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Design of a heater for the CSNS cryogenic hydrogen system

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The China Spallation Neutron Source consists of a pulsed neutron source with ~ 20 K and 1.5 MPa supercritical hydrogen used as moderator. The dynamic heat load due to the neutron moderating is removed by the circulation of cryogenic hydrogen. A pulsed dynamic heat load is induced by the intense pulsed proton beam injection and trip, and a large pressure fluctuation in supercritical hydrogen loop was brought out simultaneously. Hybrid control by the heater and accumulator is adopted, in order to mitigate the pressure fluctuation in the hydrogen loop.

The CSNS cryogenic system is under construction now, and most of the critical equipment will be developed independently. This study shows the physical design of a cryogenic hydrogen heater. Theoretical analysis was conducted through changing structural parameters of the heater, and numerical analysis was carried out on the typical case. Flow and heat transfer performance were analyzed, according to the simulation results. In order to improve the heat transfer performance, optimal structure of the hydrogen heater was proposed. Theoretical analysis on the hydrogen heater, will lay a foundation for the research and development of a cryogenic hydrogen heater independently, and promote the actively construction of CSNS cryogenic system.

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