Making Alloy Steels in The Kaldo Furnace

by C. E. Brownlee

The production of alloy steel in Sharon Steel Corp.'s Kaldo furnaces was started shortly after the shop began operating in October 1962. A variety of analyses have been produced, even though the alloy heats represent less than 1% of the total shop production. These include alloys of the AISI 4100, 5100, and 8600 series and other alloys containing approximately 0.50% chromium with various amounts of copper, nickel, molybdenum, titanium, or zirconium. No special problems have been encountered in the production of these heats in the Kaldo furnace. In fact, one of the characteristics of the process, the furnace rotation, has in the past been used when making chromium additions to the furnace.

LADLE ADDITIONS OF CHROMIUM

Recently, however, all of the alloy heats have been those having chromium around 0.50% and the practice on these grades has been to add all of the chromium to the ladle. Either of two types of exothermic ferrochromium is used for the addition, depending on the desired final carbon and silicon. The material is received in cans containing the equivalent of either 22 lb of chromium, 11 lb of silicon, and 0.33 lb of carbon or 25 lb of chromium and 3.0 lb of carbon. The chromium is placed in the bottom of the ladle, prior to tapping the heat. These heats are tapped *open*.

OTHER ADDITIONS

If the specified chemistry requires copper, nickel, or molybdenum additions, these materials are charged to the furnace, generally with the last scrap charge. Electrolytic nickel, scrap copper, or molybdenum oxide comprise the additions. A preliminary test for alloys is run before the addition and before the heat is tapped.

Other additions such as silicon, manganese, aluminum, titanium, or

zirconium are added to the ladle while the heat is being tapped.

PROCESS DESCRIPTION

A second practice for making alloy heats containing chromium, perhaps represents the major difference between the production of alloy steels in the Kaldo process and other basic oxygen processes. In this practice the chromium is added to the furnace and the furnace rotation is utilized to facilitate the solution of the addition. Before describing this practice, perhaps a brief description of the Kaldo process would be worthwhile.

The Kaldo process as practiced at Sharon Steel Corp. differs from other Kaldo operations in that the oxygen is injected to the furnace through either a high or a low velocity lance. It further differs from other basic oxygen processes in that the operating position of the furnace is at 17° with the horizontal. The furnace rotates at speeds of up to 27 rpm while at this angle. The furnaces are rated at 150 tons, and we are tapping 155 to 160 tons per heat. About 40% of the metallic charge is scrap. A heat normally consists of one hot metal charge, 2 or 3 scrap charges, 2 or 3 blowing periods, 2 or 3 temperature tests, and either 1 or 2 tests for chemistry. The initial charge consists of the hot metal and 30 or 35 tons of scrap. This charge is followed by a lime addition and the first blowing period during which essentially all of the silicon is oxidized and the temperature of the bath is raised to approximately 2650°. The first slag is partially flushed off while a bath temperature is being taken. A 40-ton scrap charge follows and the second blow is started. Additional lime is charged during the beginning of this blow. Most of the carbon is removed during this blow and the temperature is raised almost to the tapping range. A second temperature and a sample for carbon and alloys is taken. If necessary a final short blow is made to adjust temperature or carbon. After this blow, a final test is taken for temperature and chemistry and the heat is tapped.

FURNACE ADDITIONS OF CHROMIUM

The practice for making chromium additions to the furnace merely consists of having sufficient temperature in the bath at the desired tap carbon to dissolve a small silicon *block* and the chromium addition. The *block* consists of 3000 lb of 15% ferrosilicon and the chromium is added as a charge chrome alloy containing approximately 65% chromium, 2% silicon, and 5% carbon. The scrap charging equipment is used for both additions. A bath temperature of approximately 75 to 100° above the tapping range is required since no oxygen is blown after the additions are made.

Once it is determined that the heat is ready to tap, with respect to carbon and temperature, the furnace is tilted to the charging side and the silicon is charged. The furnace is normally returned to the operating side for observation before charging the chromium. The chromium is then charged in the same manner and the furnace is returned to the operating position and rotated for 5 to 7 min at 5 rpm. Immediately after the rotation, the lime dam is built and the heat is tapped.

A test for chromium was taken from the furnace immediately after rotation on several heats. However, the tests were taken too soon after the addition and were not representative. Ladle tests indicated that chromium was very uniform from the first to the last ingot. Chromium recoveries using this practice were, in general, good, but varied from 85 to 97% on individual heats.

An average of about 25 min was required from the time of the silicon addition to tap. The time factor and the somewhat erratic chromium recoveries, plus the fact that the chromium can satisfactorily be added to the ladle has resulted in our discontinuing this practice for the present. However, if alloy steel having higher chromium contents than those we are presently making, are scheduled for the Kaldo shop, it is very possible they would be made by adding the chromium to the furnace.

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