

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.⁴ Large exogenous inclusions may cause trouble in the form of inferior surface, poor

Inclusions In Continuous Casting Of Steel

Joacim Rocklöv



Inclusions In Continuous Casting Of Steel:

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 *Effect of Steel Manufacturing Processes on the Quality of Bearing Steels* J. J. C. Hoo, 1988 **Continuous Casting of Steel**, 1978 *New Materials and Processes* Wen Zhe Chen, Qiang Li, Yong Lu Chen, Pin Qiang Dai, Zheng Yi Jiang, 2012-02-27 Selected peer reviewed papers from the 3rd international Conference on Manufacturing Science and Engineering ICMSE 2012 March 27 29 2012 Xiamen China *Engineering Materials V* Chin Yi Chen, J.T. Chang, 2011-04-19 Selected peer reviewed papers from the 5th Cross strait Workshop on the Engineering Materials CSWEM 5 held in I Shou University Taiwan on November 19 20 2010 Industrial Minerals Patrick Degryse, Jan Elsen, 2003 This issue of Aardkundige Mededelingen deals with industrial minerals their resources characteristics and applications It is the result of an academic session on industrial minerals in honour of Em Prof Dr R Ottenburgs The contributions are organized according to five topics In a first part The Industrial Mineral World some considerations on our natural resources their use and political impact are presented In a second part of the study Aggregates and Natural Building Stone a number of case studies on the use of industrial minerals as aggregate and ornamental or building stone are discussed In a third part of the volume Mortar Cement and Concrete the study of ancient mortars as well as exploratory research into new materials is illustrated In a fourth session Clays and Soils environmental aspects of soils and the economical use of clay deposits are highlighted In a fifth and final part of the book Steel the link between ores and industrial minerals is made It is clear that the study of industrial minerals has many faces and covers many disciplines The impact of industrial minerals on the world s economy but also on the environment cannot be emphasized enough This book gives an overview of the wide and rich diversity of research currently performed in the realm of the industrial minerals *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 Science,

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