SHIM STOCK ANALYSIS

Technical Data

Analysis of 'true' carbon potential in a furnace can be achieved by this simple procedure. The results can then be used to adjust the calculated value of carbon potential in the furnace atmosphere controller, as measured by carbon sensors or other analytical techniques such as infrared, dew point analysis, etc.

INTRODUCTION

The purpose of this paper is to describe a recommended apparatus and technique for measuring true or actual carbon potential. Precautions and considerations are described for accommodating to any atmosphere control system.

THE TECHNOLOGY

The procedure consists of allowing a coupon of carbon steel shim stock of known carbon content to equilibrate with carbon in the furnace atmosphere, and then measuring the resultant carbon content. This can be done either by measuring the weight increase, or by chemically analyzing the coupon for carbon content. Historically, there have been a variety of techniques by which equilibration of shim stock in the furnace atmosphere has been conducted. In some heat treat facilities, the shim stock is attached to the workbasket and follows the work through the process, including quenching. Unfortunately, this can result in a low measured carbon due to decarb in the vestibule prior to quenching. In other instances, the routine described in the ASM Metals Handbook is followed loosely without due consideration for some of the recommendations. This paper will describe a preferred routine that adheres to some fundamental principles, and a simple, inexpensive apparatus that allows convenient determination of the true carbon potential.

SAMPLE PREPARATION

1 Cut a coupon of AISI 1010 (0.10 %C), certified shim stock to 1 3/8" x 4".

2 Clean the coupon thoroughly with acetone and a paper towel, rubbing to remove loose deposits.

3 With rubber gloves, weigh the coupon in an analytical balance to the nearest 0.1 mg. This is defined as the *original weight*.

4 Roll the coupon lengthwise into a complete cylinder.

SHIM STOCK ANALYSIS

Technical Data

THE APPARATUS

Figure 1 shows the installation of the recommended apparatus in a typical furnace wall. The assembly should be placed at a height on the furnace wall, which allows the shim to be positioned a few inches above the workbasket, in order to provide unimpeded exposure to the atmosphere. To install, drill a 1" diameter hole through, (and perpendicular to) the furnace wall, and through the insulation. Weld the 1" NPT x 3" nipple to the wall as shown. Thread the 1" ball valve onto the 3" nipple and thread the 6" nipple into the ball valve.

Modifications to the original ASM arrangement have been made for convenience and safety in use. In operation, the ball valve is closed and the rod (with the cap in place) is prepared for insertion by applying the rolled shim stock around the rod between the fixed washers at the insertion end. The coupon end is then placed in the 6"nipple, and the cap is screwed into place.

THE PROCEDURE

1 Wait until the furnace is up to temperature and the atmosphere has lined out at the set point carbon potential. There should be work in the furnace in order to best test the stable carbon potential.

2 Open the ball valve and insert the rod fully into the furnace. Start timing. The sample should remain in the furnace for the minimum time listed in the following table:

TEMPERATURE (°F)	SAT'N %C	MIN. TIME-MINUTES
1550	1.05	45-65
1600	1.11	30-50
1650	1.21	20-40
1700	1.31	15-30
1750	1.4	10-25

3 Pull the rod out until the center washer contacts the cap, then move back in 1/4". Wait for ten minutes, then close the valve.

4 Unscrew the cap and remove the rod from the nipple. With gloves on, remove the shim and reweigh it. This is defined as the *new weight*. Report the results as:

$$new\ \%\ carbon = \frac{(new\ weight - original\ weight) * 100}{new\ weight} + \ original\ \%\ carbon$$

SuperSystems incorporated

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Note that a negative weight change corresponds to a lower % carbon in the atmosphere than the original shim material, and the calculation will provide the correct atmosphere composition.

SHIM STOCK INSERTION ASSEMBLY

NOTE: SEE ASM HANDBOOK,VOL.4,NINTH EDITION,PAGES 434,435.

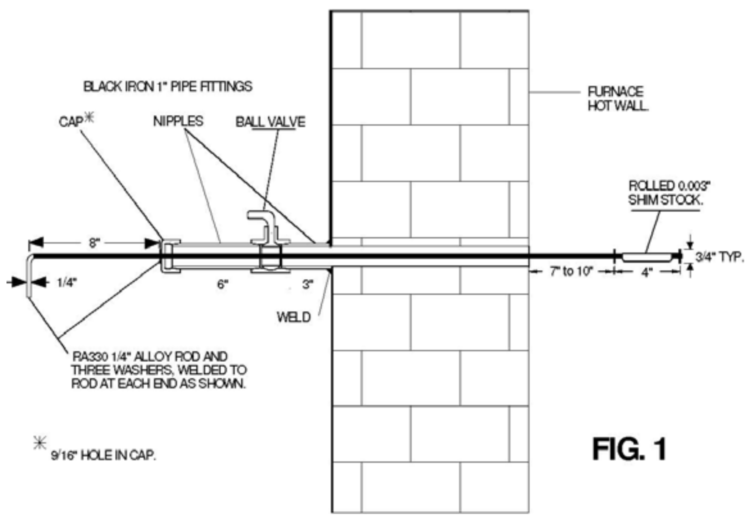

FIG. 1

CONSIDERATIONS

It is desirable to mount the shim apparatus close to the carbon sensor or sampling location. This is especially important in continuous furnace where the controls are for the zone in question. When working in atmospheres above saturation levels, (as shown in the dwell timetable) the coupon will normally have a matte finish representing loose dry carbon. This material should be wiped off before weighing. Note that the dwell timetable lists a range of dwell times. The appropriate actual value should be established by trial and error for each individual installation. The dwell time is affected by many factors such as the degree of agitation, the normal carbon level, and proximity to catalytic alloy. In any event, it is desirable to equilibrate for no longer than the recommended time due to the development of carbides at carbon levels above saturation. No stock other than 0.003" thick should be used. This provides for a minimal time in the atmosphere and expedites the results.

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EVALUATION

Because the shim stock is so thin, it will achieve the true carbon potential throughout. The work will not normally achieve the same level at the surface because diffusion to the core keeps it at a lower level.

CALCULATION OF CORRECT PROCESS FACTOR

Since the purpose of the test is to verify the validity of the controller calibration, the following equations provide you with the tools necessary to modify the calibration factor used in your atmosphere controller.

The following simple equation may provide you with a reasonably good COF value for precise control:

COFnew = COForiginal x %Cshim stock / %Cset point (1)

If, using this value there is still some disparity between the set point value and the shim stock value, multiply the COFnew value as calculated above, by the correction factor F, shown in equation (2), using the same values from Equation (1):

COFnew(corr) = F x COFnew where F= (3.79-%Cset point) / (3.79-%Cshim stock) (2)

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Notes