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Taiyo Nippon Sanso Corporation

Sales Agreement Signed in Russia for Turbo Refrigerator for High Temperature Superconducting Power Application (NeoKelvin®-Turbo 2kW)

Taiyo Nippon Sanso Corporation ("TNSC") has announced that it has signed an agreement with SuperOx Japan LLC (President: Sergey Lee, "SuperOx Japan") to sell three units of the turbo-Brayton [Note 1] refrigerator NeoKelvin®-Turbo 2kW for use in the superconducting fault current limiter equipment of UNECO, an electric utility in Moscow. NeoKelvin®-Turbo 2kW is able to cool superconducting power equipment to -200°C or lower by using neon gas as the working fluid.

1. Background to Signing the Agreement

In recent years, as demand for electricity has grown, Moscow has faced the need to increase the capacity of circuit breakers in order to counter fault currents (particularly, short circuit accidents) in the power grid. However, the high cost of these refurbishments had presented an issue for the city.

SuperOx, a Russian high temperature superconducting wire manufacturer, and its Japanese affiliate SuperOx Japan, had proposed that UNECO introduces superconducting fault current limiters ("SFCLs") [Note 2] to replace circuit breakers, because this approach would reduce the refurbishment costs while providing superior operating performance. From 2015, UNECO and the aforementioned two companies have been jointly making preparations to introduce SFCLs. As a result, UNECO has decided to install and implement trial operations of SFCLs for a 220 kV line at its substation in Moscow.

The operation of SCFLs requires the stable maintenance and control of a low temperature environment of -200°C. To meet this requirement, TNSC's turbo-Brayton refrigerator for high temperature superconducting power application (NeoKelvin®-Turbo 2kW) has been adopted for use.

TNSC has signed an agreement to sell three units of NeoKelvin®-Turbo 2kW to SuperOx Japan. SuperOx and SuperOx Japan will integrate the SCFLs into the system, and install the system at the UNECO substation in Moscow.

2. Outline of NeoKelvin®-Turbo

TNSC has developed a turbo-Brayton refrigerator (NeoKelvin®-Turbo 2kW) with the cooling capability of 2kW by using neon gas as the working fluid, as part of the "Technological Development of Yttrium-based Superconducting Power Equipment (2008 – 2012)," a project led by the New Energy and Industrial Technology Development Organization (NEDO). TNSC commercialized NeoKelvin®-Turbo 2kW in May 2013.

Moreover, in 2016 TNSC commercialized NeoKelvin®-Turbo 10kW, a unit with a cooling capability 5 times greater than the 2kW model. Both the 2 kW and 10 kW models are undergoing extensive trial operations worldwide for the cooling of high temperature superconducting power transmission cables.

(1) Feature of machine

1） We have adopted active magnetic bearings for the turbo-machine to compress and expand neon gas as it can be operated without mechanical contact by floating the main shaft in the air to eliminate the maintenance.
2） We have adopted an energy efficient structure in which the power generated by the expander is returned to the compressor as regenerative power.
3） We have adopted a high precision operating temperature control method based on adjusting the rotational speed of the compressor.

(2) Specifications of the 2kW model

Refrigeration temperature:	70K (-203ºC) (Temperature of liquid nitrogen at the outlet of the refrigerator)
Refrigeration capability:	2 kW
Power source voltage:	3-phase alternating current, 400 V
Electricity consumption:	55 kW
Cooling water:	250 L/min

3. Developments going forward

SFCLs offer a competitive price and superior operating performance compared with large-capacity circuit breakers. In fact, SFCLs are able to apply a limit to fault currents 100 times faster than large-capacity circuit breakers. Therefore, SFCLs can more reliably prevent large fault currents from negatively impacting sound equipment. For these reasons, demand for SFCLs is expected to increase on a global basis. In step with this global growth in demand for SFCLs, TNSC will take proactive steps to ensure that its NeoKelvin®-Turbo units are adopted for use.

< Glossary>

[Note 1] Turbo-Brayton refrigerator

This is a refrigerator to generate cold by four processes ((1) Adiabatic compression, (2) Isobaric cooling, (3) Adiabatic expansion, and (4) Isobaric heating). The neon gas that is compressed by the turbo compressor ejects the compression heat to the atmosphere, then it is expanded under adiabatic conditions by a turbo expander to lower the temperature of the neon gas. After that, it absorbs the surrounding heat, and it is returned to the inlet of the turbo compressor. In the case of an actual refrigerator, a heat exchanger is inserted between the turbo compressor and the turbo expander to collect the cold generated at the expander.

[Note 2] Fault Current Limiter

This is one type of safety equipment designed to reduce the overload current swiftly at accidents caused by short-circuit / electric leakage in the electricity transmission and distribution system. Notably, superconducting fault current limiters have outstanding responsiveness to fault currents because they make use of extremely rapid superconducting phase changes.

Exterior of the NeoKelvin®-Turbo 2kW machine