The Study on Hydrogen Storage Control Strategies Coordinating Underground Structures and Ground Storage Tanks

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Abstract

This study explores a coordinated hydrogen production, storage, transportation, and utilization system, integrating underground structural spaces with ground storage tanks. It aims to address the limitations of traditional ground storage tanks, such as large land requirements and limited capacity, while enabling large-scale, efficient hydrogen storage and flexible supply. Through simulations using the SCILAB Xcos tool, the system's 24-hour operation was analyzed, focusing on key parameters such as ground storage hydrogen levels, compressor performance, underground hydrogen storage fluctuations, hydrogen production rates, pipeline transmission speeds, and high-purity hydrogen demand. The results indicate that the ground storage tank adjusted its operation mode only four times in response to random demand fluctuations, without any shutdowns, thereby enhancing the lifespan of compressors and purification systems. The ground storage levels fluctuated between 40% and 70%, without triggering protection mechanisms. The underground storage saw minimal changes, with two injection-extraction cycles, aligning with the practices of salt cavern hydrogen storage. The system effectively balanced hydrogen supply and demand, fulfilling high-purity hydrogen sales requirements without operational interruptions, even with ground storage capacity being only one-tenth of typical hydrogen refueling stations. This system demonstrates high efficiency and stability in regulating hydrogen supply and demand, significantly improving storage and supply flexibility and cost-effectiveness, offering a reliable technical solution for advancing hydrogen energy applications.

Keywords

New Energy, Hydrogen Energy, Energy Management, Underground Hydrogen Storage, SCILAB