Generalized Data Base Model for Heat Energy Radiated in Rolling Mill

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Abstract: *In the rolling mill large amount of energy waste and now a day everywhere energy crises go on. Such wastage energy no- one take the care about it. In mushy zone a huge amount of specific heat energy loss. Thermal conductivity goes on vary at different level according to heat energy assumption. The exhaustive literature survey was carried out on the radiated heat energy in industry. The literature survey revealed that enough work has not been carried out on the above title, hence this work is carried out. An experimental approach is proposed to estimate the heat energy radiated in rolling mill. Also how to collect heat energy from horizontal duct process*

Keywords: *Rolling MIll, Heat, Energy loss, Continius Casting, Modelling.*

1. Introduction:

Fig shows the different regions of the C.C. A typical method of modeling the strand thermal condition shown in fig. the mathematical model is applied to slices of strand that start at the meniscus and travel through the machine at the casting steel. The new slices are generated periodically. A sufficient number of slices exist in each condition zone to give an accurate representation of the thermal condition in each zone.

Fig. 1 CONTINUES CASTING PROCESSES (DHANDE ET AL)

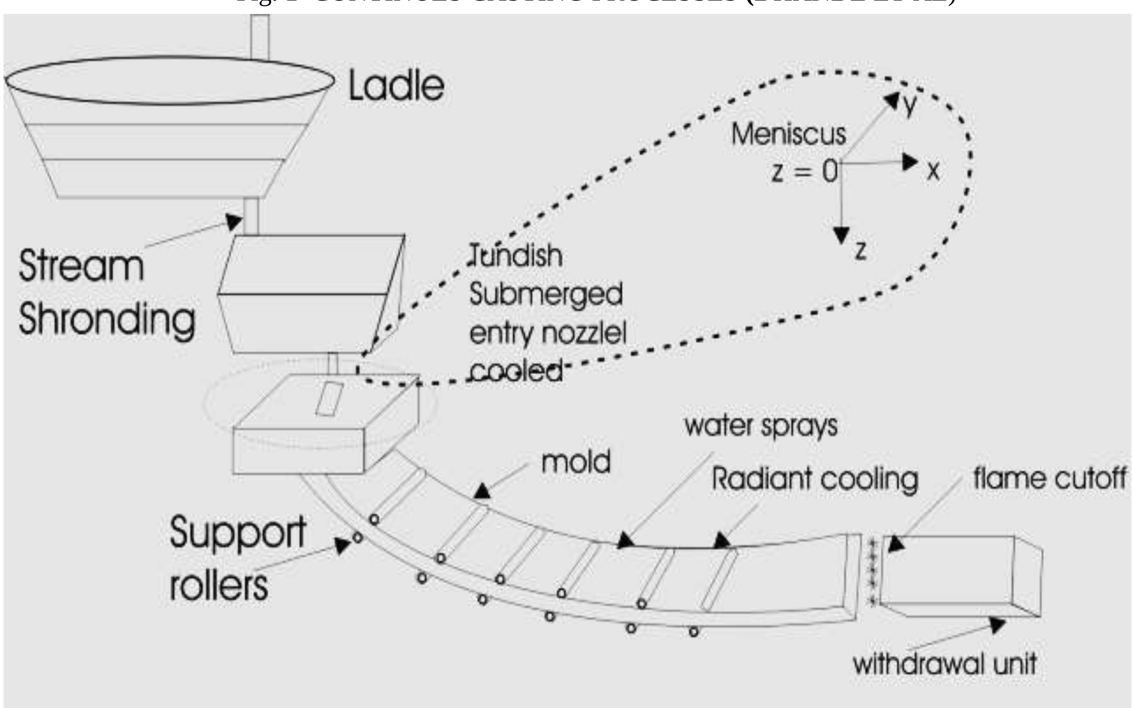


Fig. 3D-Schematic representation of the C.C. Process

1.1 Objective -

- Fabrications and validation of the experimental set-up.
- To study the temperature loss over bloom plate.
- To validate the experimental results with ANSYS Simulation Software.

