More-**efficient pumping** for fuel cells

Bus riders in British Columbia are getting a close-up view of future clean vehicles. That's because BC Transit has a fleet of 20 hydrogen fuel-cell buses — the largest single deployment of zero-emission fuel-cell buses worldwide. Water is their only by-product.

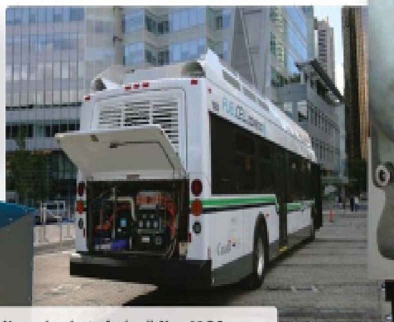
The buses get power from FCvelocity-HD6 fuel cells made by **Ballard Power Systems Inc.,** Vancouver, Canada. The BC Transit fleet is the first to incorporate the heavy-duty fuel-cell module into a hybrid fuel-cell/battery architecture.

The two crucial pieces of the system are the fuel-cell stack and the hydrogen recirculation device. The recirculation device collects unused hydrogen fuel from the stack, compresses it, and resupplies it to the stack using a blower motor.

But the design of the recirculation device has proven to be tricky because of condensation and moisture in the hydrogen coming off the stack. The fuel cell generates hot water and steam, which must be removed. Otherwise, moisture eventually reduces the amount of power the stack can generate. Moreover, water vapor and moisture can corrode the recirculator as well.

The past 10 years have seen numerous attempts to develop a hydrogen recirculation device based on existing air compressor designs. In 2006, **Ogura Industrial Corp.,** Somerset, N. J., began working with Ballard on a recirculation device based on design ideas from its TX

Resources:
Ballard Power Systems, *www.ballard.com*
Ogura Industrial Corp., *www.ogura-clutch.com* **RS# 406**



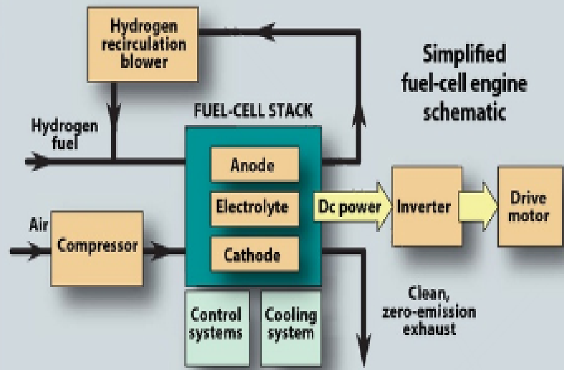
No engine, just a fuel-cell: Now 20 BC Transit buses get power from Ballard fuel cells rather than from diesels. Design constraints for Ogura recirculating pump proved to be challenging because of the moisture in the recirculated hydrogen fuel.

Series Air Blower. Now dubbed the TX04U-MA pump, the device is a positive-displacement blower driven by a brushless-dc motor. It operates by pulling gas through a pair of smoothly meshing rotors. These rotors connect to each other by gears. As the rotors turn in opposite directions, they trap gas in the pockets formed between the rotors and the housing. Every revolution of the rotor pumps a volume of gas from one side to the other.

The rotors are hollow for low inertia and are made to exceptionally tight manufacturing tolerances. This, plus a special proprietary coating, allows exceptional sealing, minimal temperature rise, and high pumping efficiencies. The pump also incorporates a new style of rotary shaft seal specifically designed to retain hydrogen (the lightest of all gases) within the pump, while withstanding a constant barrage of high velocity water molecules.

Proprietary treatments of the aluminum housing and steel shafts help these components resist the corrosive effects of wet hydrogen while providing low drag torque and exceptionally long life. Special redundant pathways within the blower's internal cavities handle hydrogen and timing-gear lube (patent pending). This lets the pump continue operating without contaminating the hydrogen stream in the unlikely event of a seal failure. And a special mechanical interface to the drive motor eliminated the need for separate flexible couplings.

Ogura says the rotary design is smaller and lighter than pumps based on centrifugal or regenerative turbine methods, and comprises a lighter electrical load as well. Additional fuel-cell applications including lift trucks and stationary power generators. **MD**



To prevent the fuel-cell anode from degrading, there must be a supply of hydrogen greater than the minimum (stoichiometric) value that the fuel-cell stack needs. This results in excess hydrogen fuel at the exit of the stack. The recirculation blower compresses and sends the unused fuel back to the inlet of the fuel cell.