

Application News

Measuring Concentrations of CO and CO₂ in a Metal Wire Heat Treatment Furnace

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User Benefits

- ◆ It creates highly reliable data using the same measuring principles as stationary gas analyzers.
- ◆ The all-in-one gas analyzer is transportable and simple to operate with an onboard sample pretreatment unit that includes a built-in sample pump, filter, and dehumidifier.
- ◆ Save recorded data on a USB flash drive for easy editing on a computer or sharing with other departments.

Introduction

Some common metalworking processes are mechanical machining to bend, stretch, and cut metal materials and heat treatment and surface finishing, which alter the properties and improve the performance of metal materials (Fig. 1). These processes transform metal materials into products with a range of desirable properties, including hardness, ductility, and corrosion resistance, according to the application or end use.

Of the above metalworking processes, heat treatment requires careful control over CO and CO₂ concentrations. This article describes using Shimadzu's CGT-7100 transportable gas analyzer to manage CO and CO₂ levels in a metal heat treatment process.

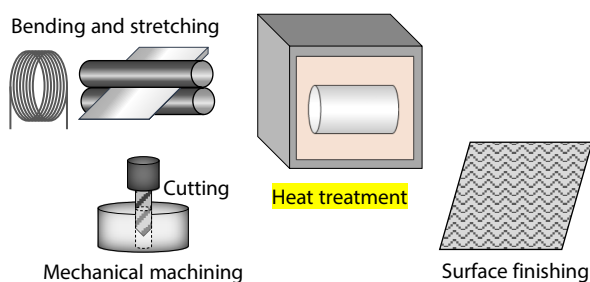


Fig. 1 Common Metalworking Processes

Heat Treatment of Metal Materials

The furnace in this article used heat treatment to give metal materials a prescribed tensile strength. Heating a metal material to its austenitizing temperature followed by rapid cooling creates an extremely hard structure, which is called a martensitic structure. However, a potential issue during this process is the formation of an oxide layer (scale) on the surface of the metal material. Because scale is more prone to form when oxygen is present in the furnace atmosphere, CO and CO₂ are fed into the furnace at controlled concentrations to prevent its formation. CO and CO₂ concentrations must be constant to ensure the metal materials being produced are of consistent quality, so accurate gas concentration measurements are essential for this purpose.

In this article, the CGT-7100 was used to measure the concentrations of CO and CO₂ and verify that the CO and CO₂ supplied to a heat treatment furnace had consistent concentrations and were within the prescribed ranges.

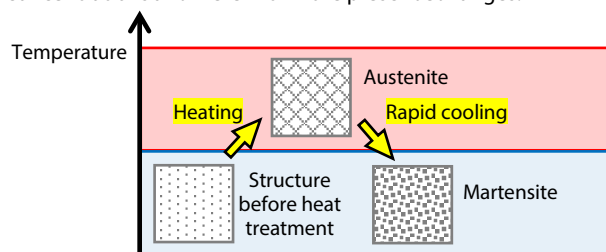


Fig. 2 Transformation of Metal Structure

CGT-7100

The CGT-7100 is a transportable, all-in-one continuous gas analyzer. The compact chassis of the CGT-7100, which contains an onboard sample pretreatment unit with an electronic cooler for dehumidifying, a filter for dust removal, and a pump to draw sample gas into the analyzer, offers a standalone solution for gas analysis.*1

The CGT-7100 can measure up to three gases: two gases from among CO₂, CO, and CH₄ by non-dispersive infrared (NDIR) absorption, and oxygen measured by an O₂ meter (optional) with a zirconia-based limiting current sensor. The concentration of each gas can be monitored over time across a wide concentration range from ppm to volume percentage levels. With a minimum sample gas flowrate of 100 mL/min, the CGT-7100 can monitor gas concentrations in small sample gas volumes for a wide range of potential applications.

Non-Dispersive Infrared (NDIR) Absorption

The CGT-7100 uses non-dispersive infrared (NDIR) absorption for measurements. Heteroatomic gases, such as CO₂, have unique infrared absorption spectra. The concentration of individual heteroatomic gases in a mixed sample gas can be determined by passing infrared light through the gas sample and then detecting the amount of infrared light transmitted in absorption bands that are unique to each gas species. The NDIR analyzer uses a proven optical system that has been used in online gas analyzers and gives robust and stable measurements.



Fig. 3 Shimadzu CGT-7100 Transportable Gas Analyzer

*1 It is dependent on analytical conditions. For more details, contact your Shimadzu representative.

Measurement Method

A schematic illustration of the measurement system is shown in Fig. 4. A flow of gas was taken from the gas supply line between the atmosphere gas generator and the furnace and fed into the CGT-7100. Measurements were taken continuously for 60 minutes under the conditions shown in Table 1.

