

## Summary

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As explained in the Introduction, this is a state-of-the-art review of less-well-known aspects of ferroalloys and other additives and less-common materials. As such, it should serve well as a review and source of thought for those engaged in the production and control of ferrous materials.

The initial paper by Huhn outlines in detail the background history, scope, and evolution of ferroalloy specifications as developed by ASTM Committee A-9. This paper points out that the ferroalloy industry is basically a service industry to the steel and nonferrous industries and is constantly undergoing changes in the products produced as a result of technological advances that have taken place in these industries.

Weston's paper reviews the current status of the International Standards Organization and how it is structured. Emphasis is placed on the necessity of involvement by ASTM to insure that the United States has a forum for asserting her influence on the international standards being published.

The seldom-mentioned subject of the Government's role as purchaser of ferroalloys for stockpiling is presented by Corder—who tactfully understates the pitiful state of financing of the program passed by Congress in July 1979. The paper was, of course, written before the change of the government in the United States in January 1981. It remains to be seen if this program as outlined is funded and implemented.

The recent decline, and prospects, of the ferroalloys industry in the United States is the subject of Gate, who highlights the problem in chromium and manganese products, while Deeley reviews in some detail the recent past and probably the future of the usage of ferroalloys, stressing the thermal aspects, and the possibilities of usage as powders injected into the liquid metal; a valuable list of references follows Deeley's text.

The intriguing possibilities of covering a large part of U.S. needs for a number of ferroalloys by the mining of ocean nodules is presented by one of the participants in the original exploration, U.S. Steel Corp. But the author, Balash, only alludes to the possibly severe political complications, the "underdeveloped countries," often major producers of ferroalloys or at least their ores, strongly objecting to the development of ocean mining, even within territorial waters defined recently, at their insistence, as extending to 200 nautical miles [230 miles (360 km)] from a shore.

Two steel producers discuss the control of purchasing and quality of incoming materials: Peters presents the case of a large nonalloy steel mill while Stryker states the problems of a high-alloy steel producer. There are signifi-

cant differences in the two approaches based on the diverse needs of the plants and the markets served.

The second half of the symposium dealt with the less-well-known "modifiers" of properties, rare earths and titanium, followed by a discussion of aluminum and its replacement in continuous casting. The usage trends and addition mechanics of rare earths are covered by Trethewey and Jackman in some detail with particular emphasis on the growth in usage of rare-earth metals. A description of the role of these elements in modifying graphite cast iron shapes, by Cornell and Lalich, extends this discussion to complex additives. Demos and Kremin outline the leading titanium alloy sources for the lowest-cost titanium additions to iron and steel.

Silver of the Jones and Laughlin Steel Corp. gives an extensive discussion of alloy practices and relative costs of alloys and methods used to produce high-strength low-alloy steels, most of which are deoxidized with aluminum. The role of aluminum and aluminum recovery in steelmaking and the various forms available are covered by Larsen, followed by a paper by Deeley reviewing aluminum deoxidation practices and the use and properties of ferroaluminum as an alternative to metallic aluminum. Wright discusses the production of fine-grained steel using vanadium or columbium as the necessary substitutes for aluminum in open-stream continuous casting.

The last paper, by Peters, describes the additives used to produce free machining steels, their forms, conditions of use, and the reasons why a majority of these steels are not likely to be made in the future via the continuous casting process.

Appendix I broadly lists the alloys and other additives used in the ferrous and nonferrous industries, indicating their coverage by ASTM. Appendix II lists densities and thermal effects of the addition of a number of common ferroalloys, these having been calculated by R. J. King and W. R. Chilcott, Jr., U.S. Steel on a consistent basis. While the numbers may serve only as a guide, they represent a unique assembly of data not available in a condensed form.

A thread common to all presentations is their practicability. No theoretical considerations are given, the symposium having been designed as a forum for the exchange of ideas between the practitioners of the art and producers of the alloys and additives. It is hoped that the present *Special Technical Publication* will serve a similar purpose.

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