Supersonic Transport with Zero Carbon Emissions

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Abstract

The supersonic hydrogen tube vehicle is a new concept in high-speed transport allowing supersonic transport with zero carbon emissions. Operation of a vehicle in a hydrogen atmosphere, because of the high sonic speed and low density of hydrogen, would allow supersonic speed (with respect to air outside the tube) and concurrently lower energy consumption than conventional subsonic aircraft. A hydrogen atmosphere requires that the vehicle operate in a hydrogen-filled tube or pipeline. To prevent leakage of air into the tube, hydrogen pressure is slightly above outside air pressure, and the tube serves as a phase separator.

Because a tube has an outside and inside, the vehicle has two Mach numbers, one with respect to air outside the tube and one with respect to hydrogen inside. Based on the ratio of the speed of sound in the two phases, a speed of Mach 2.8 with respect to air outside corresponds to only Mach 0.74 inside. Thus, the vehicle can be strongly supersonic outside and remain subsonic inside. Because required vehicle power increases linearly with gas density – with a sufficiently large cross-sectional area of the tube – the hydrogen atmosphere will reduce energy consumption at a given speed by a factor of 15 relative to air.

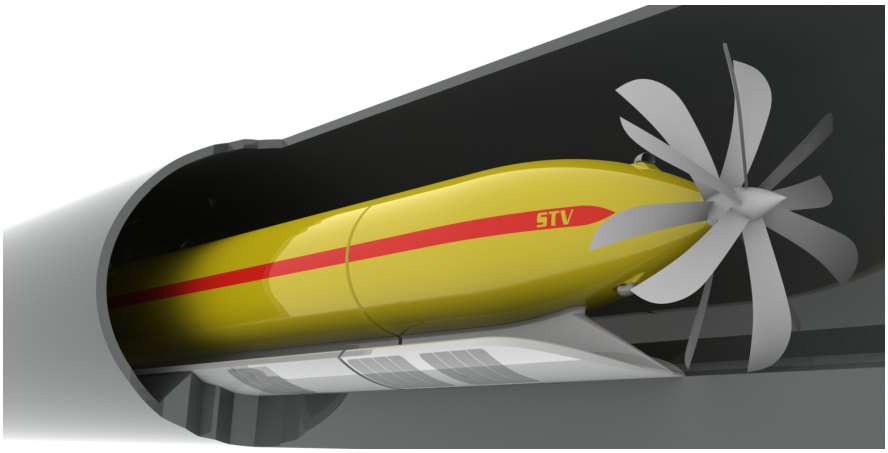

Fig.1. Supersonic tube vehicle within its hydrogen tube

The proposed supersonic tube vehicle consists of a vehicle levitating on a magnetic field of fluid film over a guideway within the tube (see Fig. 1). It is propelled by onboard hydrogen-oxygen fuel cells driving contra-rotating propellers. Hydrogen fuel is breathed from the tube itself, liquid oxygen is carried onboard, and the product water is collected and stored until the end of a run. Breathing fuel from the tube solves the challenging problem of hydrogen storage for long-range hydrogen fuel-cell vehicles. Unlike other vehicles that consume fuel, the supersonic hydrogen vehicle gains weight as it operates. If the tube hydrogen is produced from renewable or nuclear energy, zero carbon emissions will derive from the supersonic vehicle.

This presentation will discuss the latest results on aerodynamics of the vehicle in a hydrogen atmosphere within a tube and present design features stemming from the analysis. Design features include the tube geometry and propeller characteristics. An overview of a formal hazard analysis will also be presented.