To study the effect of various parameters like different configurations such as circular, rectangular v-slot in horizontal duct.

1. Heat loss.
2. Heat input.

On the heat energy loss characteristics for different horizontal bloom Configurations.

- To develop a correlation in terms of Non dimensional numbers (Grash of number, Prandtl number) which is not available yet in order to find out the heat transfer coefficient, for each horizontal plate configuration. This will be useful in selecting the optimum dimensions for the purpose of designing the systems such as refrigerators, heat exchangers, nuclear reactor fuel element, dry cooling towers & cooling of electric & electronic equipment like computers, home ventilation etc.

1.2 Relevance:

- The proposed project is the very good as far as Heat transfer by Radiation is concern. As an academic interest it includes the application of the subject knowledge in university practical.
- The facilities created for the project can be used for the research degree programs, which our institute is aiming at to start in further future.

The laboratory that will be developed under this project will be a tool of more help to the students, faculty members and the practicing engineers to undertake the research in this thrust area.

1.3 Expected outcome:

The outcome of the project can be made available to extract heat energy from the optimum reduce the heat loss. Collected heat energy reutilize to the production electricity, which is helpful to run the extra equipment. Such work is not available in the literature review till. Nobody concentrate on this topic throughout the history therefore still scope remain. Hence this work is to need patented.

2. Literature survey on National &International scenario: After doing exhaustive literature survey in International and National journals it has been found enough work has not been carried out on this topic, hence this work is undertaken. (250 National and International Journal papers are reviewed).

2.1 Techno-Commercial status / Outcome / IPR / Social benefit /other: The proposed Project will be helpful to provide a cost-effective approach for production of electricity.

2.2 Technical Consultancy / Revenue generation: As the teaching to student purpose.

2.3 Time & activity chart: Table 1 shows the time management of experimental set up of Rolling Mill

Activity	Months												
	0	1	2	3	4	5	6	7	8	9	10	11	12
Design and Fabrication of Experimental setup													
Experimentation & Analysis of data													
CFD Analysis (Validation)													

Report writing													
Patent filling													

Table: 1 time management of experimental set up of Rolling Mill [Dhande et al]

2.4 Facilities / equipment available in the area of research proposed:

Name of equipment	Make and model	Cost in Rs.	Year purchased
Fabrications of heat energy radiated	Workshop, Nagpur	12,50,000/-	2019-20

Table: 2 Facilities / equipment available for experimental set up of Rolling Mill

Budget Estimates – Non Recurring:

Proposed equipment/s	Specifications	No of units	Cost in Rs.	Justification
Experimental test rig with rectangular size horizontal duct, with different configurations, Heating coils, Voltmeter, Ammeter, Digital temperature indicator, framework, thermocouples for each configurations etc. (including manufacturing cost)	As per design	1no. each	4,25,000/-	As per material and quality
Data Acquisition system	As per design	1	2,00,000/-	As per material and quality
CFD(Computational Fluid Dynamics) Simulation software	As per design	1	6,25,000/-	As per material and quality
Total(NR)			NR 12,50,000/-	

Table: 3 Budget Estimates – Non Recurring for experimental set up of Rolling Mill

2.5 Budget Estimates –Recurring:

	Estimate for Year 1	Estimate for Year 2	Estimate for Year 3
AMC/Service charges	Nil (warranty period)		
Consumables & Contingencies		35,000	35,000
Other		30,000	30,000
Total		Rs 65,000/-	Rs 65,000/-

Table :4 Budget Estimates – Recurring for experimental set up of Rolling Mill

3. Research Methodology:

Independent parameter: Heat energy variation, area of land, Shape of slab, Market demand, Customer satisfaction, Manpower variation.

Dependent variable: Environmental factor, Heat radiation.

