POWER PROCESSING UNIT OPTIONS" FOR 1 HIGH POWERED NUCLEAR ELECTRIC PROPULSION USING MPD THRUSTERS

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Abstract

This paper summarizes an evaluation of various megawatt-class power processing unit (PPU) design and technology options for high-power nuclear electric propulsion (NEP) vehicles using turboalternators and advanced magnetoplasmad ynamic (M PD) thrusters, Four design and technology options with the potential of improving overall system efficiency and reducing cabling mass are analyzed.

The first option uses high voltage AC from turboalternators. This approach has the advantage of reducing the mass of cabling from the alternators to the power processing module (PPM) but it introduces an increase in the mass and losses of an added transformer required to reduce the voltage to that needed by the thrusters (1 WV).

The second option involves the use of a turboalternator "star" winding instead of the "wye" windings assumed in the baseline system. The "star" topology has the advantage of requiring only half the rectifiers of the "wye" option, with a potential reduction in rectifier mass and losses, but this must be balanced against the greater number of cables in the long turboalternator-to-PPM boom in the "star" configurate ion.

The third option is to place the PPU rectifier electronics near the thrusters and use a remotely-located radiator. "l'his has the advantage of reducing the length of the low-voltage DC cables and, when combined with the first option of using high-voltage AC turboalternators, holds the promise of dramatically reducing the total mass and losses of the long boom cables. However, this must be. traded against replacing the simple heat-pipe PPM radiator in the baseline configuration with a pumped-fluid loop cooling system which would be more mechanically complex and power-intensive.

Finally, the fourth option involves the use of ultra-high efficiency power conversion using cryogenic MOSFETs and high -temperature superconductors. For terrestrial applications, a non-trivial cooling system is required for this option; however, in space it may be possible to passively cool the various components to the required temperature (77 degrees K) by designing a system with minimal heat leaks from the "warm" spacecraft and maintaining a view of deep space (rather than of a planet or the sun). In this case, the improved power conversion efficiency would be traded against the increased system complexity and mass. In other words, there is a small gain in efficiency but the cost due to complexity in design and implementation makes it a least attractive option.

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