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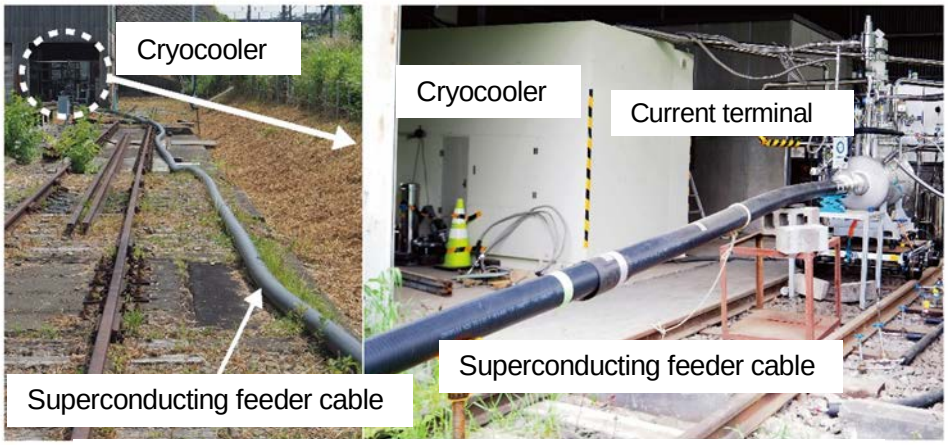
RTRI Develops New Superconducting Feeder Cable System for Testing on Commercial Railway Line

RTRI has developed a new superconducting feeder cable system which is closer to practical use, and is planning to test the system on an urban commercial line.



New superconducting feeder cable system
at RTRI's Hino Civil Engineering Testing Station

【New Superconducting Feeder Cable System】

By improving its cryocooler mechanism, RTRI has succeeded in developing this new superconducting feeder cable system that has stable enough performance to be tested on commercial lines.

The superconducting layer of its cable is made of a material with high insulation performance in order to keep constant temperature inside the cable (Fig. 1), and the current terminal has a structure which prevents heat conduction. Furthermore, a Brayton-cycle-type cryocooler customized for the cable has been adopted. Due to these improvements, the new system has come a step closer to commercial application, with the following features.

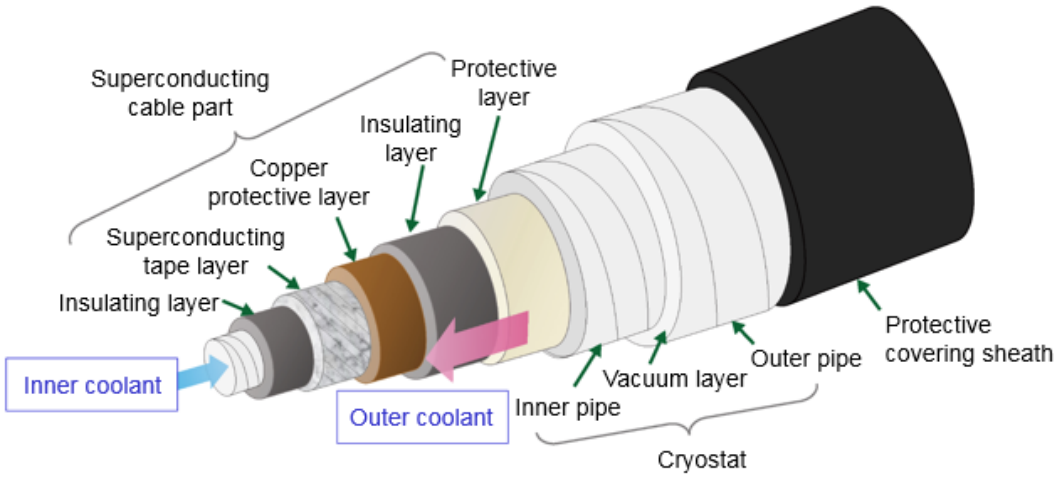


Fig. 1　Inside of Superconducting Feeder Cable

- The cable temperature can be set anywhere between 65 (−208℃), and 77K. Since the existing cable needs to be cooled down to 77K, it has been impossible to maintain superconducting state, when a cryocooler goes down due to any trouble. But this new system is capable of keeping the superconducting state for a few days even if its cryocooler is down. It means that we will be able to keep the superconducting state if we need to shut down the cryocooler for maintenance purpose.
- Due to the improvement on the cryocooler, this system does not need an auxiliary cryocooler which requires refilling of coolant.
- We have already tried 2-week continuous operation and confirmed that the system works normally.

This new system has thicker layer of superconducting material and its ampacity is 8,000 A or more for 408-meter-long cable. (Fig.2)　This ampacity allows 2 or 3 trainsets of 10 cars running at a time in the same block between substations, a typical operation pattern on urban commuter lines.

We are planning to conduct power transmission tests with this system on a commercial track.

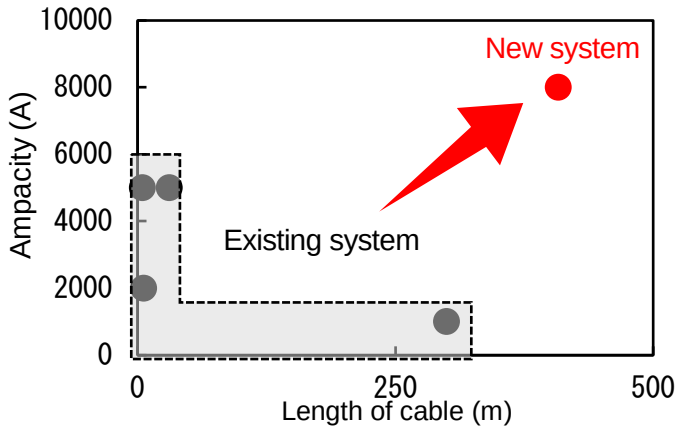


Fig.2: Ampacity of the New System

✧ Part of this project has been supported by the subsidy for railway technical development by the Ministry of Land, Infrastructure, Transport and Tourism.
✧ Part of this project has been implemented as the Program to Promote Strategic Innovation by the Japan Science and Technology Agency.

【Existing superconducting feeder cable system】

In the superconducting feeder cable system, the cable made of high-temperature superconducting material is cooled to extremely low temperatures which creates superconducting state and transmit electricity with zero electric resistance. This system requires a cooling system using -196℃(77K) liquid nitrogen as a coolant. We have installed the existing system to RTRI's test track and conducted running tests in order to seek the possibility of applying high-temperature superconducting material to railway systems. These running tests have been conducted with a trainset of 2 to 3 cars for a few days. The existing system has a sterling-type cryocooler and, in order to continue the running tests, it has been necessary to refill the auxiliary cooling device with coolant and cryocooler control by engineers has also been required. Therefore, development of high-performance, reliable cryocooler mechanism has been our top-priority issue in order to apply the superconducting feeder cable system to commercial operation.