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DNB heat flux in forced convection of liquid hydrogen for a wire set in central axis of vertically mounted flow channel

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Liquid hydrogen has excellent physical properties, high latent heat and low viscosity of liquid, as a coolant for high critical temperature superconductors like MgB2. The knowledge of DNB (Departure from Nucleate Boiling) heat flux of liquid hydrogen is necessary for design and cooling analysis of high critical temperature superconducting devices.

In this paper, DNB heat fluxes of liquid hydrogen were measured under saturated and subcooled conditions at the pressure of 0.4, 0.7 and 1.1 MPa for various flow velocity in the range of 0.5 m/s to 15 m/s. Two round test heaters made by Pt-Co alloy with the length of 200 mm and the diameter of 0.7 mm were used. These heaters were assumed superconducting wire. And these round heaters were set in central axis of a flow channel made of GFRP with the inner diameter of 8 and 12 mm respectively. These test bodys were vertically mounted and liquid hydrogen flowed upward through the channel.

The experimental values show DNB heat fluxes for flow velocity curve consists of a slower flow velocity region with a higher gradient and faster flow velocity region with a lower gradient. Considering the use of liquid-hydrogen for superconductors cooling, it can be said the efficient flow velocity for cooling exists in industrial use.

From these experimental values, the correlations of DNB heat flux under saturated and subcooled conditions for the vertically mounted heater set in central axis are presented in this paper. This correlations represent the value of DNB heat fluxes within 15 % error compared with the experimental values.

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