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ADVANTAGE OF USING TURBOPUMP IN HYBRID ROCKET APPLICATIONS

Abstract

Hybrid rockets store propellants in two different phases as opposed to liquid rocket engines where both oxidizer and fuel are stored in liquid form. In many hybrid rocket applications, liquid oxidizer has to be fed into combustion chamber where fuel resides in solid phase. Thus, liquid propellant fed system should be considered as one of the major components of hybrid rocket assembly and be optimized in order to achieve combustion stability with desired thrust and burn time. In general, two different propellant systems are designed to feed liquid oxidizer into combustion chamber. The simplest propellant feed system is called pressure fed system where a high-pressure gas is used to pressurize oxidizer tank. The other system uses a pump which is driven by electric motor or turbine and liquid oxidizer pumped into combustion chamber at desired flow rate and pressure. Even though pressure fed systems are simpler and easier to build, only small-scale propellant feed systems can be designed due to requirement of heavier high-pressure tanks. In addition, combustion chamber pressure is limited when propellants are fed by pressure. Also, the pressure of the combustion chamber decreases at the end of the burn time because of blowdown effect phenomena in between high-pressure tank and oxidizer tank. On the other hand, electric pump feed system brings additional weights such as electric motor, batteries, and inverters although recent advancements in battery/motor technology offer better results in terms of efficiency and weight. Therefore, a turbopump system is designed and analysed for hybrid rocket motor in order to optimize weight and "Δ V" performance. The design parameters of turbine of turbopump system will be showed in detail. In addition, an example of system design of hybrid rocket assembly with combined hybrid rocket motors will be presented. The effect of turbine – driven pump to the system over conventional pressure fed propellant system will be investigated. As a result, longer burn time with higher combustion chamber pressure is expected to be achieved.