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C3Po1A-06: Improving the precooling efficiency of the cryogenic compressed hydrogen with the temperature-distributed refrigeration method

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Cryogenic compressed hydrogen is one of the most possible hydrogen storage methods to achieve a high storage density, which can meet the long-distance driving demand of hydrogen fuel cell vehicles. In the process of transportation, the precooling process of cryogenic compressed hydrogen is very important. This precooling process requires a continuous refrigeration power from ambient temperature down to a low temperature in the range 30–100 K. It is usually cooled with a single-stage refrigerator, especially when the temperature is above about 50 K. There is a significant loss during the precooling, because the sensible heat of H2 is distributed all around the temperature range and refrigeration is fixed at the cold-end temperature. In this case, the efficiency is relatively low. In this paper, we will show a method of applying the temperature-distributed refrigeration power on the regenerative refrigeration. Such a temperature-distributed refrigeration relies on real gas effects of the working fluid. The pure N2 with an average pressure of larger than 4 (reduced pressure) generates the temperature-distributed refrigeration power between about 75 K and above 200 K, which decreases the heat loss of precooling significantly. The precooling efficiency of the cryogenic compressed hydrogen is able to achieve more than two times larger than that cooling with only the fixed cold-end temperature in some specific range.

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