

Control of Carbon Potential in Carbonizing Furnaces

Industry: Machinery, Iron & Steel (Heat Treatment)
Product: Control and Measurement Station (CX1000/CX2000)

Overview

In order to obtain the surface stiffness and internal flexibility of various mechanical components used in automobiles, aircraft, ships, building materials, machine tools, and other items, a heat treatment called carburization is applied in which the amount of carbon in the surface coat is increased, and only the surface coat is quench hardened. The choice of solid carburizing, liquid carburizing, gas carburizing, vacuum carburizing, and other techniques is made according to factors including production volume, size of equipment and facilities, and necessity of automation. However, there is a trend toward gas carburization because adjustment of the degree of carburization is relatively easy, lending itself to automation and mass production. The CX1000/CX2000 Control and Measurement Station automatically computes the equilibrium carbon concentration (carbon potential, or CP value) of the atmospheric gas carburizing furnace, and maintains the optimal CP value inside the furnace.

Customer Needs

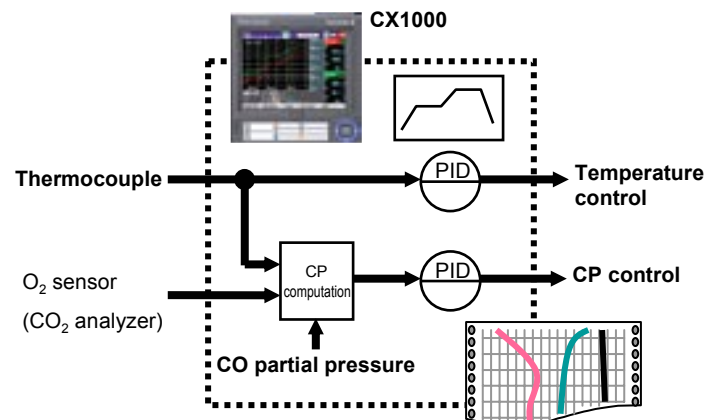
- To identify and control the carbon potential in real time, avoid excess carburizing, and increase quality.
- To lower future operating costs by digitally recording the control process and saving the results as quality data thereby reducing man hours on maintenance of spare parts.
- To achieve such CP control and digital recording in a simple and high cost-performing solution.

Process Outline

It is not possible to directly measure and control the carbon potential (CP) inside an atmospheric gas carburization furnace. Therefore, adjustment of the furnace atmosphere used to be performed by simply using a dew cell dew point indicator. To gain the advantages of sensitivity and rapid response, the mainstream has more recently adopted infrared gas analyzers for controlling CO₂ levels, and zirconia type O₂ sensors for analyzing O₂.

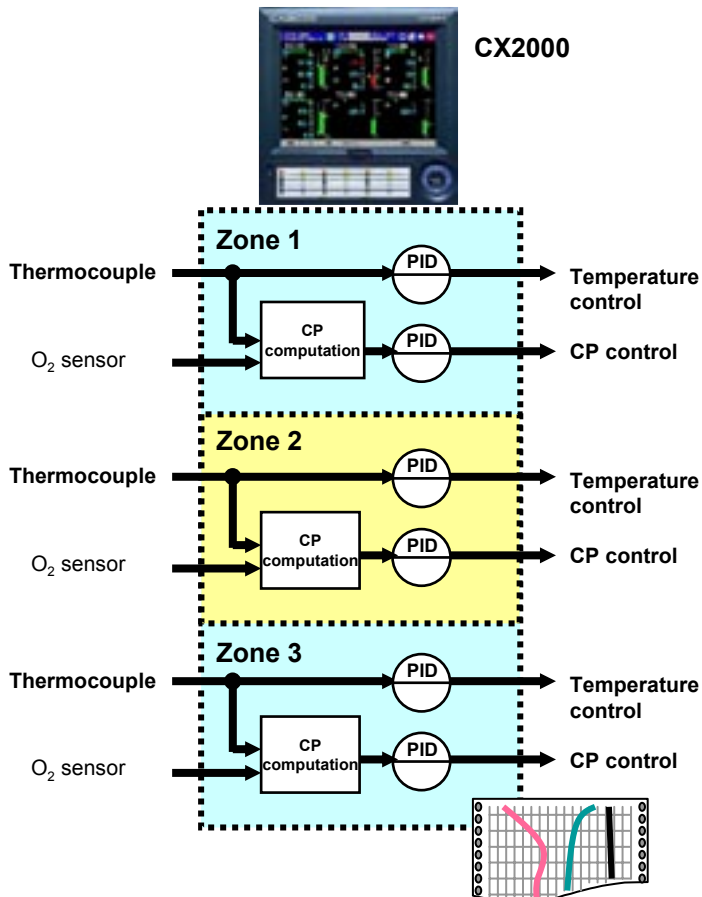
The CX1000/CX2000 supports both infrared gas analyzers and zirconia type oxygen sensors, and automatically and internally computes the CP value according to the output from those devices. By incorporating this automatically calculated CP value into a PID control loop as a process value, real time monitoring, control, and recording of CP values can be performed very easily. Also, pattern control of the internal temperature of the furnace is necessary in order to correct the temperature rise time according to the acceleration of carburization and wall thickness of the item being processed, as well as perform primary and secondary quenching and annealing after carburization. However, in addition to being able to control multiple loops, a single CX series instrument can control the CP value while performing pattern control of this internal furnace temperature.

