

## APPLICATION NOTE

# TOOL FOR ATMOSPHERIC CARBON POTENTIAL ANALYSIS

A question frequently asked by heat treaters is: "What is the actual carbon in my furnace?" There are many tools for continuous atmosphere monitoring, verification, and troubleshooting. They address standard heat treating practices and industry requirements, such as AMS or CQI-9, to ensure continuous control and periodic verification of the furnace atmosphere used for the heat treatment process.

Heat treaters regularly seek ways to prevent and reduce rework and scrap loads by implementing procedures and tools to make sure the heat treating process meets customer expectations and specifications. One process parameter requirement is to ensure consistent atmosphere carbon content. Measuring carbon absorption into steel is commonly done to verify atmosphere consistency. Super Systems's CAT-100 instrument is an atmosphere carbon potential analyzer that provides a cost-effective way to measure carbon using a wire coil that functions in a way similar to using shim stock.

## Working principles

The CAT-100 measures carbon potential in a positive-pressure atmosphere. The value is determined by measuring specific properties of a steel wire coil inserted into an atmosphere made up of a carbon-bearing gas for a predefined time. The concept behind the instrument is similar to that behind the company's Shim Port method. Both use metal pieces "soaked" in a carbon-containing atmosphere as the basis for carbon analysis. Two important differences between the instrument testing method and the shim-stock method are the time required to generate a carbon-potential reading and the cost associated with the measuring instruments.

CAT-100 is capable of providing on-site carbon-potential measurement in less than one hour, while the shim-stock method requires specialized equipment that many heat treaters do not have on

site. This requires having an off-site laboratory measure the shim stock, adding several days to the process. Wire coils are available for use with the CAT-100, and instrument calibration is relatively easy.

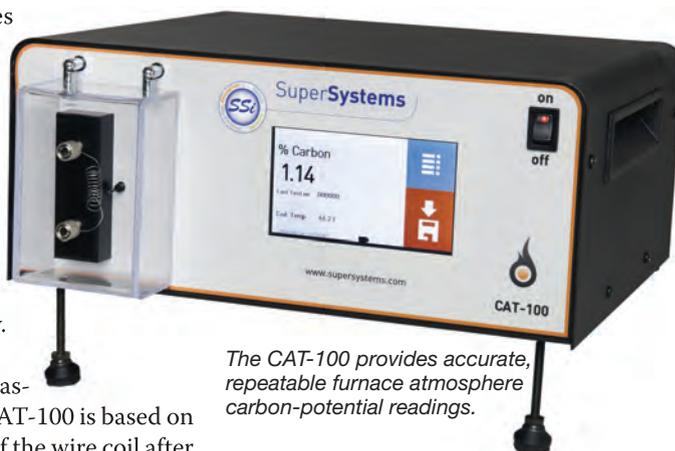
Carbon potential measurement using the CAT-100 is based on the carbon content of the wire coil after soaking in the furnace, which is measured by analyzing changes in the metallurgical properties of the coil. For example, metallurgical changes caused by carbon diffusing into the coil affect its electrical resistance. Measurements are made on the coil after removing it from the furnace (at ambient temperature). Measurement accuracy is dependent on the coil temperature.

Measured carbon potential is also dependent on changes in surface metal properties. The steel surface eventually reaches equilibrium with a given gas composition and furnace temperature. Electrical resistance is directly proportional to the amount of carbon present in the fine-wire coil. Using the baseline electrical resistance and carbon content for the untreated wire, the addition and/or depletion of carbon in the heat treated wire can be accurately measured. The instrument provides a direct reading of percent carbon without the influence of gas composition.

The measurement can be influenced by nitrogen absorption into the coil from the furnace atmosphere. Because this results in erroneous readings, the instrument should not be used for carbonitriding processes.

## Operating procedure

The instrument must be calibrated for use with a specific wire coil. The reason is that different lots of coils could have



*The CAT-100 provides accurate, repeatable furnace atmosphere carbon-potential readings.*

different carbon content, and the presoak carbon content of the coil is crucial for accurate carbon potential measurement. Before the testing process begins, the furnace atmosphere must be verified as suitable for a coil soak. Furnace temperature should be generally uniform before the coil is introduced to the atmosphere, and should not change greatly during the soak. A special insertion rod is used to place the coil into the furnace atmosphere; it must not be inserted within a furnace charge or in a basket. The coil soaks in the atmosphere about 30 to 40 minutes depending on the temperature, and is removed after the soak is completed.

When the coil cools sufficiently (quenching must not be used), it is attached to testing posts on the instrument and a carbon potential value is displayed after about 30 seconds. Readings can be stored in the instrument's internal memory and can be downloaded to a computer using included software. Following proper procedures, carbon-potential readings are accurate and repeatable. The CAT-100 is designed to provide results within 0.03% of the carbon in an atmosphere containing 0.1 to 1.3% carbon (the effective testing range of the instrument). **HTPRO**

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