

# A REVIEW ON PERFORMANCE OF A BILLET QUALITY BY REDUCING SHRINKAGE AND POROSITY DEFECTS IN STEEL BY CFD IN CONTINUOUS CASTING

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## ABSTRACT

*The objective of this paper is to review the defects found in vertical continuous casting process. Remedies and Causes for shrinkage and porosity defects are discussed that would help to improve the quality of casting product. It found parameters effect the casting quality are casting speed , cooling speed , casting temperature, high extraction speed, secondary cooling zones, water flow rate, oscillation frequency Material flow analysis can be done in CFD that helps to detect shrinkage and porosity defect. The remedies that are discussed below help to reduce rejection rate.*

**Keywords-** Continuous Casting, Casting Defect, Shrinkage, Porosity, Simulation, CFD

## INTRODUCTION

Modern billet and bloom casting has ever stringent demands for product quality, meanwhile maintaining high productivity as well as low production cost. This requires better understanding and control of the casting process, including fluid flow phenomena, solidification microstructures, as well as various defect formation mechanisms. Especially, inclusion control has become a top important issue in the steel production worldwide, which is deeply involved in almost every aspect of steelmaking and casting processes.

Introduction Porosity is a major defect in metal casting which will significantly decrease the mechanical performance of the resulting material due to degradation of fatigue resistance and tensile strength..

## CONTINUOUS CASTING DEFECTS

The defects arising from the steel continuous casting can be classified as follows:

Surface defects, internal defects Surface Defects are following:

1) Longitudinal Casting Cracks:

Cause- uneven removal of the heat in the mould  
Remedy- increasing the perimeter of the mould

2) Pin Holes :

Cause- evolution of gases resulting from casting powder decomposition during casting  
Remedy- proper mixing of molten metal and lubrication of mould

3) Star Crack:

Cause- intense local cooling, which induce local tensions  
Remedy- correlation between the spray flow and the casting speed (automatic flow control)

4) Transverse Crack:

Cause- the thermal stresses due to the uneven solidification  
Remedy- set proper secondary cooling and minimizing the localized temperature fluctuations

Internal Defects are following:

1) Intercrystalline Cracks

Cause- internal stresses due to different rates of cooling of outer and deeper layers  
Remedy- minimized by proper mixing of the molten metal, lowering the Sulphur level

2) Internal Blow Holes-

Cause- insufficient de-oxidation of steel, Moisture present in the casting powder  
Remedy- Sufficient de-oxidation of steel by using dry materials and additives.

4) Shrinkage Porosity

Cause- metal changes phase from the molten state to the solid state, it always shrinks in size  
Remedy- Proper mixing of molten metal

## **LITERATURE REVIEW**

1. Carlos A. Santos, Jaime A. Spim Jr., Maria C.F. Ierardi, Amauri Garcia

In this paper different parameters affecting the continuous casting quality to be given.

The productivity and quality of a continuous caster depend mainly on process parameters, i.e. casting speed, casting temperature, steel composition and Cleanliness of the melt, water flow rates in the different cooling zones