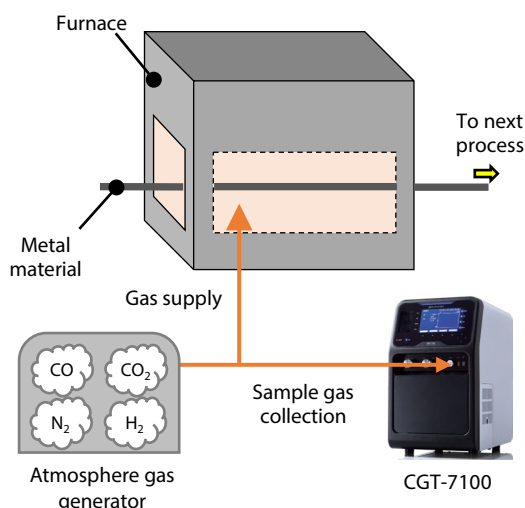


Fig. 4 Schematic Illustration of Measurement System

Table 1 Analytical Conditions

Analyzer:	CGT-7100
Measured Components:	CO, CO ₂
Measurement Range:	Undisclosed
Sample Gas Flowrate:	200 mL/min (Varying between 100 and 400 mL/min)

Results

The results are shown in Fig. 5. Since the actual data cannot be disclosed, the control limits and CO and CO₂ measurements are shown normalized between 0 and 1 based on their respective measurement ranges.

The control limits of the normalized gas concentrations are as follows:

- CO control limits: lower control limit: 0.580, upper control limit: 0.700
- CO₂ control limits: lower control limit: 0.380, upper control limit: 0.430

CO and CO₂ were detected at the following normalized gas concentrations:

- CO measurements: minimum: 0.602, maximum: 0.605
- CO₂ measurements: minimum: 0.411, maximum: 0.423

These results show that the CO and CO₂ supplied by the atmosphere gas generator remained stable and within the target control limits throughout the 60-minute measurement time.

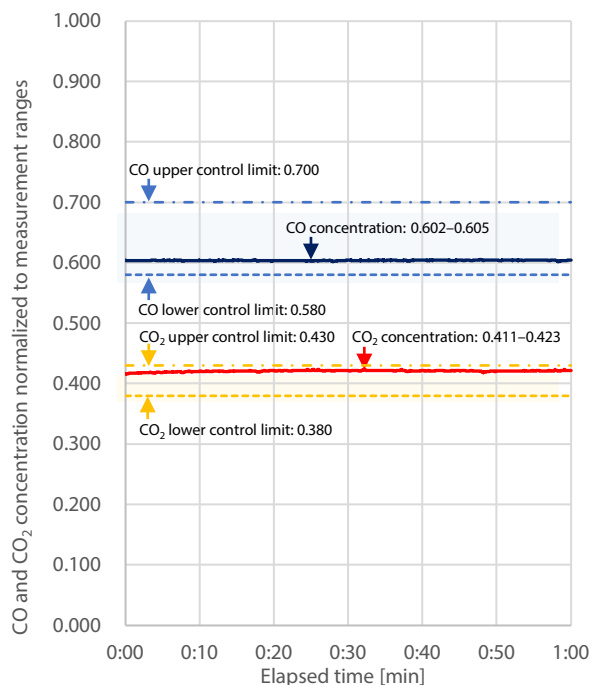


Fig. 5 CO and CO₂ Concentration in Furnace Atmosphere Gas

Conclusion

In this article, the CGT-7100 was used to monitor the gas supplied to a heat treatment furnace by an atmosphere gas generator and to verify that the CO and CO₂ supplied were of consistent concentrations and within the control limits.

While it monitored gas concentrations for 60 minutes, there are situations in which the operating conditions of a furnace require the constant and uninterrupted monitoring of gas concentrations. In such cases, gas concentrations may be monitored by a stationary online gas analyzer, with the CGT-7100 used as circumstances require, such as for reference measurement collection during inspections or as a backup.

The CGT-7100 transportable continuous gas analyzer is flexible and adaptable to a range of measurement applications and is well suited to verifying the stability of gas concentration levels and the real-time monitoring of changes in gas concentrations over time.

From the measurement of combustion exhaust gases to various testing and research applications, Shimadzu's transportable gas analyzer is an excellent tool for all kinds of situations that require the continuous measurement of gas concentrations.

Related Links

For more information about the CGT-7100, please see the product website below.

<https://www.shimadzu.com/an/products/continuous-monitoring-analysis/portable-gas-analysis/cgt-7100/index.html>

For information about the NOA-7100 transportable NO_x-O₂ analyzer, please see the link below.

<https://www.shimadzu.com/an/products/continuous-monitoring-analysis/portable-gas-analysis/noa-7100/index.html>