Kinetic

1-Effects of hydrogen addition on ignition characteristics and engine performance of ammonia-hydrogen blended fuel: A kinetic analysis

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Abstract

To investigate the effects of hydrogen addition on the ignition characteristics and engine performance of ammonia-hydrogen fuel, a reaction kinetics mechanism suitable for high-pressure engine conditions was proposed. The study explores the influence of hydrogen blending ratios on the ignition delay time (IDT) of ammonia-hydrogen fuel, revealing the sensitive reactions and evolution characteristics of reaction pathways during the ignition process of ammonia-hydrogen fuel promoted by hydrogen. The study also investigates the impact of hydrogen blending ratios on the engine performance of ammonia-hydrogen fuel. The results show that the IDT of ammonia significantly decreases with increasing hydrogen blending ratios and temperature. The addition of hydrogen to ammonia significantly lowers the autoignition temperature boundary of the mixture. Under low-temperature and low-pressure conditions, ammonia, which would not ignite originally, ignites due to the addition of hydrogen. The addition of hydrogen shifts the sensitive reactions of the mixture from NH3 and NH2-related reactions to H-2/O-2-related reactions, without altering the reaction pathway of ammonia, only changing the pathway flux of components such as NH2, H2NN, H2NO, and HONO. In a spark-ignition (SI) engine, maintaining the total fuel heat value and ignition timing constant, an increase in hydrogen blending ratio significantly raises the peak cylinder pressure. However, due to the forward movement of the heat release process, the power performance of engine experiences varying degrees of reduction. Therefore, it is necessary to delay the ignition timing of engine with the increase in hydrogen blending ratio, moving the combustion center beyond the top dead center (TDC). Furthermore, increasing the hydrogen concentration in the blend significantly raises the temperature and pressure during the engine combustion process, leading to an increase in the concentration of thermal NOX in the emissions.

Keywords

Author Keywords

Ammonia-hydrogen blended fuelAutoignition characteristicSensitivity analysisReaction path analysisZero-dimensional engine simulation

Keywords Plus

HIGH-TEMPERATURE OXIDATIONAMMONIA/HYDROGEN MIXTURESSHOCK-TUBELAMINARMECHANISMBEHAVIOROXYGEN

Kinetic

2-Thermodynamic and kinetic insights for manipulating aqueous Zn battery chemistry: Towards future grid-scale renewable energy storage systems

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Abstract

The invention of aqueous Zn batteries (AZBs) traces back to the eighteenth century. Recently, however, AZBs have been undergoing a renaissance due to the urgent need for renewable energy storage devices that are intrinsically safe, inexpensive, and environmentally benign. The escalating demand for high-energy, fast-charging AZBs, particularly in grid-scale energy storage systems, necessitates a profound exploration of the fundamental aspects of electrode chemistries. In particular, a comprehensive understanding from the viewpoints of thermodynamics and kinetics is crucial, with the aim of advancing the development of next-generation AZBs that have high power and energy densities. However, clarification about the fundamental issues in AZB chemistry has yet to be achieved. This review offers a thorough exploration of the thermodynamics and dynamic mechanisms at the anode and cathode, with the aim of helping researchers achieve high-performance AZBs. The inherent challenges and corresponding strategies related to electrode thermodynamic and dynamic optimization are summarized, followed by insights into future directions for developing high-energy, fast-charging AZBs. We conclude by considering the future prospects for AZBs and offering recommendations for making further advancements in discovering new redox chemistries, optimizing electrode architectures, and achieving integrated battery designs, all of which are considered essential and time-sensitive for making high-energy, fast-charging, and durable AZBs a reality.

Keywords

Author Keywords

Aqueous Zn batteryThermodynamics and dynamic mechanismElectrode designHigh-energy densityFast-charging capability

Keywords Plus

RECHARGEABLE ZINC BATTERYLONG-LIFECATHODE MATERIALSHIGH-CAPACITYLITHIUM BATTERIESEFFICIENT CATHODERECENT PROGRESSION BATTERIESELECTROLYTEPERFORMANCE