Open Hearth Screw Steels Replacing Bessemer

by S. Feigenbaum

FOR many years the manufacture of added sulphur free machining steels for automatic screw machine use was confined largely to the acid bessemer process. Inherently high phosphorus and nitrogen contents of conventional bessemer steel, and the excellent machinability of the bar products rolled from these grades were factors favoring the continued production of bessemer screw grades.

During recent years, however, various economic and metallurgical considerations resulted in the broad expansion of open hearth steelmaking capacity and the gradual decline and abandonment of a significant proportion of the bessemer capacity in the U. S. Concurrently attention has been directed toward the possibility of producing steels equal or superior to the bessemer screw grades B-1111, B-1112 and B-1113 in the basic open hearth, and in occasional instances even in the electric furnace. One consequence of this activity was the formulation of a new series of standard steels, designated in the AISI manuals as C-1211, C-1212, and C-1213. These steels are analogous to the bessemer grades and are made to the chemical specifications shown in Table I.

Some producers have developed modifications of these basic compositions, to obtain further improvement in metallurgical characteristics.

Some time ago Jones & Laughlin Steel Corp. initiated experimental production of open hearth free machining grades in the research laboratory 4-ton open hearth furnace and in small open hearth furnaces in the plant. Representative tonnages of cold drawn bars were shipped to customers' plants and the performance in screw machine operation carefully evaluated. Favorable trade reactions were obtained and production of open hearth screw steel grades was undertaken on a broad scale.

From the standpoint of metallurgical practice it is entirely feasible to reproduce the bessemer range of analyses in the open hearth furnace. The nitrogen content may be duplicated consistently or varied over a fairly wide range, as desired, with the use of suitable addition agents. From the operating viewpoint, however, the change to open hearth practice introduced several problems that did not previously exist in acid converter practice. Among these were:

1—In the bessemer process it was possible and frequently desirable to introduce sulphur and occasionally some phosphorus with the converter charge, since acid slag has no effect on either of these elements. In the basic open hearth these additions must be confined to the ladle.

2—Phosphorus and nitrogen contents that are inherent in acid bottom-blown converter operation must be obtained from ladle additions in open hearth practice.

3—Large heats and correspondingly large additions required in the open hearth process presented

Table I. Chemical Specifications of C1211, C1212, and C1213 Steels, Pct

	Carbon	Manganese	Phosphorus	Sulphur
C-1211	0.13 max	0.80 to 0.90	0.07 to 0.12	0.08 to 0.15
C-1212	0.13 max	0.70 to 1.00	0.07 to 0.12	0.16 to 0.23
C-1213	0.13 max	0.70 to 1.00	0.07 to 0.12	0.24 to 0.33

physical difficulties that were previously of minor concern with small bessemer blows.

4—The low bath carbon content needed to make these grades was simpler to attain in the converter.

Pittsburgh Works div. ordinarily produces the basic C-1200 series of steels in open hearth furnace of 225 net tons capacity. The practice established for these grades is briefly the following:

Furnace—Straight ferromanganese is added to meet specification split between standard and medium grades as indicated by requirements of the particular heat. Preferred bath temperature before manganese addition is 2910° to 2940°F. The heat is tapped approximately 5 min after the manganese is added.

Ladle—Flowers of sulphur and ferrophosphorus are added to meet the specification for these elements. If desired, nitrogen may be added in controlled amounts in any of several available forms. A small quantity of standard ferromanganese usually is added to make a final adjustment of analysis.

Molds—The steel is cast in 25x27 in. corrugated bottle top ingots, capped if necessary with a small quantity of crushed 90 pct ferrosilicon.

The practice described resulted in the production of steel that exhibits an excellent degree of uniformity within the heat and a high order of consistency from heat to heat. While a missed heat in the open hearth represents many times the tonnage of a bessemer blow, experience indicates that in the aggregate the C-1200 series has been less troublesome in that respect than the B-1100 group.

The surface quality of bessemer screw steels, particularly B-1113 grade always has been troublesome. The corresponding open hearth grades display somewhat similar hot rolling characteristics. In general experience indicates an appreciable superiority for the open hearth steels with respect to conditioning bed rejections and less extreme variation in quality from heat to heat. As the carbon content approaches the maximum of the specification, the hot rolling performance is adversely influenced. Manganese content over 0.80 pct is desirable and usually heats finish within the 0.80 to 1.00 pct range. Since tapping and teeming temperatures ordinarily may be controlled more closely in open hearth practice than in bessemer, it is reasonable to attribute some proportion of the improvement to this factor.

Thousands of tons of open hearth free machining steels have been made for a wide variety of applications and experience indicates that in ultimate use, the new grades are superior to the bessemer grades they have displaced.

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