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Conceptual Design of the Liquid Hydrogen Moderator Cooling Circuit for the European Spallation Source

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The European Spallation Source in Lund, Sweden, is planned to be a spallation neutron research center of 5 MW beam power. As subsystem of the target station the moderators play a vital role in decelerating high energy neutrons which were set free during the spallation process. To provide maximum neutron flux intensities with high availability for scattering experiments a proposal for a liquid hydrogen moderator cooling circuit was developed. Circulating supercritical Hydrogen at approximately 17 K and 1.5 MPa will be utilized to absorb energy of the penetrating neutrons in two parallel moderator vessels. A helium refrigerator provides the necessary cooling. Strategies for the mitigation of rapid pressure and temperature changes due to beam interruptions are being presented. Solutions in form of accumulator or expansion vessels are evaluated. Different supercritical hydrogen circulator implementation scenarios are compared to indicate the most reliable setup. For an efficient moderation process a parahydrogen concentration of more than 99 % has to be guaranteed at the moderator inlet. A possible irradiation impact on the apparent parahydrogen concentration, the positioning of a catalyst bed and methods for a continuous concentration measurement will be pointed out. The proposed arrangement and interactions of all major components will be discussed in the paper.

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