Reusable Hot Tops Proven Successful in Ingot Pouring Practice

by Joel C. Carpenter

IN the early days of steelmaking, no attempt was made to control the shrinkage cavity and major zone of segregation in killed steel ingots. Steel which was suitable for application as prime product rarely amounted to more than 60 pct of the total ingot. The top 40 pct or so, containing the pipe cavity and major segregation zone was either scrapped, or possibly applied to orders on which substandard quality was permitted. The price which could be obtained for this top portion was either scrap value, or at most, considerably less than that which could be obtained for prime product.

To make a greater percentage of the ingot available for application as prime product has long been the aim of steel plant operators and metallurgists. During the past 50 years, innumerable ideas have been tried for controlling and relocating the shrinkage cavity, and its effect upon center soundness and internal quality of killed steel ingots. Some of these ideas have involved the use of hydraulic or mechanical pressure for squeezing out the pipe cavity, and some have employed gas generating substances to build up pressure to try to control feeding, but most ideas have been directed toward maintaining a reservoir of molten metal at the top of the ingot to feed the shrinkage cavity.

Reusable Hot Top

Several years ago, a reusable insulated low volume C&D hot top was developed by the Ferro Engineering Co., and it has been tested and proved successful in the steel industry. It consists of a cast iron casing lined with insulating fire brick and employs the usual appurtenances for protecting the bottom of the casing preventing the flow of molten steel between the mold hot top. It may be poured with only a slight hesitation to obtain a seal at the hot top-mold junction. After pouring, the supporting blocks are knocked out, so that no *hanging* of the ingot will occur.

The insulating fire brick used absorbs only 30 pct as much heat as regularly fireclay brick and has an insulating value 3.1 times as great at 2600°F. The use of this material has resulted in a notable increase in the efficiency of the hot top.

A reusable hot top requires that the refractory lining be capable of repeatedly withstanding contact with molten steel, and the abrasion incident to the stripping of the hot top from the sinkhead portion of the ingot. To protect the insulating fire brick lining from the molten steel, a refractory veneer, approximately ½ in. thick is applied to the inner

face of the hot top lining before each use. This veneer is applied as a mortar, and is thoroughly dried before using, forming a monolithic surface, which resists penetration by the molten steel. Replacement of the insulating firebrick lining should only be necessary at infrequent intervals if the protective veneer is properly applied and dried.

During the past several years, tests of insulated low volume C&D hot tops, conducted at a number of steel plants making both electric furnace and open hearth steel, have shown an increase in prime product yield, when compared with that obtained with regular hot top practice. These tests were conducted using regular production ingot molds at each plant involved in the testing program. Mold cavity configurations included square, rectangular and duodecagonal cross sections, with various contours and different flutings.

Comparisons were made by substituting insulated low volume C&D hot tops for regular hot tops at certain positions in the drag of molds, usually somewhere after the first buggy of molds. The practice on molds with regular hot tops was to pour ingots with sinkheads of from 13.6 pct to 16 pct by weight, molten, depending upon the size and shape of the ingot and the grade of steel being poured. Ingots made in molds with insulated low volume C&D hot tops were usually poured at 3 pct less by weight, molten, than the comparison ingots made in molds with regular hot tops. In the case of comparison ingots, both types of hot tops were set the same distance in the mold, so that the ingot body weights would be the same. Evaluation of prime product obtained showed that the insulated low volume C&D hot top increased the yield by at least 3 pct, at a comparable quality level with that obtained with regular hot tops. Quality level was determined by macro etch tests and chemical segregation tests, made at the top of the product in accordance with accepted metallurgical testing practice.

An additional important feature of the insulated low volume C&D hot top is that it is heavy enough so that it will not float off of the ingot mold during or after pouring. Furthermore, this hot top is easily removed from the sinkhead before the ingot is loosened, and the sinkhead has a chance to cool sufficiently to be hard enough to be gripped by stripper crane bits without collapsing. In actual practice, no difficulty has been experienced in handling ingots made with these hot tops, although the sinkheads are somewhat smaller than those made with regular hot tops.

Reference

- ¹ J. W. Mueller: A Progress Report on Hot Top Research. *Proc. National Open Hearth Conference, AIME* (1949) 32, pp. 120-126.

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