

INCLUSIONS IN CONTINUOUS CASTING OF STEEL

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ABSTRACT

This paper first reviews the sources of inclusions in continuous casting of steel including both indigenous and exogenous inclusions, focusing on reoxidation, slag entrainment, lining erosion and inclusion agglomeration on linings. Secondly, the resulting defects in continuous cast steel products are reviewed, such as flange cracked cans, slag spots, and line defects on the surface of rolled sheet. Thirdly, the current "state-of-the-art" in the evaluation of steel cleanliness is summarized, discussing over 30 different methods including direct and indirect methods. Finally, this paper reviews operating practices to improve steel cleanliness at the tundish and continuous caster.

Key Words: Steel, Inclusions, Defects, Slab Caster, Plant Measurement, Review, Detection Methods

INCLUSIONS AND DEFECTS

1. Introduction

The ever-increasing demands for high quality have made the steelmaker increasingly aware of product "cleanliness" requirements. Non-metallic inclusions are a significant problem in cast steels that can lead to excessive casting repairs or rejected castings. Ginzburg and Ballas reviewed the defects in cast slabs and hot rolled products, many of which are related to inclusions.¹⁾ The mechanical behavior of steel is controlled to a large degree by the volume fraction, size, distribution, composition and morphology of inclusions and precipitates, which act as stress raisers. The inclusion size distribution is particularly important, because large macroinclusions are the most harmful to mechanical properties. Sometimes a catastrophic defect is caused by just a single large inclusion in a whole steel heat. Though the large inclusions are far outnumbered by the small ones, their total volume fraction may be larger.²⁾

Ductility is appreciably decreased by increasing amounts of either oxides or sulphides.³⁾ Fracture toughness decreases when inclusions are present in higher-strength lower-ductility alloys. Similar property degradation from inclusions is observed in tests that reflect slow, rapid, or cyclic strain rates, such as creep, impact, and fatigue testing.⁴⁾ **Figure 1** shows that inclusions cause voids, which can induce cracks.⁵⁾ Large exogenous inclusions may cause trouble in the form of inferior surface, poor

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Continuous Casting N. A. McPherson, A. McLean, 1995 *Handbook of Non-Metallic Inclusions in Steels* Lifeng Zhang, Ying Ren, 2025-01-13 This handbook reports fundamentals industrial practices and new aspects for the formation and control solution of non metallic inclusions in different grades of steels It summarizes the latest research achievements of thermodynamics and kinetics such as deoxidation of real steels rather than pure iron precise calcium treatment prediction of the amount size composition and spatial distribution of inclusions in steel continuous casting semis which were rarely reported in other books in this field It is a useful reference for researchers in steel industries for the control of non metallic inclusions in steel and the production of high quality steels in industries such as automobiles household electric appliances bearings electric transformers high speed trains oil pipes and cutting wires

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Metals Abstracts Index, 1996 **Chemical Abstracts**, 1911 **Non-metallic Inclusions in Steel** Roland Kiessling, Nils Lange, 1978 *The Journal of the Iron and Steel Institute* Iron and Steel Institute, 1929 Includes the institute s Proceedings **Transactions of the American Foundrymen's Society** American Foundrymen's Society, 1930 Vols 5 6 9 include the Proceedings of the annual meeting **Transactions of the Iron and Steel Institute of Japan** Nihon Tekkō Kyōkai, 1985 *Metals Abstracts*, 1996 *Materials Science, Testing and Informatics ...*, 2007 **Materials**

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