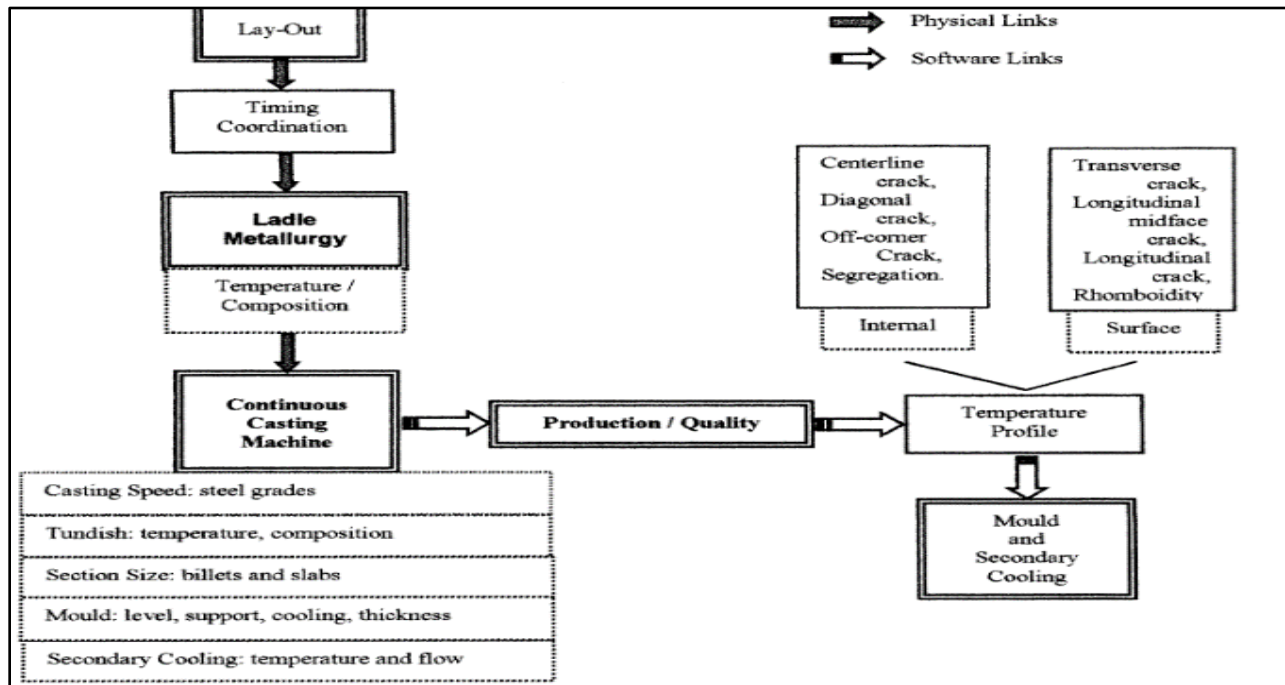


Figure 1: Variables Affecting the Quality of the Final Product in the Continuous Casting of Steel [1]

2. N. Cheung, C.A. Santos, J.A. Spim, A. Garcia

In this paper determine the improved cooling conditions for the sprays zones of a real Continuous Caster for the production of quality billets. The improved cooling conditions of mould and spray Cooling zones of a continuously billet casting machine were determined with the application of Computational program based on an interaction between a heat flow mathematical model and an Heuristic search technique supported by a knowledge Base based on metallurgical quality and Technological constraints

3. Qi Peng Dong, Jiong Ming Zhang, Bo Wang, Xinkai Zhao

In this paper Porosity is a major defect in metal casting which will significantly decrease the mechanical performance of the resulting material due to degradation of fatigue resistance and tensile strength. Based on the size, porosity can occur as micro-porosity and macro-porosity (also called void).

Porosity cannot be eliminated by subsequent heat treatment process, and the best strategy to reduce

Porosity is to better understand the formation of porosity to determine appropriate strategies to prevent its occurrence.

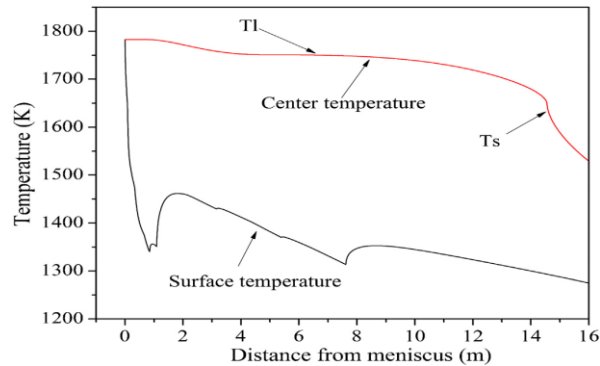


Figure 2: Predicted Temperature at the surface And The Centre of Billet [3]

