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Forced flow heat transfer from a round wire in a vertically-mounted pipe to supercritical hydrogen

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The knowledge of forced flow heat transfer of low temperature hydrogen under supercritical pressure is important for designing superconducting magnets wound with cable in conduit conductor.
Forced flow heat transfer of hydrogen from a round wire in a vertically-mounted pipe was measured at the pressure of 1.5 MPa and the temperature of 21 K by applying electrical current to give an exponential heat input ($Q=Q0\exp(t/\tau)$,τ=5 s) to the round wire. Two round wire heaters, which were made of Pt-Co alloy, with the diameter of 1.2 mm and the length of 54.5 and 120 mm were set in the central axis of a flow channel made of FRP with the inner diameter of 5.7 and 8.0 mm, respectively. The average temperature of the heater was obtained by a resistance thermometry by four-terminal method. Supercritical hydrogen flowed upward in the channel. Flow velocity was varied from 1 to 12.5 m/s. The heat transfer coefficients of supercritical hydrogen were compared with the conventional correlation presented by Shiotsu et al[1]. It was confirmed that the heat transfer coefficients for round wire were expressed by the correlation using the hydraulic equivalent diameter.

[1] M. Shiotsu, T. Takegami, K. Hikawa, Y. Shirai, H. Tatsumoto, Heat transfer characteristic test of forced flow supercritical hydrogen for superconducting cooling, Proceedings of ICEC 24-ICMC 2012. (2013) 165-168.

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