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C3Po1D-07: Optimization of liquid hydrogen tank-to-tank transfer: A comparative study of six transfer systems

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Liquid hydrogen is considered as one of the most promising carriers for large-scale hydrogen storage and transport. However, boil-off losses that occur during the transfer of liquid hydrogen from the trailer to storage at refueling stations pose a significant challenge to the efficiency and cost-effectiveness of these processes. Therefore, the design of the liquid hydrogen transfer system is crucial for ensuring the efficient transfer. In this study, six liquid hydrogen transfer systems based on different methods are proposed, including self-pressurization pressurization-based transfer systems (with and without vapor return), pump-based transfer systems (with and without vapor return) and pressurization-pump integrated transfer systems (with and without vapor return). The transfer process of liquid hydrogen from a 50-m3 trailer (source tank) to a 30-m3 station storage tank (receiver tank) is considered as a case study for assessing the energetic and economic potential of the six proposed systems. The six systems are compared in terms of the transfer process time, source tank holding time after liquid hydrogen offload, boil-off losses, and total costs of the infrastructure. The results show that transferring the excess gas from the receiver tank to the source tank prior to the transfer process significantly enhances the overall energy balance of liquid hydrogen. The transfer process time of the self-pressurization-based system with vapor return is 1.4 h, with boil-off losses of 7.43%. This work may provide guidelines for configuration selection and optimum design of liquid hydrogen transfer systems in liquid hydrogen supply chain.

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