March 12, 2021

TNSC Develops Oxygen-Enriching Lance Combined with Self-Induced Oscillation to Achieve Energy Saving and Reduce NOx

Taiyo Nippon Sanso Corporation ("TNSC") hereby announces that it has developed the "Innova-Jet® OxLance", an oxygen-enriching technology that can achieve high efficiency and low NOx output in melting furnaces in the glass manufacturing process by swinging an oxygen jet applying self-induced oscillation.

1. Background to Product Development

In the glass manufacturing process, glass raw materials are melted down in a furnace, which loses its combustion efficiency over a lifecycle of about 10–15 years, decreasing the production capacity of the product. Introducing oxygen into the furnace and conducting oxygen-enriched combustion improves combustion efficiency and maintains production capacity.

Meanwhile, limits on permissible concentrations of NOx in exhaust gases emitted from furnaces are strict. Generally, there is a correlation between the NOx emissions and the temperature inside the furnace, with the NOx emissions easily increasing in oxygen-enriched combustion as flames get hotter. As a result, an issue arose with limited examples of application in ordinary oxygen-enriched combustion in furnaces.

TNSC has resolved this issue by developing the "Innova-Jet® OxLance", an oxygen-enriching technology for glass melting furnaces that applies self-induced oscillation.

2. Technical Overview

Self-induced oscillation is a technology that uses a fluid phenomenon known as the Coandă effect, in which a fluid ejected from a nozzle flows along a nearby wall surface. Applied to a lance, this phenomenon causes the jet flows to change direction periodically, expanding the heated area. Moreover, the "Innova-Jet® OxLance" eliminates the need for a mechanical propulsion unit, and has a simple structure that's easier to maintain.

TNSC marketed the "Innova-Jet® Swing" oxygen-enriching burner that uses the self-induced oscillation and has already introduced a large number of applications for tundish preheaters in the steelmaking processes. (News release dated July 28, 2017.)

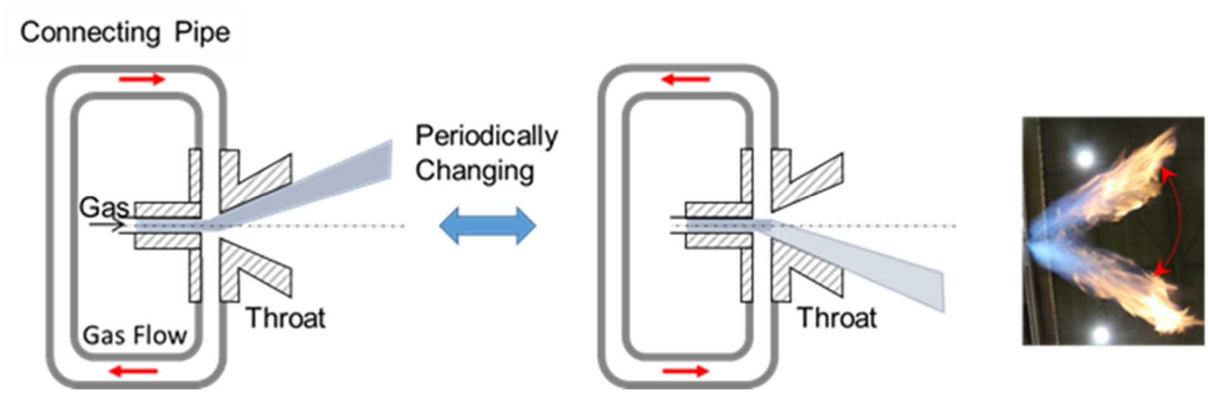

Fig. 1 Structure of self-induced oscillating burner (left),
and a photograph of the flames of the "Innova-Jet® Swing" (right)

This oxygen-enriched combustion technology using self-induced oscillation incorporates a variety of expertise derived from results obtained from the "Innova-Jet® Swing", and the following developments were conducted for application in oxygen-enriched combustion in glass melting furnaces.

(1) Miniaturization for glass melting furnaces, where installation space is limited
(2) Minimization of NOx emission volume by optimizing the swing cycle of flames

As a result, the extensive, even distribution of heat made possible by the swing jet improves thermal transfer efficiency compared to air combustion and reduces the NOx volume generated by up to 25% compared to conventional oxygen-enriched combustion.

3. Application Examples

In the glass manufacturing process, "Innova-Jet® OxLance" is applied when heating glass melting furnaces, which are used to melt raw materials.

The structure of a glass melting furnace includes an internal melting chamber comprised of fireproof walls with a pair of nozzles called ports on the sides. High-temperature preheated air is alternately ejected from each port using alternating combustion, which mixes with fuel to form a flame that melts and heats the glass raw materials inside the chamber. Due to this distinctive structure and operation method, complicated gas flows form within the furnace, which requires optimization of the installation position and swing jet angle.