3.1 Mathematical Model:
Production rate in a day = Capacity of machine + Manpower utilizing & other factors

Formulation: For finding the output of industry [17]

$Y = K [A^{a} \text{ x } B^{b} \text{ x } C^{c} \text{ x } D^{d} \text{ x } E^{e} \text{ x } F^{f} \text{ x } G^{g} \text{ x } H^{h} \text{ x } I^{i} \text{ x } J^{j}]$---------------------------equ.[1]
Taking log both sides
log□ □ Y=log□ □ K [a log□ □A x b log□ □B x c log□ □ C x dlog□ □D x e log□ □ E x f log□ F x g□
log□ □ G x h log□ □ H x i log□ □I x jlog□ □ J---equ.[2]
Y (Output of Production)
K= Propornationality Constant
N = Name of Rolling mill

P□ = FACOR, HIngna MIDC, Nagpur, Maharashtra, India,
P□ = NECO MIDC, Hingna, Nagpur, Maharashtra, India,
P□ = Sunflag Steel, Bhandar, Maharashtra, India,
P□ = Bhilai Steel Plant, Bhilai, Chattisgarh, India
Wt. A + Wt. B + Wt. C + Wt. D + Wt. E + Wt. F + Wt. G + Wt. H+Wt. I+Wt. J = are respective raw material waightage w. r. t. plant owener assinged the qualitative quantitity.
Therefore: P□ + P□ + P□ + P□ =1
A, B, C, D, E, F, G, H, I, J = Are the variables of plant need. Like processing material, Electricity, Manpower, Finance, Water, Transportation Facility, Land, Machinary, Maintenance system.
a,b,c,d,e,f,g,h,i,j are respective indices of plant need.
In table 1 shows the constant & Movable variables with classification.

Solvent Extraction Plant Model					
S. N.	**Constant Variables**	**Movable Variables**		**Classification of Movable Variables**	
Variables:1	Oprator[A]	Education	A_1	Technical	Non- Technical
		Age	A_2	20-30	30-58
		Place	A_3	Native	Transferable
		Wages	A_4	High	Medium
		Experience	A_5	Higher	Lower
		Maintality	A_6	Sound	Normal
		Family Background	A_7	Industrial Oriented	Non- industrial
		Intellectual Capability	A_8	High	LOw
		Add-on Program attd.	A_9	High Number	Low Number
		Software awareness	A_{10}	Modern software	Normal software
		Vehical using	A_{11}	Own	Industrial vehical
		Higher study deserving	A_{12}	Part time	Study leave
		Categories of operator	A_{13}	Permanant	Contract
		Working Capability	A_{14}	Hardcore	Software

		Operator Availability	A_{15}	Mass Quantity	Limited
Variables:2	Location [B]	Hill area	B_1	High hill	Lower hill
		Distance from city	B_2	Nearby	Not possible to operator up-down
		Quality of Land	B_3	Dry	Stone oriented
		Facility	B_4	Gardening	Robust area
		Water facility	B_5	Amples	Only working
		Land ownership	B_6	lease	owen purchased
Variables:3	Transport [C]	Raw material& final goods	C_1	Road	Rail
		By Trucks	C_2	Logistic	Daily/ Weekly/ Monthaly
Variables:4	Working Environment [D]	Ergonomics	D_1	Light system	Colour light system
		Seating arrangement	D_2	Suitable m/c operating oriented chair	Abedent
		Air system	D_3	Air conditioning	Naormal
		Suitable to body	D_4	Healthy	Tidious
Variable:5	Electrification [E]	Power Consumption	E_1	Heavy	Normal
		Current Flowing Capability	E_2	A/C	D/C
Variable:6	Finance [F]	Money Mode	F_1	Bank	Own Finance
		From Market Collection	F_2	Share	Bond
Variable: 7	Machine [G]	Rolling M/c Set up	G_1	Automatic	Semi-automatic
		M/C Orientation	G_2	Traditional	Unconventional
Variable:8	Innovation[H]	Place of invention	H_1	Institute Invention	Industrail Invention
		Invention	H_2	Industry Incubation	Business Incubation
		Idea	H_3	New idea	Research Idea
		Enhancement Level	H_4	Corporation level	Institute level
		Opinion invention	H_5	Interactive invention	Experimental invention

