The Benefits of a Rocket Vehicle Concentric Cryogenic Tank Design

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Abstract - Space transportation maximum productivity can be much enhanced by way of a concentric cryogenic tank design to achieve maximum affordability of space launch operations.

The Need for Productivity

To achieve productivity (number of flights per given time), ground turnaround and traditional operations must be minimized or eliminated. Operations risks, failure modes, and operations required to control risks must be eliminated or reduced from traditional operations. Elevated umbilicals from the vehicle to ground requiring a ground tower needed for servicing propellants before launch need to be eliminated. These functions need to be located at the base of the vehicle to reduce risk, cost, and turnaround time. Long LOX feed lines add large risk of geysering, causing either tank collapse or huge water hammer, with line refills potentially destroying the total system. There is a need to eliminate gaseous helium that is used for traditional geysering suppression. By shielding the LH2 tank with the LOX tank, the heat flux into LH2 will be reduced and will eliminate ice/frost forming on the LH2 tank outer surface without adding considerable tank insulation. The ground interface for the LOX and LH2 pressurization and vent line can be located at the base of the vehicle, thus simplifying the ground system (reduced turnaround time) and reducing cost. This also reduces risk of failure at launch.

Concentric Cryogenic Tank Design Benefits

A cryogenic tank design will greatly reduce the LH2 loss in space, thus allowing its use for in-space service by reducing the heat transfer into the LH2. This is accomplished by the LH2 tank radiating into the cold LOX tank (which is wrapped around the LH2 tank) and not into space. Control authority during launch is increased without the use of tandem tank design, along with all of its risks and drawbacks. This eliminates the need for an enter tank and its mass. All flight to ground interfaces are at the base of the tank. This eliminates the concern for LOX geysering and the traditional geysering suppression systems. This eliminates all external tank perturbances and external pressurization and vent lines by using internal pressurization and vent risers internal of the tanks. This eliminates LH2 tank concern for ice/frost that may be damaging to other parts of the vehicle. This allows for a minimum amount of insulation on the LH2 tank, with either the use of isogrid or skin and stringer design approach. This will eliminate the concern for extra LOX tank wall thickness by using a truss type anti-slosh approach to the interwall of the LOX tank. This will reduce the chill-down time and allow shorter propellant loading time. All ground systems hazards are thus virtually eliminated for launch. This will reduce the overall height of the vehicle, allowing a fair reduction of the ground launch facilities. This will allow the use of turboalternators located at the base of the tank to capture electric power driven from the tank pressurization gas during flight, with no impact to performance of the propulsion system. This power can be used to provide control during flight.

Rocket vehicle concentric cryogenic tank design research clearly merits greater attention from engineers.

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