The Georgetown/UTC Fuel Cell Bus

IN DEPTH

Georgetown UNIVERSITY

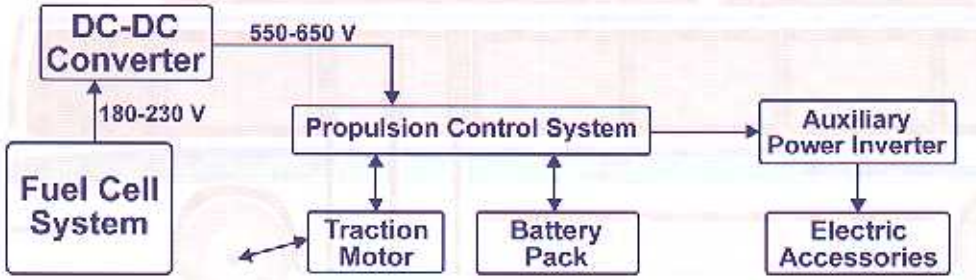
A Federal Transit Administration Project

Georgetown University's fourth liquid-fueled fuel cell transit bus combines a methanol-fueled UTC Fuel Cells 100 kW Phosphoric Acid Fuel Cell (PAFC) system with a 600-volt traction battery and propulsion system from BAE Systems to create a highly efficient, quiet, ultra-low emission urban transit vehicle.

Using methanol as a hydrogen carrier yields a range of 350 miles and allows refueling to be completed in less than 5 minutes. Emission levels for this 40-passenger bus are nearly zero and are well below current and projected clean air standards.

Hybrid Electric Power & Propulsion System

BAE Systems provided the power & propulsion system for the fuel cell bus, based on their commercial HybriDrive system. This propulsion system is currently in production by BAE Systems, and is operating aboard hundreds of Orion VII 40-foot diesel hybrid electric buses in cities across the U.S. and Canada.



Fuel Cell System

This Phosphoric Acid Fuel Cell System can deliver 100 kW (net) electric power. Details on this system are on the flip side of this brochure.

DC-DC Converter

This device efficiently boosts fuel cell voltage to match the higher voltage of the battery pack.

Propulsion Control System

The PCS generates 3-phase power for the traction motor, and manages the state-of-charge and module equalization of the batteries.

Traction Motor

The bus is driven by a 185 kW (250 hp) AC induction motor that is quiet, smooth, and capable of outperforming conventional drivetrains.

Battery Pack

Consists of 46 -12 volt lead-acid batteries connected in series. The battery pack supplies extra power for acceleration and allows for regenerative braking.

Auxiliary Power Inverter

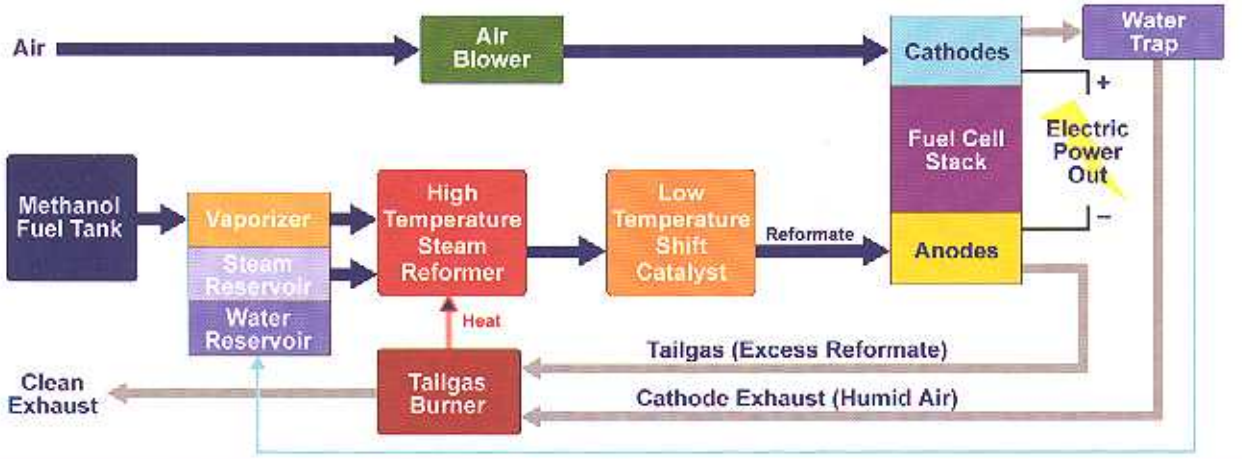
The API generates regulated 3-phase power for the electric bus accessories.

Electric Accessories

Includes air conditioning, power steering, and the bus air compressor.

Fuel Cell Power System

UTC Fuel Cells (a division of United Technologies Corporation) provided the fuel cell system in the bus. The fuel cell is based on technology used in UTC's commercial PureCell 200 stationary electric utility power plant (formerly designated as the PC25), incorporating a 200 kW PAFC with a fuel processing system designed for natural gas. The fuel cell system in the Georgetown/UTC Fuel Cell Bus is a methanol-fueled 100 kW version, with drastically reduced size and weight to make it appropriate for a transit bus.



Methanol Fuel Tank

The methanol tank holds approximately 150 gallons, giving the bus a range of up to 350 miles. The fuel tank can be completely filled with methanol in just minutes, with the same type of pump systems used at diesel filling stations.

Vaporizer

A heat exchanger integrated into the water/steam reservoir vaporizes the liquid methanol before the methanol is fed into the steam reformer.

High Temperature Steam Reformer

The heated reformer catalytically reacts the steam and methanol to produce hydrogen (H_2), carbon dioxide (CO_2), and carbon monoxide (CO).

Low Temperature Shift Catalyst

Since carbon monoxide is harmful to the catalyst in the fuel cell, the Low Temperature Shift Catalyst reduces the amount of CO in the reformate through a water-gas shift reaction, producing CO_2 and H_2.

Fuel Cell Stack

The fuel cell stack receives the reformate along with air to create electrical current. The fuel cell on the bus is a downsized version of UTC's commercial PAFC system, with a net power output of 100 kW.

Water Trap

Water is condensed from the cathode exhaust and sent to the water/steam reservoir to be used in the reformer to enhance hydrogen production.

Tailgas Burner

During fuel cell operation, excess hydrogen in the anode exhaust is burned to keep the high temperature steam reformer hot.

Exhaust

The only significant emissions from the fuel cell system are air, carbon dioxide, and water. There are trace amounts of hydrocarbons and CO, but the emission levels of the bus are far lower than any current or projected transit bus standards.

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http://fuelcellbus.georgetown.edu/