1. Example of a Batch-Type Carbonizing Furnace



The CX1000 has a compact case (144 mm x 144 mm), can control temperature and CP simultaneously, and functions like a paperless data recorder. You can instantly determine the progress status even when running programs by viewing the PV/SP simultaneous display and time base display.

2. Example of Continuous Carbonizing Furnaces

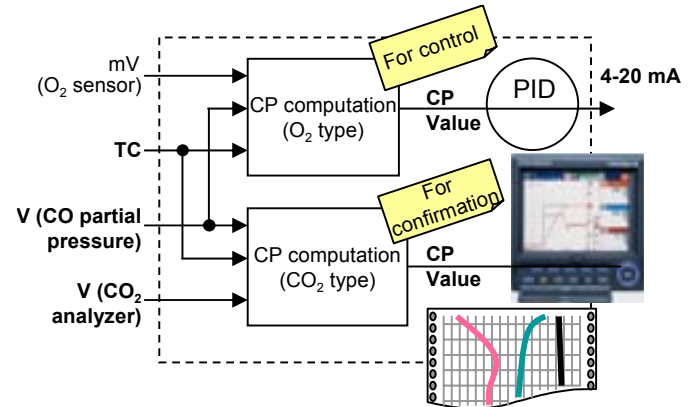


The CX2000 enables independent PID control on up to six loops. The capability of CP computation on all six loops makes it equally applicable for large-scale continuous carbonizing furnaces. Compact and highly cost-efficient, the CX offers an excellent solution for multi-loop PID control.

3. Combine an O₂ Sensor and CO₂ Analyzer in One System

Both the CX1000 and CX2000 support zirconia type O₂ sensors and infrared CO₂ atmospheric gas analyzers. As they can be mixed in a single system, you can display phenomena measured on both the O₂ sensor and CO₂ analyzer for comparison. Control is performed with the O₂ sensor since it offers faster response time, and confirmation is performed by the CO₂ analyzer, which is more accurate.

Example of Combined Sensors



Yokogawa's Solution



Carbon Potential Computation Function
Carbonization Furnace Controllers:
CX1000/S35 & CX2000/S35

CX1000/S35

- Two-loop controller built in to the 144 mm x 144 mm size case
- Function for running thirty-pattern programs
- Max. eight-point paperless recorder built-in (two points of control + 6 points for measurement)

CX2000/S35

- Max. six-loop controller built in (288 mm x 288 mm)
- CP can be computed and controlled for each zone
- One unit handles multiple CP computations and offers high cost-performance
- Max. twenty-six-point paperless recorder (6 points of control + 20 points for measurement)

Paperless recorder function for both the CX1000 and CX2000

- Automatically records PV, SP, and OUT
- Recording and real time monitoring of the carbon potential
- Includes CF card memory, Web monitor, FTP, and e-mail functions

Conclusion

With its CP value calculation function, the CX1000/CX2000 can be applied to a wide variety of applications involving atmospheric gas carburization, and offers a simple, high cost-performance solution for improving quality and efficiency. Also, digitally recording the control process will yield low cost operation well into the future.