Technology

Advanced Oxygen Control System for Post-combustion in EAF

「SCOPE-JET® SCAN」

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1. Introduction

Our company has been developing our high-speed oxygen burner lance, SCOPE-JET, for the electric arc furnace(EAF) steelmaking process since 2001. In 2017, we improved the performance of SCOPE-JET and developed a new model SCOPE-JET that can handle low-pressure and low-calorie fuel. We have also been developing SCOPE-JET Post Combustion which is used to burn unburned exhaust gas in electric arc furnaces. To utilize the EAF steelmaking process know-how that we have accumulated and to improve energy-saving performance to contribute to the realization of a carbon-neutral society, we have developed SCOPE-JET SCAN which is an advanced oxygen control system that includes an oxygen control system and a laser gas analyzer unit. Compared with conventional EAFsteelmaking processes, we succeeded in reducing oxygen intensity by 20 percent 1).

2. Technological Content

Secondary combustion is a part of the melting period in the EAF steelmaking process. The unburned gas (CO, H2, etc.) that is produced from raw material scraps, carbon material and fuel in the electric arc furnace is exposed to the pure oxygen from the oxygen lance installed on the walls of the furnace. This burns the unburned gas. This is a technology that aims to reduce the unit of electric power and improve productivity by using the scrap layer filled with the heat of the combustion. Figure 1 shows the configuration of the SCOPE-JET SCAN system. This system is installed in electric arc furnaces and is made up of a laser gas analyzer unit (Zolo Scan probe, assessment system), an oxygen control system, and an oxygen lance.

Because the composition of unburned gas in the steelmaking process changes considerably from moment to moment, accurately knowing the exhaust gas properties is important for improving the efficiency of secondary combustion. To accurately know the properties of the exhaust gas generated in the melting period of the EAF steelmaking process, we have adopted the Zolo Scan produced by On Point Solutions which is a gas analyzing unit that uses semiconductor laser spectroscopy 2). Laser gas analyzer units have the characteristic of being able to instantly (response speed: within 2 seconds) and continuously measure the gas concentrations of the CO, CO2, and H2O in the exhaust gas and gas temperatures with a single laser. Table 1 shows the specifications. The gas concentration measurement range of this unit is very large and the accuracy is sufficient to understand the exhaust gas properties. The Zolo Scan probe is installed in the exhaust gas duct in Figure 2. It must be installed in the optimum location after conducting a computational fluid dynamics (CFD) analysis of the gas flow in the exhaust duct, calculating, and assessing the gas concentration distribution and gas temperature distribution in the duct. The Zolo Scan assessment system has the ability to analyze and display the measured data from the Zolo Scan probe and transmits the acquired data to the oxygen control system.

The oxygen control system uses the transmitted exhaust gas data and past information to calculate the appropriate oxygen supply volume to control the oxygen volume from the oxygen lance. Figure 3 shows an example of the control screen. The system controls the oxygen flowrate to improve oxygen volume response when there are fluctuations in the gas concentration, and helps to create a stable and reliable system. The control screen can be customized according to customer demands.

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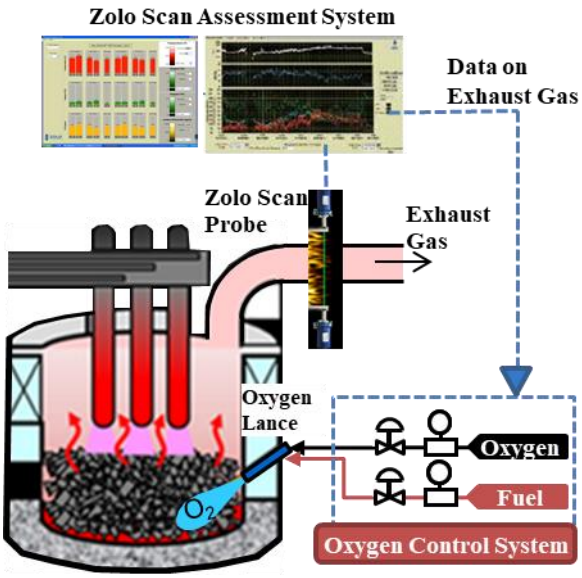

Figure 1. SCOPE-JET SCAN Configuration

Figure 2. Zolo Scan probe

Table 1. Analyzer Specifications

		Measurement range	Measurement accuracy
Gas concentration	CO （%）	2 to 80	±2%abs
	CO_2 （%）	2 to 80	±1%abs
	H_2O （%）	1 to 50	±1%abs
Gas temperature(℃)		260 to 1700	±1.5%FS