		Categories of invention	H_6	Number of idea	Complete Invention
Variable:9	Marketing [I]	Spread in Market	I_1	Order base	Door to Door
			I	Mass Quantity	Retailor
			I	Digital	Communication
Variable:10	Feedback [J]	Inventional Product	J	Individual	Group
			J	Product Improved	Product Rejected
			J	Product Limited Demand	Product Heavy Demand

Table:5 Constant & Movable variables of solvent extraction plant Dhande at al 2019 a & b]

Following equ. put in equ. [i] to [x] put in equ.[1]

$A=A_1^a, A_2^a, A_3^a, A_4^a, A_5^a, A_6^a, A_7^a, A_8^a, A_9^a, A_{10}^a, A_{11}^a, A_{12}^a, A_{13}^a, A_{14}^a, A_{15}^a$ -------------equ.[i]

$B=B_1^b, B_2^b, B_3^b, B_4^b, B_5^b, B_6^b$---equ.[ii]

$C=C_1^c, C_2^c$---equ.[iii]

$D=D_1^d, D_2^d, D_3^d, D_4^d$---equ.[iv]

$E=E_1^e, E_2^e$--equ.[v]

$F=F_1^f, F_2^f$--equ.[vi]

$G=G_1^g, G_2^g$--equ.[vii]

$H=H_1^h, H_2^h, H_3^h, H_4^h, H_5^h, H_6^h$--equ.[viii]

$I=I_1^i, I_2^i, I_3^i$---equ.[ix]

$J=J_1^j, J_2^j, J_3^j$---equ.[x]

$Y= K\ [(A_1^a, A_2^a, A_3^a, A_4^a, A_5^a, A_6^a, A_7^a, A_8^a, A_9^a, A_{10}^a, A_{11}^a, A_{12}^a, A_{13}^a, A_{14}^a, A_{15}^a) \mathbf{X} (B_1^b, B_2^b, B_3^b, B_4^b, B_5^b, B_6^b) \mathbf{X} (C_1^c, C_2^c) \mathbf{X} (D_1^d, D_2^d, D_3^d, D_4^d) \mathbf{X} (E_1^e, E_2^e) \mathbf{X} (F_1^f, F_2^f) \mathbf{X} (G_1^g, G_2^g) \mathbf{X} (H_1^h, H_2^h, H_3^h, H_4^h, H_5^h, H_6^h) \mathbf{X} (I_1^i, I_2^i, I_3^i) \mathbf{X} (J_1^j, J_2^j, J_3^j)] = 1$ ----------------------------equ.[3]

4. Simulation of Rolling Mill:

Why used Ansys: To find the graphical results.
Software Selection: Creo – parametric 2.0 and Ansys 11.0
Hardware:
I 5 processor
4 GB RAM
1 GB Graphic
1 TB HDD

Que. What the details of input raw material ?
Ans. Steel material
Que. What are the Products?
Ans. Slab, Bloom, Billet, Wire, Ingot.
Que. What are the properties of material while making the simulation?
Ans. Density, conductivity, thermal properties.

125Simulation

Processor for graphical modeling on simulation:-
Pro E- 2D, 3D model or Ansys direct
3D FEM – element part
Thermal load
Temperature insert
Heat loss estimate

5. Results for slab :-

5.1.) Results for Slab I: 200 x 1500 mm:-

a) Conduction
In slab size 200 x 1500 mm for conduction case the minimum flux generated i.e. at initial stage. Rest of the portion as shown in simulation (Fig). The stress generated with respect to area. In temperature gradient with respect to displacement in x direction, - 0.286872 & max 0.378015. At the bending portion or curvature portion low displacement & other portion continue. The temp case lower temp at initial & final of slab at 370C. The maximum temp generate at latter on initial & beginning of final near about 15460C . At curvature portion average of 10430C. For the thermal expansion total flux case in fig. shows vector diagram float from top to bottom. The minimum flux at curvature portion and gathers of flux vector at initial and final stage of slab.

