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Removal of ladle & saving the effective heat energy radiated in steel industry

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ABSTRACT

Tremendous heat energy waste in steel plant through ladle, but nobody think over this issue. A Heat Energy Solidification process are simulated for a continuous casting machine and the constructive shape of the liquid pool is predicted considering at different conditions. Heat energy and Solidification model is described for the C.C. of Steel Slabs. The Model has been established on the basis of the technical conditions of the slab caster in the C.C.

Keywords

Ladle, Heat energy, Steel, Industry.

Introduction

Tremendous heat energy waste in steel plant through ladle, but nobody think over this issue. A Heat Energy Solidification process are simulated for a continuous casting machine and the constructive shape of the liquid pool is predicted considering at different conditions. Heat energy and Solidification model is described for the C.C. of Steel Slabs. The Model has been established on the basis of the technical conditions of the slab caster in the C.C. unit of Bhilai Steel Plant, C.G. India. This model involves 3-dimentional transient energy equation. The governing equation was solved using control volume method and ansys simulation process. The boundary condition of the mold, water spray cooling and air cooling region have been defined. The mathematical model it is able to invent the shell thickness, temperature distribution in the mold and shell, interfacial gap between shell and mold.

Input data for experimental condition & Result:

 T_1 - Ambient Temperature, T_2 -air inlet blower, T_3 - Inlet of blow plate,

 $T_4\mathchar`-$ Center of blow plate, $T_5\mathchar`-$ Outlet of blow plate, $T_6\mathchar`-$ Outlet of duct Air flow rate (manometer) -10m/sec

Result:





