TAIYO NIPPON SANSO
The Gas Professionals

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Development of Hydrogen-Oxygen Burner for Industrial Furnaces
Carbon-Free Fuel and Oxygen Combustion Technologies Contribute to the Reduction of CO_2 Emissions in Industrial Furnaces

Taiyo Nippon Sanso Corporation (President: Kenji Nagata; hereinafter "TNSC"), a Japanese industrial gas company of Nippon Sanso Holdings Group, has developed a hydrogen-oxygen burner fueled by hydrogen gas for industrial furnaces. The development enables TNSC's oxygen burner series (SCOPE-JET®, Innova-Jet®, and Innova-Jet®Swing) to use hydrogen as fuel. Combustion using hydrogen gas produces zero carbon dioxide (CO_2) because the fuel does not contain carbon. By deploying this technology, TNSC will contribute to the social implementation of hydrogen energy and the reduction of CO_2 emissions in the industrial furnaces field.

1. Background to Product Development

Around 1.12 billion metric tons of CO_2 is emitted annually in Japan, 35% of which comes from the industrial sector. CO_2 is emitted from many industrial furnaces. The number of industrial furnaces in Japan is estimated to be about 37,000, and to achieve the government's goal of carbon neutrality by 2050; these facilities need to take measures to reduce CO_2 emissions.

TNSC has been focusing on ammonia as a carbon-free fuel and developing an ammonia-oxygen burner since 2014. Hydrogen attracts attention as a carbon-free fuel for industrial furnaces along with ammonia. TNSC has been developing a hydrogen-oxygen burner since FY2021 to offer customers various options to reduce CO_2 emissions in the industrial furnace field.

2. Outline of the Development and Features

SCOPE-JET® high-speed oxygen lance burner

SCOPE-JET® is a lance burner which forms a supersonic oxygen jet and is an energy-saving technology for electric arc furnaces ("EAF") for melting iron scrap. Unlike conventional auxiliary burners, SCOPE-JET® functions in the steelmaking process as an oxygen burner that helps scraps to melt faster during the "melting stage" immediately after iron scraps are fed into the EAF and as an oxygen lance during the "refining stage" after the scraps are melted down. These features significantly contribute to productivity improvement and energy intensity reduction in the EAF steelmaking process.

Hydrogen combustion with SCOPE-JET® results in high flame temperatures and high combustion speeds, causing high temperatures near the burner and requiring measures to reduce the heat load on the burner. Applying TNSC's unique nozzle structure enables stable combustion and acquires jet characteristics equivalent to those of natural gas fuels.

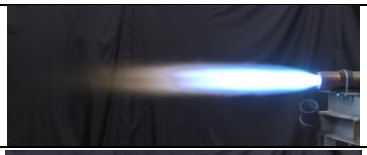
[Lance mode] Natural gas 80 Nm^3/h Oxygen 800 Nm^3/h	
[Lance mode] Hydrogen 400 Nm^3/h Oxygen 800 Nm^3/h	
[Burner mode] Hydrogen 500 Nm^3/h Oxygen 800 Nm^3/h	

Fig.1 SCOPE-JET® combustion flames

Innova-Jet® ultra-low NOx oxygen-enriched burner

Innova-Jet® is an energy-saving technology for heating furnaces and melting furnaces and contributes greatly to energy intensity decrease by significantly reducing heat loss due to exhaust gas. When adopting oxygen-enriched combustion in heating furnaces, a large amount of NOx generated needs to be controlled. TNSC's unique nozzle structure and multi-stage combustion significantly reduce NOx emissions, and the burner has been applied to various industrial furnaces.

Hydrogen combustion with Innova-Jet® results in a high flame temperature, requiring further NOx control measures. Improving the conventional nozzle concept so that it is optimal for hydrogen reduces NOx emissions to a level that can be used in industrial furnaces and acquires heat transfer characteristics equivalent to natural gas burners. TNSC is currently conducting evaluation tests of Innova-Jet® in actual furnaces in Europe.