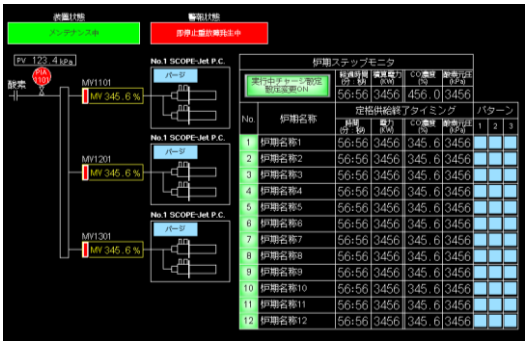

Figure 3. Oxygen control system control screen

Figure 4 shows an example of CO concentration behavior and Figure 5 shows an example of the behavior of the oxygen supply volume from the oxygen lance to the electric arc furnace. Figure 5 compares the oxygen volume behavior of conventional operations with that after the SCOPE-JET SCAN system is installed. As Figure 4 shows, the fluctuation of CO concentration is very high. In conventional operations, oxygen volume was controlled in steps, but with this system, the oxygen volume can be changed in response to the CO concentration as Figure 5 shows. After introducing this system to a customer's electric arc furnace, secondary combustion heat could be effectively applied to the raw material scrap, and the power intensity was reduced by 7 kWh/T compared to the previous setup. Moreover, it was successful in reducing oxygen volume by 20 percent.

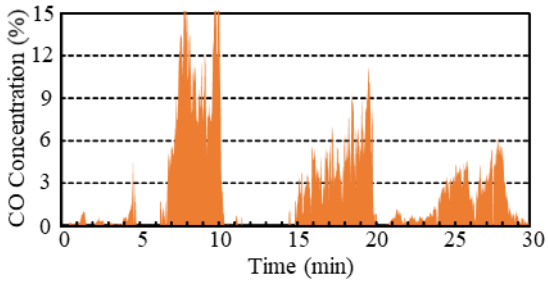

Figure 4. CO concentration behavior

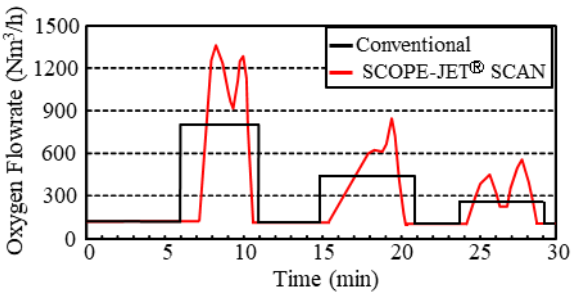

Figure 5. Oxygen supply volume behavior

This technology can be used with other applications used in the EAF steelmaking process (oxygen burners, furnace-front lances , carbon injection, etc.), and the following controls are possible depending on the exhaust gas properties.

- Reducing costs by controlling the supplied volume of oxygen, fuel, and carbon.
- Reducing electric power by controlling the airflow of exhaust fans.
- Preventing accidents by early prediction detection of water leaks and other problems.

3. Summary

To date, Taiyo Nippon Sanso has developed the SCOPE-JET and Innova-Jet systems for EAF steelmaking processes to help improve productivity and energy-saving performance. To improve oxygen utilization rates in the future, we will propose more improvements for the EAF steelmaking process that produces less CO2 emissions than blast furnaces by combining laser analyzer units, burner lances, carbon injection units, etc. In addition, we plan to develop various systems combined with laser analyzer units for heating furnaces and converter furnaces to increase the applications centering on the steelmaking field.

※ SCOPE-JET and Innova-Jet are registered trademarks of Taiyo Nippon Sanso.

Reference

1) Taiyo Nippon Sanso, "Zolo SCAN" Website related to Taiyo Nippon Sanso gas equipment. https://gasequip.tn-sanso.co.jp/products/zoloscan
2) "New Release: Notification about the Development of a Highly Efficient Oxygen Usage System for Electric Arc Furnace Steelmaking that is Combined with Laser Gas Analyzer Units," Taiyo Nippon Sanso. 2021-03-08. https://tn-sanso.co.jp/jp/file_download.php?id=CgW%2FdqYzvNI%3D&fileid=5m3Mbm091ZVqllyu4WENCuo6ln77N5Cy&link.pdf