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Date	Material		Melting Temp °c		Melting Time(min)		
03/04/2013	Lead		143°c		5 min. (7:07 to 7:12)		
Plate size	Turn	T ₁ °c	T ₂ °c	T ₃ °c	T ₄ °c	T ₅ °c	T ₆ °c
	1	34.4	35.2	3	31.6	33.5	32.9
	2	35.3	35.4	14.7	31.2	33.3	33.8
	3	35.8	35.9	27.1	32.7	33.9	34.8
	4	36.1	36.1	30.2	33.6	34.4	35
600mm*21mm*5mm	5	36.3	36.2	31.8	34.4	34.8	35.4
000mm*24mm*3mm	6	36.5	36.6	33.7	35.2	35.3	35.6
	7	36.9	37.2	35.2	36	35.7	36.2
	8	37.1	37.4	35.7	36.4	36	36.2
	9	37.1	37.2	36	36.5	36	36.3
	10	37.2	37.6	36.4	36.9	36.2	36.6
	11	37.3	37.6	36.7	37	36.3	36.5
	12	37.4	37.6	36.9	37.3	36.5	36.8
	Material						
Date	Mat	erial	Melting	Temp °c	Melti	ng Time	e(min)
Date 03/04/2013	Mat Le	erial ad	Melting 143	Temp °c 3 °c	Meltin 5 min.	ng Time (7:35 to	e(min) p 7:40)
Date 03/04/2013 Plate size	Mat Le Turn	erial ad T_1 °c	$\frac{\text{Melting}}{143}$	Temp °c 3 °c T ₃ °c	$\frac{\text{Meltin}}{5 \text{ min.}}$	ng Time (7:35 to T ₅ °c	$rac{min}{57:40}$ T ₆ °c
Date 03/04/2013 Plate size	Mat Le Turn 1	$ \begin{array}{c} \text{erial} \\ \text{ad} \\ \hline T_1^{\text{o}}c \\ \hline 35 \end{array} $	Melting 14. T2 °c 36.6	Temp °c 3 °c T3 °c 10	$\frac{\text{Meltin}}{5 \text{ min.}}$ $\frac{T_4 ^{\circ} \text{c}}{24.6}$	$\begin{array}{c} \text{ng Time} \\ (7:35 \text{ to} \\ \text{T}_5 ^{\circ}\text{c} \\ 30.7 \end{array}$	$rac{min}{7:40}$ T ₆ °c 33.5
Date 03/04/2013 Plate size	Mat Le Turn 1 2	$ \begin{array}{c} \text{erial} \\ \text{ad} \\ \hline T_1 ^{\circ}\text{c} \\ \hline 35 \\ \hline 35.7 \\ \end{array} $	Melting 143 T2 °c 36.6 36.6	Temp °c 3 °c T ₃ °c 10 15.3	Meltin 5 min. $T_4 °c$ 24.6 29.6	$\begin{array}{c} \text{ng Time} \\ (7:35 \text{ to} \\ T_5 ^{\circ}\text{c} \\ 30.7 \\ 32.1 \end{array}$	
Date 03/04/2013 Plate size	Mat Le Turn 1 2 3	$ erial xad T_1 °c 35 35.7 36.2 $	Melting 143 T2 °c 36.6 36.6 36.8	Temp °c 3°c T ₃ °c 10 15.3 21.4	$\begin{array}{c} \text{Meltin} \\ 5 \text{ min.} \\ T_4 ^{\circ}\text{c} \\ 24.6 \\ 29.6 \\ 30.8 \end{array}$	ng Time $(7:35 \text{ to})$ T_5 °c 30.7 32.1 32.7	
Date 03/04/2013 Plate size	Mat Le Turn 1 2 3 4	erial rad T ₁ °c 35 35.7 36.2 36.4	Melting 143 T2 °c 36.6 36.6 36.8 36.7	Temp °c 3°c T ₃ °c 10 15.3 21.4 25	Meltin 5 min. T ₄ °c 24.6 29.6 30.8 29.6	$\begin{array}{c} \textbf{ng Time} \\ (7:35 to \\ \hline T_5 ^{\circ}\text{c} \\ \hline 30.7 \\ \hline 32.1 \\ \hline 32.7 \\ \hline 34.6 \end{array}$	$\begin{array}{c} e(\min) \\ \hline p \ 7:40) \\ \hline T_6 \ ^{\circ}c \\ \hline 33.5 \\ \hline 34.3 \\ \hline 34.5 \\ \hline 35.5 \end{array}$
Date 03/04/2013 Plate size	Mat Le Turn 1 2 3 4 5	erial $T_1 °c$ 35 35.7 36.2 36.4 37.1	Melting 14; T2°c 36.6 36.8 36.7 37.4	Temp °c 3°c T3 °c 10 15.3 21.4 25 31.7	$\begin{tabular}{ c c c c c c c } \hline Meltin \\ 5 min. \\ \hline T_4 ^{\circ} c \\ 24.6 \\ 29.6 \\ 30.8 \\ 29.6 \\ 34.6 \end{tabular}$	$\begin{array}{c} \textbf{ng Time} \\ (7:35 tc) \\ \hline T_5 \ ^{\circ}c \\ 30.7 \\ 32.1 \\ 32.7 \\ 34.6 \\ 35 \end{array}$	$\begin{array}{c} \textbf{e(min)} \\ \hline 0.7:40) \\ \hline T_6 ^{\circ}\text{c} \\ \hline 33.5 \\ \hline 34.3 \\ \hline 34.5 \\ \hline 35.5 \\ \hline 35.7 \\ \end{array}$
Date 03/04/2013 Plate size 600mm*24mm*5mm	Mat Le Turn 1 2 3 4 5 6	erial $T_1 °c$ 35 35.7 36.2 36.4 37.1 37.2	Melting 14: T2 °c 36.6 36.6 36.7 37.4 36.7	Temp °c 3°c T3 °c 10 15.3 21.4 25 31.7 32.1	Meltin 5 min. T_4 °c 24.6 29.6 30.8 29.6 34.6 35.2	$\begin{array}{c} \textbf{ng Time} \\ \hline (7:35 tc) \\ \hline T_5 ^{\circ}c \\ \hline 30.7 \\ \hline 32.1 \\ \hline 32.7 \\ \hline 34.6 \\ \hline 35 \\ \hline 35.2 \\ \end{array}$	$\begin{array}{c} \textbf{e(min)} \\ \hline 7:40) \\ \hline T_6 ^{\circ}\text{c} \\ \hline 33.5 \\ \hline 34.3 \\ \hline 34.5 \\ \hline 35.5 \\ \hline 35.7 \\ \hline 35.9 \\ \end{array}$