b) Convection
In convection of temp more temp about 15460C at throughout plate,
less end 28.1840C.The total gradient case minimum through the plate but maximum at top of plate. Some average also generate shown by spot in fig. The total flux consideration of simulation minimum at 0.765 E-03 at front of the part of
126Simulationslab. Maximum at 153.932 at end stage again some expansion available on plate.

c) Radiation
The vectors in upward direction whereas in conduction in downward direction. The maximum at 0.34803J curvature portion. The minimum gradient 0.303657 at initial of plate rest of outward portion average way shown in fig. The flux in x-direction nodal solution is minimum 0.183 E-12 at curvature portion shown by dark spot fig. Maximum at 0.339 E-12 initial of plate. The radiation gradient in x-direction fig. the expansion maximum at again curvature portion & minimum at initial exactly opposite to flux in x-direction. In fig. the total flux shown by vector form more at initial 0.427 E-15 &shown by dot at end of plate & small amount of on in between of plate. The total gradient shown in fig. again dot way at end of plate & minimum at initial of plate.

6. DESIGN OF ENERGY SAVING SYSTEM

6.1 There are various energy saving methods being air fuel considering offer mixture. Knowing the losses occupying in the rolling mill or steel plant. The prevent of losses has become essential looking at current energy scenario and financial loss to plant. SWOT Analysis:-

STRENHTHS End use sales Controls & Direction Right Products. Quality and reliability.

WEAKNESSES Customer list not test Some gaps in range for certain sectors

OPPORTUNITIES Could development new products Local competitions have poor products

THREATS Legislation could impact Environmental effects would favor larger competitors

6.2 Losses of energy in practical case:-

(1) Transportation of ingot one shop to another shop by chair way.

(2) Transportation of tundish. (3) Transportation ladle. (4) Slag layer is wastage product over the molten metal. (5) Heat energy loss in continuous casting. (6) Molten metal float through land channel. (7) Heat energy radiate at pouring time.

6.3 The following methods are proposed in the design :-

6.3.1 Controlling Method

I) Air Fuel mixture: When the heated material flow through the cavity or over the roller that time heavy amount of heat energy loss, the air passes over for collecting heat i.e. air fuel ratio should be maintained.

II) Position of each stock item in the furnace: In side furnace how position to put product.

III) Direct fuel use reductions through optimization of combustion efficiency: Good quality of coal used for furnace. So less quantity of ash form.

X) Measure to save energy:-

(1) Thermocouple. (2) Thermometer for molten solution. (3) Arrangement of water duct over C.C. to radiated energy collects there. (4) Improvements and sharpness in chemical treatment for quality of coal. (5)Electrical energy case electrical energy meter check regularly. (6) Convert heated water to vapour & strike turbine for production of electrical energy, to generate. (7) Less slag generation so insert powder there. (8) Maintenance activity effectively workout. (9) Wattmeter use. (10) Recharge battery use.(11) Storage energy. (12) Developed the energy management system. (13) Collection of energy to install water pipe in through ash dumping.

6.3.2 Energy Saving System - 2:-

(Design of heat saving system for rolling process); In fig 3 shows experimentally arrangement. The heated molten metal poured through ladle in die cavity. The water get warm. The temp measures at different points. 143Design of Energy Saving System. The experimental type arrangement fabricated for different products such as cylindered rod, square & rectangular plates or other. Through this arrangement design of heat saving system for rolling process is justified. Energy consumption For calculating heat one experimental set up discuss here as a model which is diagrammatical shown below Fig. 6.3Experimental set up for heat energy radiated in steel plant

7. EXPERIMENTAL INVESTIGATION

7.1 Introduction:- The experimental investigation for carried out by fabrication of a small prototype model using Lead-Tin material.

7.2 CAD model :-First made CAD model in Creo parametric (2.0) software before the experimental set up fabrication. In CAD modeling assembly design sub part given did the work over. Again some Top down, medium down & bottom approaches are there. Out Top down approach is the best suitable for this model.

