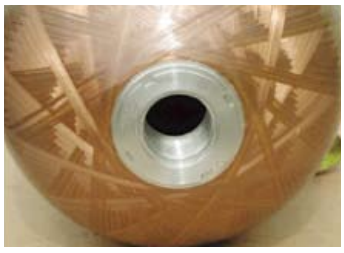
This Honda Civic was crushed to the "B" pillar behind the driver's seat. The driver walked away and there was no rupture in the CNG fuel tank or system housed/installed in the rear of the vehicle (center).[8]

Used with permission. Courtesy of ATK Launch Systems.

According to Cleanvehicle.org, this plastic gas-tight liner is reinforced, or "full wrapped" by a composite wrap around entire tank.[8]



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The TriShield™ composite tank is constructed of polymer threads and proved its strength in a variety of tests.[1]

- Hydrogen vehicles can also use lightweight composite tanks. Quantum Technologies developed the 87 lb. (39.46 kg) 5,000 psi TriShield™ tank, which contains an impermeable, modified polymer liner surrounded by a carbon fiber inner shell and a hard external shell made of a proprietary fiber/resin woven system and impact-resistant polymer domes on each end.[5,1]
- Used in the Hyundai Santa Fe fuel cell SUV, the ultra-lightweight TriShield™ tank holds up to 3 kg (6.61 lb) of hydrogen—the average pressure held by steel tanks, which is enough for a 200–km (124.27 mi) trip in a standard sedan.[6,7]
- To ensure its safety onboard vehicles, Quantum Technologies extensively tested the TriShield™ tank. It passed crash car tests as well as tests "firing armor-piercing bullets at it, dropping the cylinder from six feet onto a concrete surface, placing it in a diesel fire, cycling it thousands of times,* and subjecting the cylinder to extreme cold and to corrosive liquids encountered in automotive environments, such as battery acids, saltwater, brake oils, and methanols," according to Neel Sirosh, a mechanical engineer and director of fuel storage systems at Quantum.[1]

*** An average gasoline-powered car that gets 25 mpg with a 15-gallon tank driving 15,000 miles per year that lasts for 10 years would cycle only 400 times in its lifetime. (10 years x 15,000 miles = 150,000 miles / 25 mpg = 6,000 gallons of fuel for car lifetime. 6,000 gallons / 15 gallons = fill up 400 times = cycled an average of 400 times)**

Additional Information

- Today worldwide, some 3.5 million CNG (compressed natural gas) vehicles are in operation, mostly in Italy, Argentina, Brazil, Pakistan. CNG vehicles are also growing rapidly for transit operations as Europe seeks lower emission fuels.[8]
- "Several companies in North America are in commercial production of at least partially–advanced composite CNG tanks in the hundreds of units for municipal bus and utility truck contracts. World–wide, there are half a million to 800,000 such tanks on the road, according to the International Association for Natural Gas Vehicles."[9]

This 2007 Honda Civic GX contains a 4-cylnder single overhead cam (SOHC) engine that runs on CNG and has a driving range of about 170 miles.[10,11,12] The fuel tank is made by Structural Composites, Inc.[13] Using a clean-burning fuel, this engine achieves a fuel economy of 28/39 city/highway miles per gasoline-gallon equivalent, as compared to the 30/40 city/highway mpg that the gasoline-powered 2007 Honda Civic DX, LX, and EX achieve.[13,14]

Used with permission. Courtesy of Honda.

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Pictures

NGV Bus: http://www.nrel.gov/docs/fy03osti/33280.pdf

Crashed car: http://www.cleanvehicle.org/technology/CNGCylinderDesignandSafety.pdf

Plastic gas-tight liner: http://www.cleanvehicle.org/technology/CNGCylinderDesignandSafety.pdf

TriShield™ tank: http://www.memagazine.org/backissues/feb02/features/fillerup/fillerup.html

Honda Civic Natural Gas car: Sent by Honda

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