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Optimized Para Fraction of Liquid Hydrogen for Efficient Liquefaction and Storage

Tuesday 23 July 2024 14:00 (2 hours)

A thermodynamic investigation is performed to determine the optimal para fraction of liquid hydrogen for efficient liquefaction and storage. Ortho-to-para (OP) conversion is required in hydrogen liquefaction process, because any residual ortho-hydrogen in cryogenic liquid would eventually result in a boil-off loss due to the conversion heat. On the other hand, a liquefier should be capable of more liquid production, if no or less conversion is involved in the liquefaction process. Since the OP transformation is a slow process in the absence of catalyst, the production of larger quantity of liquid with lower para fraction could provide more hydrogen to the final user, especially in case of short-term storage. A rigorous thermodynamic model is developed to predict the capacity of a practical liquefier, where four different levels of para fraction can be selected by the optional bypass of three-staged catalytic converters. A process simulator (Aspen HYSYS) is used with the real thermodynamic properties of fluids (REFPROP). By incorporating a kinetic model for the OP transformation in storage tank, it is revealed that there exists an optimal para fraction for efficient liquefaction and storage, depending on the length of storage period. Full details of analytic results are presented and discussed towards the practical application to upcoming hydrogen value chains.

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