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Taiyo Nippon Sanso Corporation

Notice Regarding Operation of Turbo Refrigerator for High-Temperature Superconducting Power Application in Russia

(NeoKelvin®-Turbo 2kW)

Taiyo Nippon Sanso Corporation ("TNSC") hereby announces that commercial operations have started for three units of the turbo-Brayton [Note 1] refrigerator NeoKelvin®-Turbo 2kW for use in the superconducting fault current limiter equipment experimental project following delivery with SuperOx LLC to UNECO, an electric utility in Moscow.

1. Delivery Background and Outline

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 introduce superconducting fault current limiters ("SFCLs") [Note 2], and UNECO installed SFCLs for a 220 kV line at its substation in Moscow.

TNSC concluded an agreement with SuperOx Japan in 2017 to sell three of its NeoKelvin®-Turbo 2kW units, and completed installation at a UNECO substation in Moscow in December 2018. Later, trial operations of the entire system, including SFCLs, were completed, the units connected to the power grid and full-scale commercial operations launched.

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 2kW and 10kW models are undergoing extensive trial operations worldwide for the cooling of high-temperature superconducting power transmission cables.

(1) Features of the 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 (individual unit)

Refrigeration temperature: 70K (-203ºC) (Temperature of liquid nitrogen at the outlet of the refrigerator)

Refrigeration capability: 2kW

Power source voltage: 3-phase alternating current, 400V

Electricity consumption: 55kW

Cooling water: 250L/min

3. Developments going forward

If the current initiative can verify the competitive advantage of SFCLs, TNSC expects further introduction in Moscow in the future, and we will continue initiatives to spread the popularity of the Company's refrigerators going forward.

< 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 into 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, which 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 turbo expander to collect the cold generated at the expander, generating extremely cold temperatures.

[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

Photo of an installed SFCL