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Taiyo Nippon Sanso Corporation

Launch of large cooling capacity turbo refrigerator for high temperature superconducting power application (Product name: NeoKelvin®-Turbo 10kW)

Taiyo Nippon Sanso Corporation (President & CEO: Yujiro Ichihara) has announced the commencement to promote large cooling capacity turbo-Brayton Note1) refrigerator NeoKelvin®-Turbo 10kW that is possible to cool a superconducting power application at -200ºC or lower by using neon gas as the working fluid.

1. Background of development

In the electricity related field, the research and development of electricity units (e.g. electricity transmission cables, fault current limiter Note2)) that uses superconducting technology is driven as one of the solutions to establish resilient electric grid. Among them, there is an expectation in the electricity transmission cable area that there will be a huge demand for the overall cable system by developing practical use going forward, and the amount of such demand is expected to be 10-15 billion yen in 2030 in Japan alone. However, in order to develop a practical application, it is necessary to have a refrigerator with the cooling capacity from 2kW to 10kW at the cooling temperature of around -200ºC.

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

NeoKelvin®-Turbo 2kW is capable to cool superconducting power cables with the length of around several hundred meters as an experimental length. However, the commercialization of NeoKelvin®-Turbo 10kW made it possible to cool superconducting power cables of more than 1km that is the length for a commercial use, and it is expected that the commercialization of superconducting power cables will be accelerated.

Currently, the prototype refrigerator is used to cool the cables to proof a concept for superconducting power cables as a test jointly executed by Korea Electric Power Corporation and LS Cable & System Ltd. at Jeju island (Korea), and the electricity transmission to the actual system has started by using superconducting power cables from March this year. This electricity transmission by superconducting power cables with the turbo-Brayton refrigerator is the first attempt in the world.

2. Feature of machine

This machine adopts neon gas as the working fluid similar to NeoKelvin®-Turbo 2kW to increase the efficiency of the turbo-machine. Feature of the machine is below.

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 developed a new turbo-machine which has the expander and the compressor on the same shaft to recover the power generated at the expander into the compressor.
3) We have used a common structure for the two turbo machines necessary for the refrigerator to improve the economic aspects and convenience of the operation.

The above mentioned turbo machines were developed jointly with IHI Corporation that have many experiences in turbo compressors for air separation plants among others in order to realize high efficiency.

3. Specification of machine

Refrigeration temperature:	70K (-203ºC) (Temperature of liquid nitrogen at the outlet of the refrigerator)
Refrigeration capability:	10kW (Cooling water temperature 20ºC, Substance to cool: Liquid nitrogen with the circulation volume of 0.6kg/s)
Power source voltage:	3-phase alternating current, 400V, 380V
Electricity consumption:	170kW
Cooing water:	750L/min

4. Development going forward

We will expedite our activities to take orders mainly in Korea and United States as they are aggressive to consider the introduction of superconducting electricity transmission cables.

Note 1) Turbo-Brayton refrigerator

This is a refrigerator to generate cold by 4 processes ((1) Adiabatic compression, (2) Isobaric cooling, (3) Adiabatic expansion, (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 condition 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 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 on of the safety equipment to reduce the overload current swiftly at accidents caused by short-circuit / electric leakage in the electricity transmission and distribution system.

NeoKelvin®-Turbo 10kW