ISSN (Online) 2456-1290
International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 2, Issue 3, March 2017

Development of Mathematical Model to Heat Radiated in Steel Plant

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***Abstract:*— In this research work mathematical model of countinious casting process has been developed. The mathematical carries the process of conduction , convection, radiation. The molten metal while flowing through the contineous casting process looses heat due to conduction, convection and radiation and changes phase and solidifications occures.The water spray is used for cooling and air cooling occures at different zones. The boundary condition are also taken in to account. The mathematical equation are analysed by using ANSYS Software using some input data and considering various cooling zone.**

I. INTRODUCTION

It was found that during convection gradient is maximum at the top of plate and minimum at front of plate. In case of radiation the maximum gradient is at curvature is minimum gradient in portion of plate. When the result is taken forslab-1,2 there is the temperature level at different zone have been analysed and it was found that the temperature gradient minimum is reduced and maximum is increased. The result are also obtained for slab-3 and slab -4.The same analysis carried out on bloom of various sizes to calculate the temperature at various zone and temperature gradient for two varrity of bloom. Similar results obtained for billets.

1.1 Objectives :

- 1] Heat energy collect from countinious casting process. The components are plate, bloom, billets, ingot , wire.
- 2] Heat energy collected from furnace & exhust gas pipe.
- 3] Genrate electrical power.

II : LITRATURE OF REVIEW :

2.1: Litrature survey :

During the research work various research paper were collected to analysis the research work done in this area. There are 50 significant papers on various areas of contineous casting system, energy analysis , temperature analysis, cooling analysis and heat transfer analysis has been carried. The various technology used in India are analise in the liturature study.

Seven times heat energy loss in curvature of cotineous casting.

2.2 Industrial Survey :

a. During the case study it was found that the heat loss ocure at

1) Laddle transport of molten metal
2) Ingot transport in contineous casting
3) In continuous casting plant furnace, flow solidified material , heat energy loss
4) heat loss in merchant mill where channel, angle produced.

b . In this research work case study was conducted in four industries

1) Bhilai steel plant , Bhilai (C.G)
2) Neco Jaiswal Industry , MIDC Nagpur (M.S)
3) Ferow Alloy Corporation , MIDC Nagpur (MS)
4) Sunflag iIndustry, Bhandara (MS) It was found,

The Bhilai steel plant case study was conducted for manufacturing of slab, bloom, billet,
wire, ingot, channels angle.

The data is collected from Bhilai steel plant on real operations and from the data book. The input data regarding the heat generation due to coal combustion was collected.

The case study was conducted Neco Jaiswal Nagpur were electric furnace is used to melt a metal.The temperature measurement using sensor was found to be in the range of 1552 °C -1670 °C

The case study at FACOR Nagpur also shows that similar process being used like Bhilai steel plant and same contineous casting process was observed in Sunflag industry.

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III. THEORY :

The results of CAD simulation are calculated at various zone using ANSYS Software. The heat conducted, convected, radiated is estimated during the simulation. The results for slab-1 of size 100mmx 200mmx1500mm.

The temperature gradient with respect to displacement in X-direction was found to 0.378 during conduction and temperature range of the slab is 37- 1546 degree Calsious the minimum flux at curvature portion occures.

IV. METHODOLOGY :

A small experimental investagation was carried out by developing the experemental setup by designing the setup using CAD software. In which Lead- tin material is used as a molten metal which is heated in the furnace and allowed to flow from a slab. In this experemental investigation heat analysed and temperature analysis was carried out by CAD modeling and experemental setup on a very small plate size.

V. MATHEMATICAL MODEL :

Part-A] Calculations for heat energy collection from slab, bloom, billets, wire & ingot through continuous casting. The collection of heat energy in mega-watt.

Specification: - Table-1 ,
T: Temp, L: Lenght,W : Width, T : Thickness, D: Diameter, A : Area

Shape	T m	W m	L m	D m	T	A m^2
Slab						
M1	0.200	1.5	-	-	45	
M2	0.320	1.5	-	-	45	5.626
M3	0.250	1.5	-	-	45	
M4	0.200	1.3	-	-	45	
Bloom						
1	0.310	0.34	-	-	45	
2	0.320	0.32	-	-	45	
3	0.280	0.28	-	-	45	2.267
4	0.265	0.34	-	-	45	
5	0.260	0.30	-	-	45	
Billet						
1	0.090	0.090	-	-	45	
2	0.100	0.100	-	-	45	
3	0.110	0.110	-	-	45	0.466
4	0.150	0.150	-	-	45	
5	0.105	0.105	-	-	45	
6	0.128	0.128	-	-	45	
Wire						
1	-	-	-	0.00055	45	0.00235
2	-	-	-	0.006	45	
3	-	-	-	0.007	45	
4	-	-	-	0.008	45	
5	-	-	-	0.01	45	
6	-	-	-	0.012	45	
Ingot						
1	0.060	0.060	0.5000	-	45	0.0018

