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Analysis of Tundish Casting with different Pouring time to improve the effect of Temperature and Velocity by Finite Volume Method

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Abstract
In our analysis, numerical model have been developed the model is considered as existing part in continuous production of ingots. The analysis results show that temperature range between 1841 to 1884 K gives absolute convergence on temperature, Validation and optimization is done to determine the effect of temperature and velocity during working heating and non – heating plasma condition. The temperature and velocity with respect to time (s) is analysed in tundish casting for enhancement of proper casting process to reduce internal stresses generated due to imbalance of temperature and velocity. Pouring time were also analysed at different heated plasma condition for enhancement of settlement of molten steel in tundish casting. Hence, temperature of 1841 to 1884 K with time of 120 to 180 exhibits optimum convergence in casting of molten steel in tundish casting with different heating plasma values i.e. 300, 350, 400, 450 and 600 KW.

Key Words – *Velocity, Temperature, Tundish casting, Non – heating plasma, Heated plasma, Taguchi optimization technique.*

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I. Introduction

Casting manufacturing is a system wherein liquefied material, together with molten steel, is poured into the cavity of a particularly designed mould and allowed to harden. After solidification, the workpiece is removed from the mold to go through various finishing treatments or to be used as a final product. Casting strategies are usually used to create intricate strong and hole shapes, and forged products are found in a huge variety of applications, which includes car components, aerospace components, etc.

1.2 Different Types of Casting and the Casting Process

Although casting is one of the oldest known production techniques, modern advances in casting technology have brought about a vast array of specialized casting techniques. Hot forming techniques, which includes die-casting, investment casting, plaster casting, and sand casting, each provide their very own specific manufacturing blessings. Evaluating each the advantages and disadvantages of the commonplace types of casting tactics can help in deciding on the technique excellent appropriate for a given production run.

1.3 Sand Casting

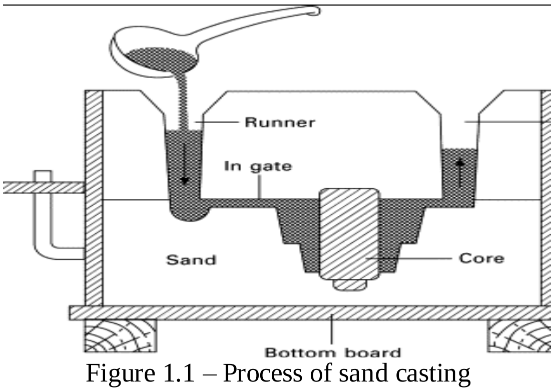

Figure 1.1 – Process of sand casting

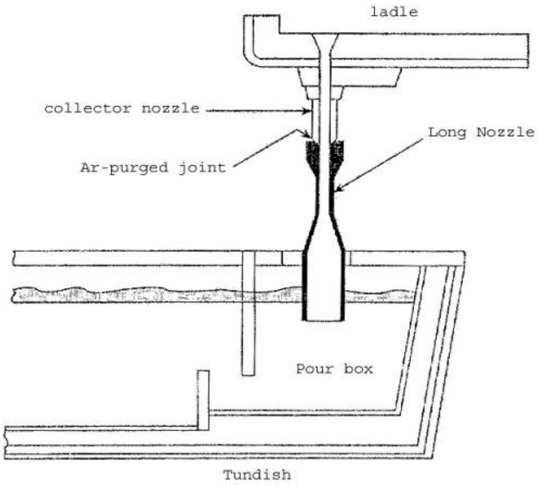

Figure 1.2 – Schematic of Tundish casting.

1.4 RESEARCH METHODOLOGY

1.4 Procedure adopted for numerical simulation of tundish casting of molten steel:

The procedure for solving the problem is

- Selection of upgraded research work.
- Survey of previous existing work.
- Identifying gaps in literature.
- Problem identification.
- Objectives for present research work.
- Selection of numerical simulation software.
- Analyzing results.

1.5 Dimensions of tundish casting model

Table 1.1 *Dimension of tundish casting.*

Parameters	**Value**
Tundish top width (mm)	1405
Tundish bottom width (mm)	857
Top length of tundish (mm)	6621
Bottom length of tundish (mm)	6073
Tundish nozzle diameter (mm)	90
Tundish height (mm)	1555
Insertion depth of long nozzle (mm)	250