To solve this issue while raising thermal transfer efficiency and reducing the NOx emissions, TNSC used a test furnace that recreated the alternating combustion occurring in glass melting furnaces and conducted verification testing of the Innova-Jet® OxLance's performance.

As a result of measuring the temperature distribution of the test furnace simulating the end port furnace used in a glass melting furnace, it was confirmed that the bottom of the furnace could be heated to a higher temperature compared to conventional air combustion, as shown in Fig. 2. In addition, assessment bottom of the furnace confirmed greater thermal transfer efficiency compared to conventional air combustion (Table 1). Furthermore, assessment of the “Innova-Jet® OxLance” confirmed an approximate 25% reduction in the NOx emissions compared to conventional oxygen-enriched combustion.

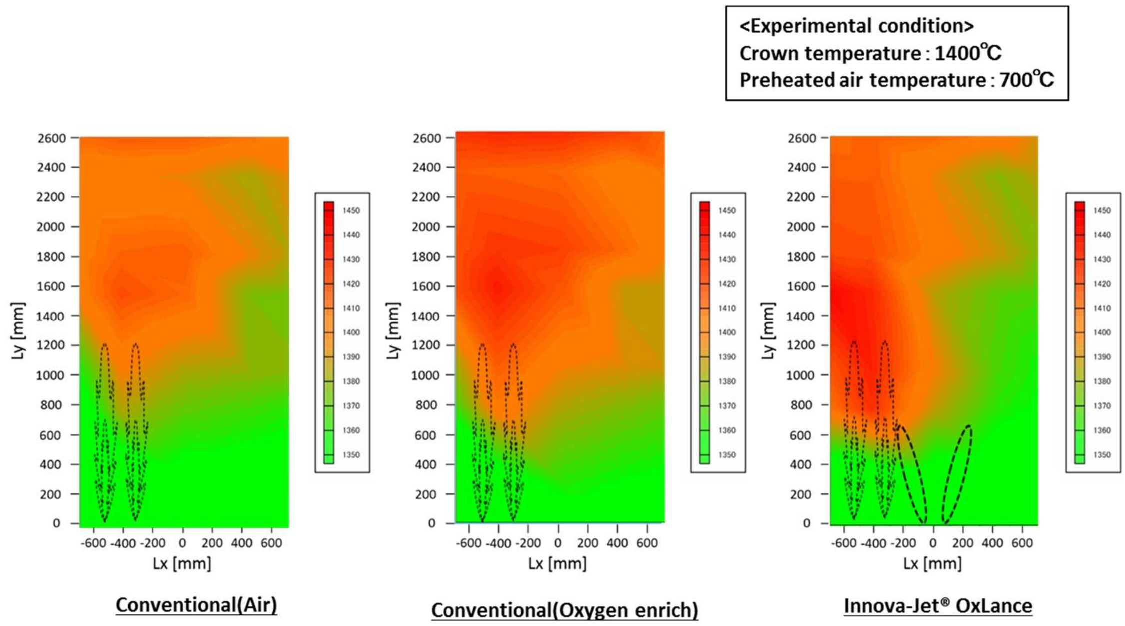

Fig. 2 Temperature distribution at the base of the furnace

Table 1 Effects of the “Innova-Jet® OxLance”

Item	Unit	Air combustion	Oxygen-enriched combustion	
			Conventional technology	Innova-Jet® OxLance
Average temp. inside furnace	[□]	1400	1400	1400
Preheated air temp.	[□]	700	700	700
Comparative thermal transfer efficiency*	[-]	1.0	1.2	1.2
NOx emission**	ppm	135	252	64

* Indicates the level of thermal transfer efficiency using air combustion as 1.00.

** Indicates a 15% oxygen concentration conversion value.

4. Future Developments

Up to now, TNSC has been making technical proposals, including total oxygen combustion and oxygen burner boosting, to achieve improved productivity and energy saving in the glass melting process.

"Innova-Jet® OxLance" is an application that can contribute further to energy saving and CO_2 reduction in glass melting furnaces, and is expected to develop as a highly efficient oxygen combustion technology in the glass melting process.

Moreover, this technology is forecast to produce energy savings and improved efficiency through oxygen enrichment, even in heating furnaces in the iron and steel field and melting furnaces in the non-ferrous field.

Going forward, TNSC will move forward in rolling out this technology in a variety of industrial fields, centering on industrial furnaces, as a technology that contributes to energy saving and reducing CO_2 emissions.

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