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Cryogenic tests of 30 m flexible hybrid energy transfer line with liquid hydrogen and superconducting MgB₂ cable

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Recently we reported about first in the world test of 10 m hybrid energy transfer line with liquid hydrogen and MgB₂ superconducting cable [1]. In this paper we present the new development of hybrid energy transfer line with 30 m length. The flexible 30 m hydrogen cryostat has three sections with different types of thermal insulation in each section: simple vacuum superinsulation, vacuum superinsulation with liquid nitrogen precooling and active evaporating cryostatting (AEC) system. We performed thermo-hydraulic tests of the cryostat to compare three thermo-insulating methods. The tests were made at temperatures from 20 to 26 K, hydrogen flow from 70 to 450 g/s and pressure from 0.25 to 0.5 MPa. It was found that AEC thermal insulation practically eliminated completely heat transfer from room temperature to liquid hydrogen. AEC thermal insulation method can be used for long superconducting power cables.

High voltage current leads were developed as well. The current leads and superconducting MgB₂ cable were passed high voltage DC test up to 50 kV DC. Critical current of the cable at ~21 K was 3500 A. It means that the 30 m hybrid energy system developed is able to deliver ~ 50 MW of chemical power and ~ 75 MW of electrical power (at 25 kV and 3000 A), i.e. ~125 MW in total.

[1] V. S. Vysotsky, et al., IEEE TRANSACTIONS ON APPLIED SUPERCONDUCTIVITY, VOL. 23, NO. 3, JUNE 2013, 5400906

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