1.5 CAD model of tundish casting:

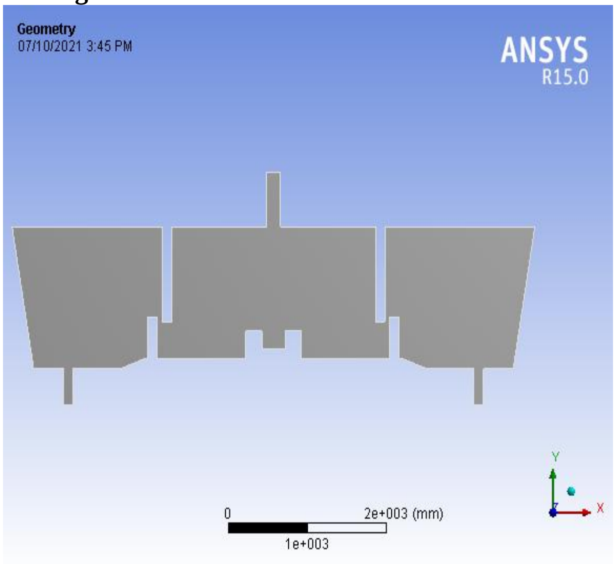

Figure 1.3 – CAD model of tundish casting for non – plasma heating.

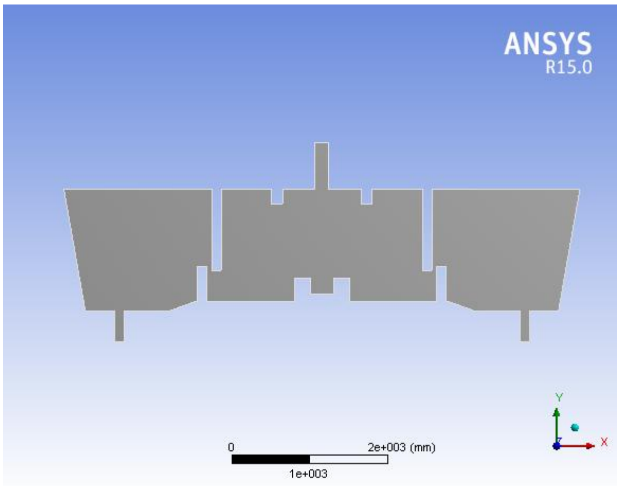

Figure 1.4 – CAD model of tundish casting for plasma heating.

1.6 RESULTS

Table 1.2 Validation results of temperature and velocity.

(Non - Plasma Heating)		
Time (s)	**Temperature/K (Non - Plasma Heating)**	**Velocity (m/s) (Non - Plasma Heating)**
50	1833.45	0.68
80	1832.78	0.66
100	1830.65	0.63
120	1825.69	0.61
150	1815.89	0.58
170	1795.32	0.54
200	1777.66	0.52

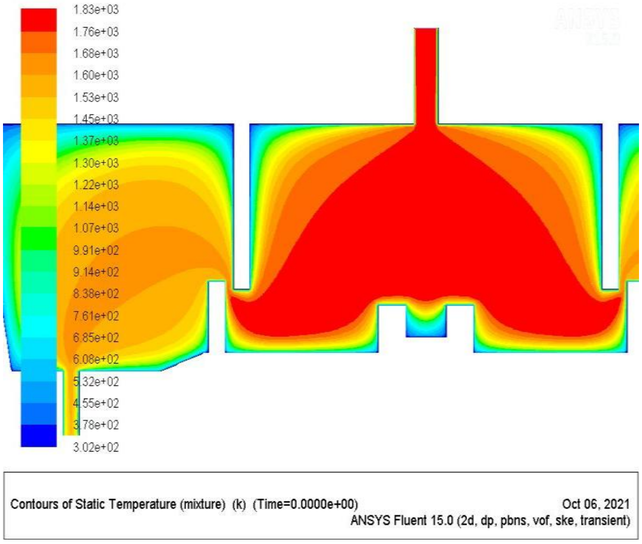

Figure 1.5 temperature distribution of molten steel w.r.t. time in tundish casting (Non – plasma heating).

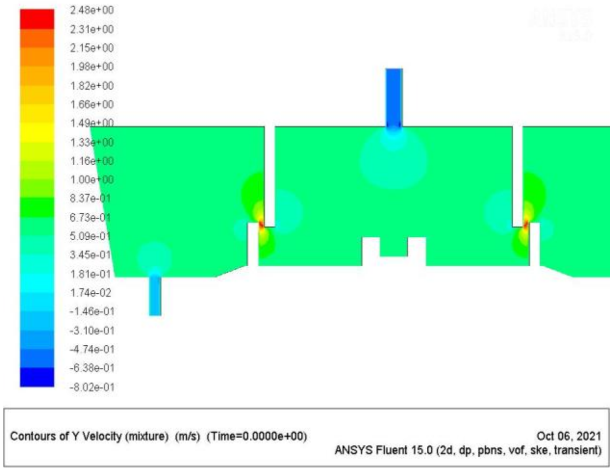

Figure 1.6 velocity distribution of molten steel w.r.t. time in tundish casting (Non – plasma heating).

Optimization result for different parameter adopted for tundish casting in heated and non – heated plasma.