Properties of steel at cabon 1% :-
Table- 2
Thermal conductivity, k , w/m c, Heat transfer coefficient, h, Emissivity, E, Avogadro Number,6 w/ m2 c

k	h,	E	6
43	12, when velocity of air=2m/s	0.26	5.669 *10

Calculations for conduction, convection & radiation: -
Table- 3
Considering values from table 1 & 2 in MW

A, m^2	Cond.	Conv.	Rad.
	$Q=KA(T_1-T_2)$	$Q=hA(T_1-T_2)$	$Q=E$ $_4$ $_4$ $_2)$
Area- 1	0.363	0.101	0.47
Area- 2	0.145	0.0407	0.19
Area-3	0.030	0.0083	0.03
Area-4	0.000151	0.00004	0.00019
Area-5	0.000116	0.00032	0.00015
Total heat from conduction, convection, radiation in MW	0.538	0.150	0.69
Adding above heat in MW	**1.38**		

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Formulations for solving part B &C
Area of furnace = 3.14*diameter* length
Volume of furnace = 3.14/4 * D2 * L
Heat from furnace or exhaust gases= UA dT
U(Universal h. t. coeff.) = 1/[(1/hi)+ AI ln (ri/ro)/2*3.148KL + (AI/AO)/ (1/ho)]
Part-B] Calculations for heat energy collection from Furnaces 1 to 7. The collection of heat energy in mega-watt. Velocity of air in furnace 50m/sec. at room temp 45 degree Celsius.

Therm	Average temp. of blast furnaces in degree Celsius						
al & body parameter of furnaces	1033 cu. m furnace			1033 cu. m furnace			1033 cu.m furnace
	1	2	3	4	5	6	7
T, Temp. in degree Celsius	850	Value not given in bsp data book	Value not given in bsp data book	942	940	1074	947
L, length, m	15	-	-	15	15	15	15
D, diameter of furnace, m	9.36	-	-	12	12	12	13
A, area, m^2	440	-	-	565			

h_i, Internal heat transfer coefficient	3010	-	-	3010	3010	3010	3010
h_o, outer heat transfer coefficient	180	-	-	180	180	180	180
n, internal radius of furnace, m	4.68	-	-	6	6	6	6.5
r_o, internal radius of furnace, m	4.73	-	-	6.5	6.5	6.5	7
Air sending Jacket gap, m	0.10	-	-	0.10	0.10	0.10	0.10
K, thermal conduc	43	--	-	43	43	43	43

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tivity							
U, universal heat transfer coefficient, w/m² c	147.05	-	-	59.5	59.5	59.5	64.5
Ao, area of outer to furnace	44556	-	-	569	569	569	612
Ai, area of outer to furnace	440.85	-	-	565	565	565	659
V, velocity of air, m/sec	50	-	-	50	50	50	50
Q, Heat, MW	52.088	-	-	31.6	31.6	31.6	35.6

Total heat, MW=182.65

Part-C] Calculations for heat energy collection from Exhaust gases come out of Furnaces, 1 to 7. The collection of heat energy in mega-watt. Velocity of air in furnace 50 m /sec. at room temp 45 degree Celsius.

Specification: - **Table- 5**

Thermal & body parameter of furnaces	Average temp. of exhaust gases coming out of furnaces in degree Celsius							
	1	2	3	4	5	6	7	Overall Average temp
T, Temp. in degree Celsius	164	Value not given in bsp data book	Value not given in bsp data book	170	140	146	95	143
L, length of gas pipe, m	30	-	-	30	30	30	30	30
d, diameter of gas pipe, m	1	-	-	1	1	1	1	1
Room te	45	-	-	45	45	45	45	45

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ISSN (Online) 2456-1290
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Vol 2, Issue 3, March 2017

mp, in degree celciu s U,								
universal heat transfer coefficient, w/m² c V,	40	-	-	40	40	40	40	40
velocity of air, m/sec Q,	50	-	-	50	50	50	50	50
Heat, MW	0.369	-	-	0.369	0.369	0.369	0.369	0.369

Total, Q, Heat, MW =1.845

6 : Outcome: The heat energy is utilised for electricity genration to fulfill human need.

7 :Conclusion & Discussion : A small experimental investagation was carried out by developing the experemental setup by designing the setup using CAD software. In which Lead-tin material is used as a molten metal which is heated in the furnace and allowed to flow from a slab. In this experemental investigation heat analysed and temperature analysis was carried out by CAD modeling and experemental setup on a very small plate size.

The SWOT analysis was carried out to understand the strength and weakness of steel plant and various threat and opportunities are opened . The losses of energy are analysed for the steel

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