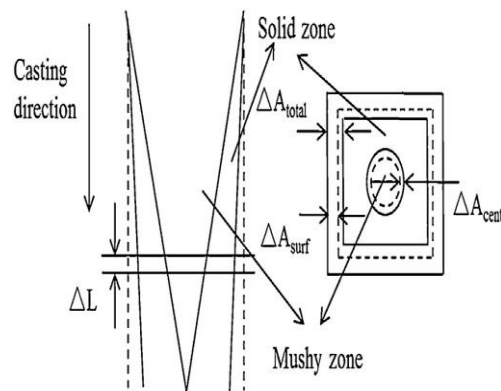


Figure 3: Schematic Diagram of the Solidification Model [3]

#### 4. Abdul Haseeb, Arvind Kumar

In this paper having all defects remedies solution of root causes. It gives idea of machining setup specification in industry. Author studied the various processes in the industry and done a project to improve the quality of billets, and thereby reducing the major loss of the company. The main

problem faced by the industry is the defects caused during casting of the billets. The defectives can only be re-used as scrap, which is the major loss of the industry. Root causes of these defects and solutions recommended are analyzed for each case. Author suggested a field mixing technology for the mixing of molten metal in correct proportion so that it reduces about 75% of its defects. Also we suggested other methods to improve the quality of billets.

#### 5. Pruet Kowitwarangkul, Maitri Kamonrattapisud and Ekachi Juntasaro

In this paper is aimed to study the flow behavior inside the three strand tundish with and without flow control mechanics. CFD software ANSYS FLUENT is used for simulation. The data of geometry and operating parameters collected from the plant.

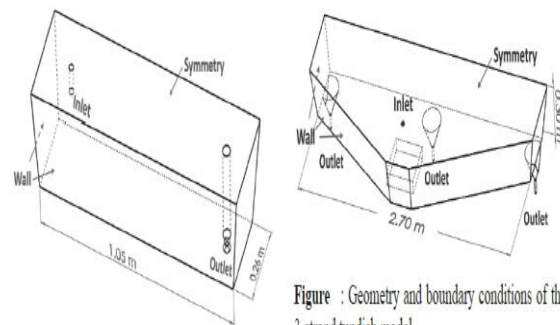


Figure Geometry and boundary conditions of the 1-strand tundish model.

Figure : Geometry and boundary conditions of the 3-strand tundish model.

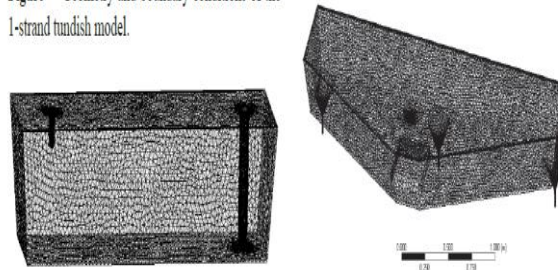


Figure Mesh for the 1-strand tundish model.

Figure Mesh for the 3-strands tundish model.

Figure 4: Geometry and Mesh for 1-Strand and 3-Strand Tundish Model [5]

## CONCLUSION

The process of manufacturing of billet by continuous casting process. Defects found in billet are two types like surface defect and internal defect. Major surface defects are longitudinal cracks, pinholes, star crack, transverse crack and major internal defects are blow holes, shrinkage porosity or centerline porosity. Shrinkage porosity or Centerline porosity contributed more towards

rejection. To reduce shrinkage porosity, simulation is to be carried out in Simulation, to visualize the material flow. Optimum parameters range is to be found during simulation like CFD in ANSYS FLUENT, where complete filling of material in tundish to mould and affecting parameters like casting temperature, high extraction speed, secondary cooling zones, casting speed, water flow rate, oscillation frequency will take place i.e. removal of shrinkage porosity defect. Experiments are to be carried out at optimum temperature, tundish metal turbulence, casting speed, range to validate result.

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