Result for heated plasma of 300 KW in Tundish casting

Table 1.3 shows the values of temperature and velocity with different value of time.

Heating Power (300 KW)		
Time (s)	**Temperature/K (300 KW)**	**Velocity (m/s) (300 KW)**
50	**1840.69**	**0.70**
80	**1837.66**	**0.68**
100	**1834.88**	**0.67**
120	**1831.69**	**0.65**
150	**1826.88**	**0.62**
170	**1818.25**	**0.60**
200	**1805.64**	**0.57**

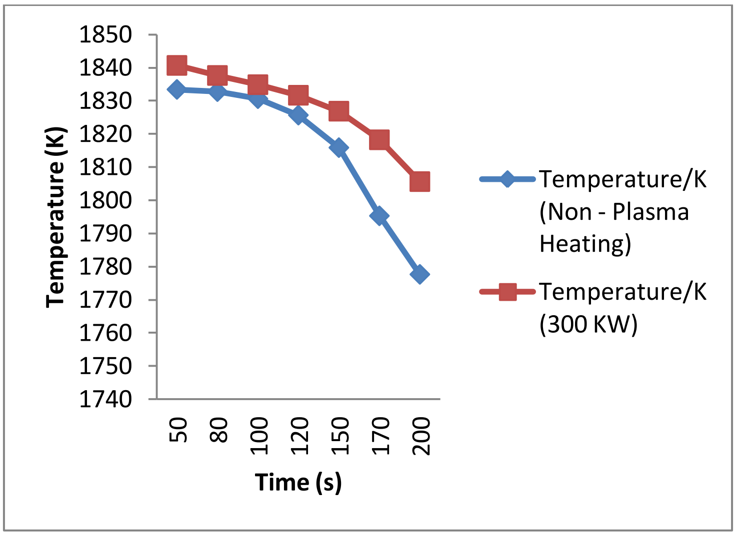

Figure 1.7 Comparison of temperature with respect to time with heating plasma of 300KW.

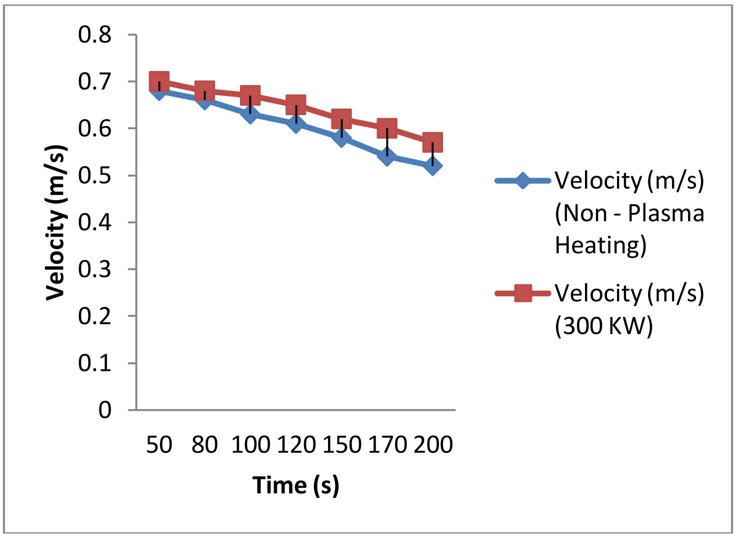

Figure 1.8 Comparison of velocity with respect to time with heating plasma of 300KW.

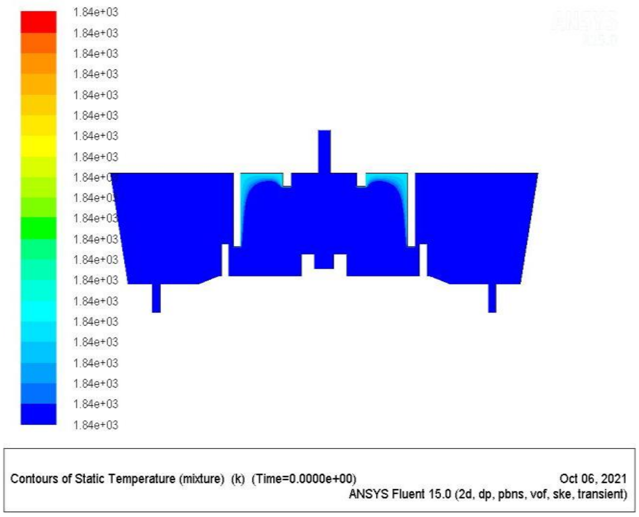

Figure 1.9 shows the values of temperature with 300KW of heating plasma in tundish casting.