Date 03/04/2013 Plate size 600mm*24mm*5mm	Mat Le Turn 1 2 3 4 5 6 7	erial T ₁ °c 35 35.7 36.2 36.4 37.1 37.2 37.3	Melting 14: T2 °c 36.6 36.6 36.7 37.4 36.7 37.5	Temp °c 3°c T3 °c 10 15.3 21.4 25 31.7 32.1 33.8	$\begin{array}{c} \text{Meltin} \\ 5 \text{ min.} \\ T_4 ^\circ \text{c} \\ 24.6 \\ 29.6 \\ 30.8 \\ 29.6 \\ 34.6 \\ 35.2 \\ 35.4 \end{array}$	$\begin{array}{c} \textbf{ng Time} \\ \hline \textbf{(7:35 tc} \\ \hline \textbf{T}_5 ^\circ \textbf{c} \\ \hline \textbf{30.7} \\ \hline \textbf{32.1} \\ \hline \textbf{32.7} \\ \hline \textbf{34.6} \\ \hline \textbf{35} \\ \hline \textbf{35.2} \\ \hline \textbf{35.1} \\ \end{array}$	$\begin{array}{c} \textbf{e(min)} \\ \hline 7:40) \\ \hline T_6 ^\circ \textbf{c} \\ \hline 33.5 \\ \hline 34.3 \\ \hline 34.5 \\ \hline 35.5 \\ \hline 35.7 \\ \hline 35.9 \\ \hline 36.2 \\ \end{array}$
Date 03/04/2013 Plate size 600mm*24mm*5mm	Mat Le Turn 1 2 3 4 5 6 7 8	erial ad T ₁ °c 35 35.7 36.2 36.4 37.1 37.2 37.3 37.5	Melting 14: T2 °c 36.6 36.8 36.7 37.4 36.7 37.5 37.9	Temp °c 3°c T3 °c 10 15.3 21.4 25 31.7 32.1 33.8 34.7	Meltin 5 min. T ₄ °c 24.6 29.6 30.8 29.6 34.6 35.2 35.4 35.9	$\begin{array}{c} \textbf{ng Time} \\ \textbf{(7:35 tc} \\ \textbf{T}_5 ^{\circ}\textbf{c} \\ \textbf{30.7} \\ \textbf{32.1} \\ \textbf{32.7} \\ \textbf{34.6} \\ \textbf{35} \\ \textbf{35.2} \\ \textbf{35.1} \\ \textbf{35.4} \end{array}$	e(min) 5 7:40) T ₆ °c 33.5 34.3 34.5 35.5 35.7 35.9 36.2 36.4
Date 03/04/2013 Plate size 600mm*24mm*5mm	Mat Le Turn 1 2 3 4 5 6 7 8 8 9	ad T ₁ °c 35 35.7 36.2 36.4 37.1 37.2 37.3 37.5 37.6	Melting 14: T2°c 36.6 36.8 36.7 37.4 36.7 37.5 37.9	Temp °c 3°c T3 °c 10 15.3 21.4 25 31.7 32.1 33.8 34.7 35.2	$\begin{array}{c} \textbf{Meltin}\\ 5 \text{ min.}\\ \overline{T_4}^{\text{o}}\text{c}\\ 24.6\\ 29.6\\ 30.8\\ 29.6\\ 34.6\\ 35.2\\ 35.4\\ 35.9\\ 36.2\\ \end{array}$	$\begin{array}{c} \textbf{ng Time} \\ \textbf{(7:35 tc} \\ \textbf{(7:35 tc} \\ \textbf{30.7} \\ \textbf{32.1} \\ \textbf{32.7} \\ \textbf{34.6} \\ \textbf{35} \\ \textbf{35.2} \\ \textbf{35.1} \\ \textbf{35.4} \\ \textbf{35.6} \\ \end{array}$	$\begin{array}{c} e(min) \\ \hline 7:40) \\ \hline T_6 ^\circ c \\ \hline 33.5 \\ \hline 34.3 \\ \hline 34.5 \\ \hline 35.5 \\ \hline 35.7 \\ \hline 35.9 \\ \hline 36.2 \\ \hline 36.4 \\ \hline 36.6 \\ \end{array}$
Date 03/04/2013 Plate size 600mm*24mm*5mm	Mat Le Turn 1 2 3 4 5 6 7 8 9 10	erial ad T ₁ °c 35 35.7 36.2 36.4 37.1 37.2 37.3 37.5 37.6 37.8	Melting 14: T2°c 36.6 36.8 36.7 37.4 36.7 37.5 37.9 37.9 38.1	Temp °c 3°c T_3 °c 10 15.3 21.4 25 31.7 32.1 33.8 34.7 35.2 35.6	$\begin{array}{c} \textbf{Meltin}\\ 5 \text{ min.}\\ T_4^{\text{o}}\text{c}\\ 24.6\\ 29.6\\ 30.8\\ 29.6\\ 34.6\\ 35.2\\ 35.4\\ 35.9\\ 36.2\\ 36.6\\ \end{array}$	$\begin{array}{c} \textbf{ng Time} \\ \textbf{(7:35 tc} \\ \textbf{(7:35 tc} \\ \textbf{30.7} \\ \textbf{32.1} \\ \textbf{32.7} \\ \textbf{34.6} \\ \textbf{35} \\ \textbf{35.2} \\ \textbf{35.1} \\ \textbf{35.4} \\ \textbf{35.6} \\ \textbf{35.4} \\ \textbf{35.4} \end{array}$	$\begin{array}{c} e(min) \\ \hline 7:40) \\ \hline T_6 ^\circ c \\ \hline 33.5 \\ \hline 34.3 \\ \hline 34.5 \\ \hline 35.5 \\ \hline 35.7 \\ \hline 35.9 \\ \hline 36.2 \\ \hline 36.4 \\ \hline 36.6 \\ \hline 36.8 \\ \end{array}$
Date 03/04/2013 Plate size 600mm*24mm*5mm	Mat Le Turn 1 2 3 4 5 6 7 8 9 10 11	erial ad T ₁ °c 35 35.7 36.2 36.4 37.1 37.2 37.3 37.5 37.6 37.8 37.8	Melting 14: T2°c 36.6 36.7 37.4 36.7 37.5 37.9 37.9 38.1 38.2	Temp °c 3°c T3 °c 10 15.3 21.4 25 31.7 32.1 33.8 34.7 35.2 35.6 36	Meltin 5 min. $T_4^{\circ}c$ 24.6 29.6 30.8 29.6 34.6 35.2 35.4 35.9 36.2 36.6 36.8	$\begin{array}{c} \textbf{ng Time} \\ \textbf{(7:35 tc} \\ \textbf{(7:35 tc} \\ \textbf{30.7} \\ \textbf{32.1} \\ \textbf{32.7} \\ \textbf{34.6} \\ \textbf{35} \\ \textbf{35.2} \\ \textbf{35.1} \\ \textbf{35.4} \\ \textbf{35.6} \\ \textbf{35.4} \\ \textbf{36} \\ \end{array}$	$\begin{array}{c} e(min) \\ \hline 7:40) \\ \hline T_6 ^\circ c \\ \hline 33.5 \\ \hline 34.3 \\ \hline 34.5 \\ \hline 35.5 \\ \hline 35.5 \\ \hline 35.7 \\ \hline 35.9 \\ \hline 36.2 \\ \hline 36.4 \\ \hline 36.6 \\ \hline 36.8 \\ \hline 36.8 \\ \hline 36.9 \\ \end{array}$