[100% natural gas fuel] Natural gas 107 Nm^3/h Oxygen 253 Nm^3/h	
[20% hydrogen, 80% natural gas] Natural gas 86 Nm^3/h Hydrogen 80 Nm^3/h Oxygen 244 Nm^3/h	
[50% hydrogen, 50% natural gas] Natural gas 53 Nm^3/h Hydrogen 200 Nm^3/h Oxygen 232 Nm^3/h	

Fig. 2 Innova-Jet® combustion flames

Innova-Jet® Swing self-induced oscillating oxygen-enriched burner

Innova-Jet® Swing is an energy-saving technology for high-temperature heating furnaces and melting furnaces. It significantly reduces heat loss due to exhaust gas and provides uniform heating over a wide area by moving the flames left and right using the self-induced oscillation phenomenon for furnaces with a shallow furnace bottom.

Hydrogen combustion with Innova-Jet® Swing enables stable combustion by improving the self-cooling technology that uses oxidizer gas so that it is optimal for hydrogen to reduce the heat load on the burner.

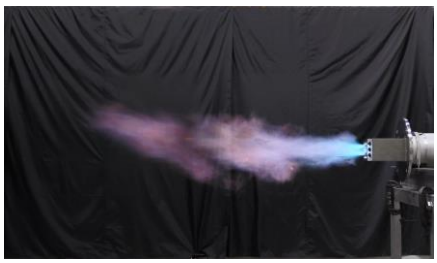
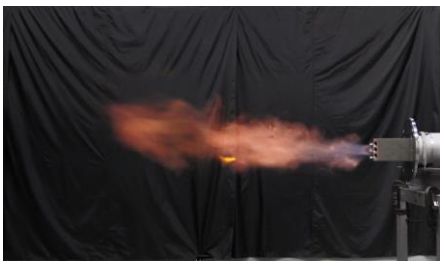
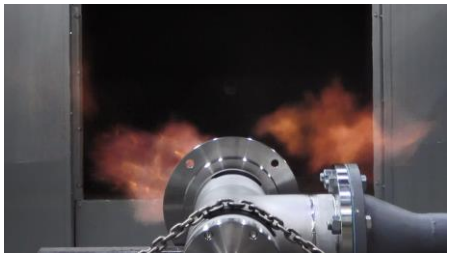
[100% natural gas] Natural gas 35 Nm^3/h Oxygen 50 Nm^3/h Air 160 Nm^3/h		
[50% hydrogen, 50% natural gas] Natural gas 17.5 Nm^3/h Hydrogen 65 Nm^3/h Oxygen 50 Nm^3/h Air 160 Nm^3/h		
[100% hydrogen] Hydrogen 130 Nm^3/h Oxygen 50 Nm^3/h Air 160 Nm^3/h		

Fig. 3 Innova-Jet® Swing combustion flames

3. Future Developments

Based on the hydrogen-oxygen combustion technology that has been developed, TNSC will continuously develop and design optimal burners for various industrial furnaces to satisfy a wide range of customer needs and propose introducing these solutions into their furnaces. Through the use of this technology, the company will aim to implement hydrogen energy in society and reduce CO_2 emissions.

[Company Overview]

Taiyo Nippon Sanso Corporation

Business description:	Manufacture and sale of various industrial gases such as oxygen, nitrogen, argon, LP gas, gas for medical uses, and specialty gases, manufacture and sale of welding equipment and materials, gas-related devices, and, air separation equipment, assembly, processing, inspection of electrical components, and equipment maintenance
Established:	October 30, 1910
Incorporated:	February 4, 2020
Capital:	1.5 billion yen
Shareholder:	Nippon Sanso Holdings Corporation (Investment ratio: 100%)
Revenue:	420.4 billion yen* *Note: This figure shows the revenue of Japan for Nippon Sanso Holdings Corporation in FYE2023

Taiyo Nippon Sanso Corporation

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