

PROCEEDINGS

Thermodynamic Performance Evaluation of a Decoupled Solid Oxide Fuel Cell-Turboshaft Engine Hybrid System with Liquid Ammonia Chemical Recuperation

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ABSTRACT

Driven by the increasingly stringent carbon reduction demands in the aviation sector, this paper proposes a novel liquid ammonia chemically recuperated decoupled solid oxide fuel cell-turboshaft engine (SOFC-TS) hybrid system. In this proposed configuration, the SOFC efficiently drives the compressor, achieving the operational decoupling of the turbine from the compressor, while liquid ammonia chemical recuperation is simultaneously utilized for hydrogen production. A comprehensive evaluation is conducted to investigate the thermodynamic performance and operational characteristics of this hybrid system. The research results indicate that, compared to the conventional ammonia turboshaft engine and ammonia-recuperated turboshaft engine, the proposed SOFC-TS hybrid system reduces fuel consumption by approximately 30% and 15%, respectively. Correspondingly, the overall efficiency of the system is increased by roughly 50% and 20%, respectively. Furthermore, under the conditions of utilizing blue and green ammonia, the hybrid system can achieve substantial lifecycle carbon emission reductions when compared to traditional aviation kerosene engines. An exergy analysis reveals that the chemical recuperator and the combustor are the primary sources of exergy destruction, jointly accounting for approximately 60% of the system's total exergy loss. Overall, compared with traditional ammonia-fueled engines, this configuration reduces the performance penalties associated with ammonia utilization and offers a viable approach to achieving aviation carbon reduction targets.

KEYWORDS

Solid oxide fuel cell; turboshaft engine; ammonia; system decoupling; chemical recuperation; hybrid system

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