

# Real-Time State Estimation Model for Converter Steelmaking



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To achieve optimization and automation of the converter process, it is important to perform appropriate operations based on internal state information such as the composition of molten metal and slag. However, due to the high temperature and explosive reaction inside the converter, it has been difficult to measure the internal state during processing. Therefore, JFE Steel Corp. has developed a model to estimate the internal state of the converter in real time, aiming to build a cyberphysical system of the converter. This model solves the conventional problems of decreased estimation accuracy caused by unknown disturbances and measurement errors, achieving high-precision and real-time internal state estimation.

## Introduction

A converter is used to remove impurities (C, Si, Mn, P) from the hot metal after the blast furnace process and to raise the temperature of the molten steel by adding subraw materials and blowing  $O_2$  into the molten metal. For high efficiency and low-cost operation of the converter, it is necessary to observe the internal state of the converter in real time and to control it appropriately. However, continuous measurement of the inside of the converter is difficult because of the high temperature and explosive oxidation reaction. Therefore, in current operation, as shown in Fig. 1, the refining control is designed based on the hot metal components and temperature obtained before the start of blowing.

The final stage of operation is determined based on the C concentration and temperature in the molten metal obtained by the in-blow sampling process. In that operation, the control of components and temperature becomes inaccurate due to the influence of unknown disturbances during blowing, and the endpoint requirements are sometimes not satisfied. In this study, in order to solve such problems, a new model was developed to estimate the internal state of the converter continuously and with high accuracy.

## Conventional State Estimation Model

Various models have been developed to estimate and predict the internal

Figure 1

### Converter process.

