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C3Po1D-09: Simulation Study on the Thermal Insulation Performance of Liquid Hydrogen Transport Pipelines

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Hydrogen engines, compared to traditional gas engines, offer higher energy density and combustion efficiency. These advantages not only significantly enhance the propulsion performance of aircraft but also extend their range, presenting substantial potential for applications in the aviation sector. As a crucial component of hydrogen engine systems, the design and performance of liquid hydrogen transport pipelines directly influence the efficiency and safety of hydrogen delivery, making them essential for ensuring a stable supply and efficient utilization. This study focuses on the thermal insulation performance of liquid hydrogen transport pipelines by developing a multi-physics coupling model that incorporates heat conduction, radiation, and convection. Simulation research based on vacuum multilayer insulation technology was conducted to explore the effects of material thickness, vacuum level, support structure, and thermal bridge design on the overall heat loss of the pipeline. Additionally, the contribution of different structural components to total heat loss is quantified. The findings provide theoretical guidance for optimizing the insulation system of liquid hydrogen transport pipelines, which is crucial for improving hydrogen storage and transportation efficiency, reducing cold energy loss, and advancing the industrial application of hydrogen energy technologies.

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