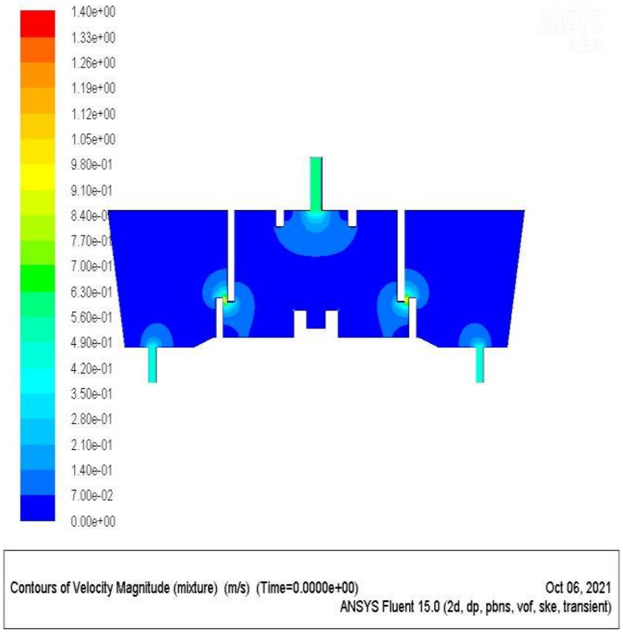

Figure 1.10 shows the values of velocity with 300KW of heating plasma in tundish casting.

Overall comparison of optimization results with validation for temperature and velocity with respect to time for heated and non – heated plasma in tundish casting:

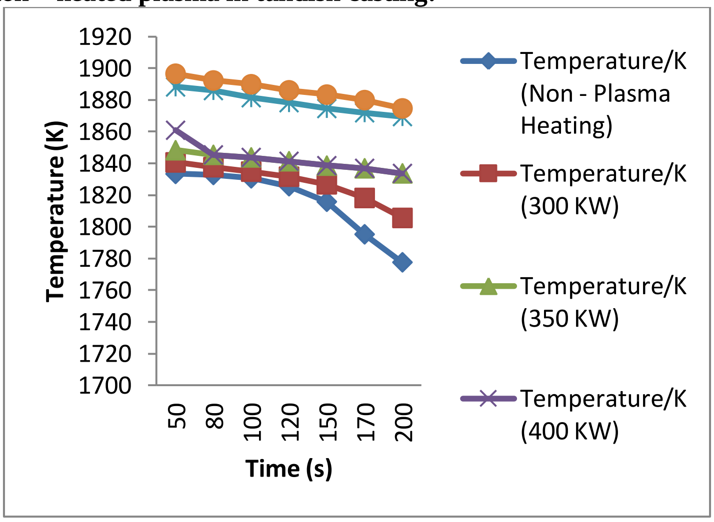

Figure 1.11 – overall comparison of temperature with respect to time in tundish casting

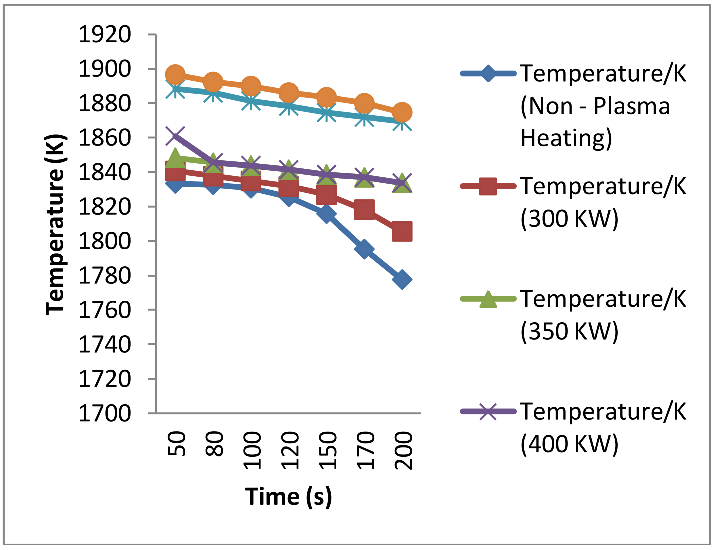

Figure 1.12 – overall comparison of velocity with respect to time in tundish casting

II. Conclusion

- Average deviation of result obtained from numerical simulation in tundish casting for base model the velocity and temperature distribution lies within the range, velocity is deviated by 1.63% for optimization model and temperature distribution is deviate 0.91% as compared to the base paper.
- Average deviation of results obtained for different heating plasma from tundish casting in temperature is deviated by 1.63 % i.e., temperature increases for 450 and 600 KW of heating plasma.
- The temperature range of 1841 to 1886 K of temperature in tundish casting exhibits optimized result for molten steel.
- the pouring time ranges between 180 to 120 s represents optimum molten steel settlement in tundish casting in all heating plasma values i.e. 300, 350, 400, 450 and 600 KW.
- This TAGUCHI analysis clearly indicates the optimum time and temperature for enhancement in tundish casting.

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