Date	Material		Melting Temp °c		Melting Time(min)		
03/04/2013	Lead		143°c		5 min. (8:10 to 8:15)		
Plate size	Turn	T ₁ °c	T ₂ °c	T ₃ °c	T ₄ °c	T ₅ °c	T ₆ °c
600mm*24mm*5mm	1	35.2	37.1	13	29.9	33	32.7
	2	36.3	37.1	12	29.3	32	33.2
	3	36.6	37	0.4	29.5	28.9	33.9
	4	36.8	37	12.4	30.2	32.3	34
	5	36.9	37.2	21.2	30.7	32.4	34.6
	6	37.3	37.7	23.5	26.6	33.3	35.3
	7	37.8	37.9	29.2	32.9	33.9	37.8
	8	38.0	37.7	28.3	33.6	34.4	33.6
	9	38.0	37.5	30.6	31.6	36.7	35.6
	10	37.9	37.6	31.8	28.1	34.9	35.6
	11	37.8	37.6	32	34.9	36.1	35.8
	12	37.9	37.7	35.4	35.3	35.4	36.8



Calculations :

Therefore for calculation purpose need only dry coal. For April 2002 month dry coal consumption $m_f = 280316 \times 10^3/30$ days = 389327.78kg/h

Therefore input heat energy supplied Q $= m_f x CV$ = 389327.78 kg/h x 30400kj/kg Q Q(i/p)= 3287656.8 kj/sec or kw Adding output $=\!Q_{conduction}+Q_{radiation}\!+Q_{convection}$

QTotal_(o/p) 3114856.2 = Efficiency of Steel Plant =Output/input=0.9474 (or) 94.7439% %age error =(Input – Output) x 100/Output = 5.5476262%

Conclusion: In Energy Loss -

- * Coal saving.
- * Removal of ladle.
- * Near about steel available in half cost.
- * Alternative source of heat energy through steel plant.
- * It's directly help to construction industry
- * The cost of building almost less 33 %

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