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Vehicle Projects' Miller Proposes Futuristic Supersonic Fuel Cell-Powered Tube Train

DENVER, CO - "Taking the tube" may at some future time take on a radically different meaning than the conventional one of riding London's subway.

It would still mean riding in a train inside a tube tunnel. But if Dr. Arnold Miller's concept is realized, it would mean whisking from, say, New York to Los Angeles in less than three hours in a bullet-shaped articulated vehicle train powered by fuel cells that spin huge counter-rotating sets of propellers front and aft.

Miller is the guiding spirit behind the fuel cell mining locomotive, fuel cell hybrid mine loader and fuel cell switch locomotive developed in recent years by Denver-based Vehicle Projects LLC and reported here (H&FCL Nov. 00, Sept. 03, March 04, Feb. 08). Miller talked briefly about his new fuel cell tube train concept at the end of his presentation at the recent World Hydrogen Energy Conference in Brisbane, Australia (H&FCL July, Aug. 08). His full proposal and analysis, including the name of his new organization set up for this project, "Supersonic Tube Vehicle LLC," are in the April 2008 issue of the "International Journal of Hydrogen Energy."

Scooping Up Tube Fuel

The key and real kicker is that Miller's Miracle Machine would not have to carry hydrogen on the train itself - onboard storage of hydrogen is one of the major challenges today for any kind of vehicle - but only liquid oxygen. Instead, it would scoop hydrogen fuel from the gaseous hydrogen atmosphere that would fill the length of the entire 4-meter dia. pipeline-type tunnel, solving at one fell swoop the problem of hydrogen fuel storage and at the same time reducing friction and drag inside the tunnel because of gaseous hydrogen's unique properties.

Compared to air, hydrogen at near-atmospheric pressure transmits sound much faster. Conversely, it means that the feared sound barrier which can buffet, shake and damage a high-speed vehicle, is delayed: Mach 1.2 in air corresponds to only about one-fourth the value in a hydrogen atmosphere, or Mach 0.32.

Riding the Tube: a conceptual visualization of the fuel cell-powered supersonic tunnel train being studied by Vehicle Projects.

According to Miller's calculations, it means his tube train/plane could travel at speeds of up to Mach 1.2, or about 1,470 km/hour (about 918/miles/hour) without ever reaching, or breaking, the sound barrier and its attendant dangers.

Miller's tube train would be propelled by counter-rotating propfans of a type used by a large Russian transport plane, the 130-tonne Antonov AN-70 which can fly at near-jet speeds. These propfans are claimed to be much more efficient than the most efficient fan jets - about 90%.

Analogous to currently considered magnetic levitation (maglev) high-speed trains, Miller's tube train would levitate - fly - fractions of a millimeter above a V-shaped guide trough, dubbed a vee-way, at the bottom of the tube, pushed up by gas-bearing aerostatic pads at the bottom of the locomotive, corresponding to the bogies, or trucks, of a conventional rail locomotive.

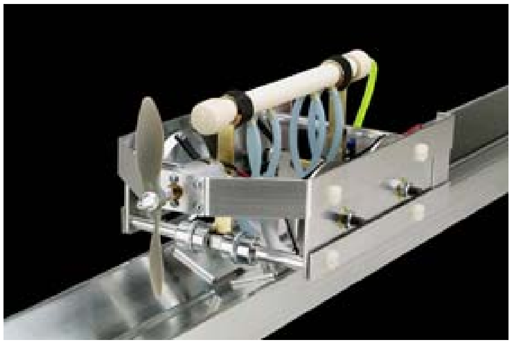
The amount of hydrogen needed to fill a New York-Los Angeles 3,960 km (2,475 miles) great-circle 4-meter dia. transport tube of this type would be large, but not prohibitively so, Miller argues: the amount of hydrogen needed would be 1.03 tons/km at slightly above atmospheric pressure, or a total of about 4,080 tons - less than 0.01% of annual global production of 45 million metric tons.

Only Liquid Oxygen Would be Carried On Board

To oxidize the fuel, liquid oxygen would be stored on board of the front and back locomotives. Basing his conceptual train design on Canada's Bombardier 74-passenger Dash 8 Q400 commuter turboprop plane because it would have the same 2.69 meter fuselage diameter, Miller calculates his 74-passenger single-car, two-locomotive train would have to carry and consume 2,330 liters of liquid oxygen during the New York-Los Angeles run, producing 2,990 liters of water that would have to be stored onboard until it can be discharged at the terminal station.

The tube train's performance would be vastly superior and much more efficient, Miller figures: While the Dash cruises at 667 km/hour (417 miles/hour), the train would be more than twice as fast at 1,500 km/hour. While the Dash requires about 5.9 MW for cruise power, the train needs only 2 MW. And the single-car tube train's energy consumption would be a little more than one-tenths of that of the plane (no energy required for wing lift): 3.8 x 104 Megawatt-Seconds for the train compared to 36 x 104 for the plane. Multiple-car trains are expected to require proportionately less energy per car because most of the power requirements are due to aerodynamic pressure drag, Miller told H&FCL.

The gas bearings - the bogies/trucks that lift the tube train slightly above the V-shaped guidance trough - represent the biggest technical challenge, Miller says. Major issues include "maintaining adequate bearing clearance and dimensional stability of such a large system in the face of potential ground movement," Miller wrote in the "Journal" article - a reference to the possibility of earth quakes in the Los Angeles area.



............and the first small working model of the fuel cell tube train built and studied by Vehicle Projects.

Also, safety from fire and detonation inside the tube has to be investigated. There is no chance of either inside the tube until enough outside air has leaked in to achieve the critical 74% hydrogen-in-air concentration; initially at least, hydrogen would leak out and mix with the outside air, there could be an outside flame if there is an ignition source, Miller wrote, and entrance of the flame into the tube would be limited by the rate of air diffusion into the tube and would likely be a slow process, extinguishing spontaneously as it progressed down the tube.

Summarizing, Miller says his, so far largely mathematical, investigation shows such a supersonic transport system would be energy efficient from city center to city center, with zero emissions and negligible noise; would operate independent of the weather; would have relatively low infrastructure costs compared to analogous long-distance maglev systems, for instance; and would provide a hydrogen storage solution for long-range.

Principal challenges include the presumably high infrastructure costs; so far no attempt has been made to figure out the total cost, but Miller says a preliminary baseline study of the economics is scheduled to get underway fairly soon.

Other challenges include maintenance of adequate hydrogen gaps in the aerostatic levitation and guidance system, and possibly dynamic instability of the levitated vehicle, according to Miller.

Also, a method has to be developed to allow passengers or freight to get onto and exit the train - presumably a type of airlock, with the train at rest in an air-filled section of the tube - or similar technology.

So far there is no indication when such a system might be built and tested. "A huge amount of basic scientific and engineering analytical work must be undertaken before a prototype carrying a person can operate at supersonic speed," Miller wrote in an e-mail. "In my estimation, foundational studies will require at least a decade, and I expect dozens of experimental prototypes will be required to reach the objective." As a small first step, Miller and his team have constructed a small battery-powered working model running on a one-meter long vee-way to demonstrate propeller propulsion and the gas film levitation.

Miller says he plans to say more about the concept at the upcoming HYPOTHESIS VIII symposium next April in Lisbon (See "Events" calendar).

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