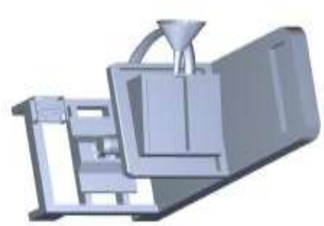


Fig.2 CAD model

7.3 Results of CAD model:-

Description

After making the 3D wire frame, 3D solid geometrical model and separate every parts with front view, top view & side view of CAD model, some Ansys result are collect in Hardware system which already specification given above the CAD model in this chapter.

Different results shows in colour. How to blow air over & generate the heating effect when plate is hot. Here used steel as a raw material.

7.4 Description of set up :-

After making CAD model the fabrication set up made with considering cad results. The fabrication made for collecting actual practical reading. Fig 10 shows the experimental set up. In this fig. shows Blower, pipe, electric heater, funnel, thermometer, flow meter air controller material flowing arrangement through the duct top & bottom portion. Temperature controller

Fig. 3 Experimental set up

8. PARAMETRIC ANALYSIS

8.1 (Part 1-CAD Modeling Results):-

Cad Modeling Ansyss

FEM Thermal Analysis

Product data

Determine Heat conduction, convention and radiation from slab, bloom, billet, wire, ingot, Furness and exhaust gas pipe

8.2 Calculation for Heat Loss in slab:-

Output heat energy required for solidification purpose, but at the same time loss of radiated heat energy collect & reutilizes to run the small steam power plant. Therefore For calculation purpose need of only dry coal.

For April 2002 month only coal consumption.
mf =280316 x 10 3 = 389327.78 kg/hour
30 days
Therefore I/P heat energy supplied
Q = mf x C.V.
Q = 389327.78kg/hour x 29836.104kj/kg
Q = 3226673.4 kj/sec

8.3 (Part II : Furnace Analysis)

s = Slip factor = 0.9
w = Work I/P factor = 1.04

=

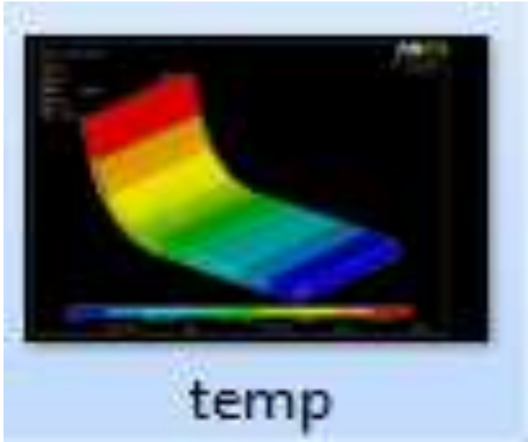
920.6 x 1.005 x 1000

1.04 x 0.9

Velocity of air = 994.2156 m/sec.
Cylindrical volume at N.E. = /4 xD 2 L
Exhaust gas = Co 2 , Co 3 , N 2 , H 2 , 0 2
Parallel flow heat Exchanger
Heat collected = 5,965, 622 kw
Heat Energy loss in compressor = 14.30 kw
Original Heat Collected =Heat A – Heat B
Original Heat Collected
= 5,965, 622 – 14.30 Kw
= 5,965,607.7 Kw

8.4 Simulation: Slab Result :-

8.4.1 Slab-1 Conduction Result (Node value given in Table 8.3)



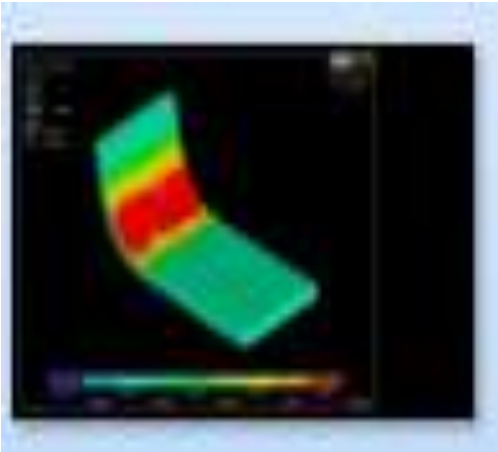


Fig. 4 Simulation: Slab Result

8.4.2 CAD Model of Tundish

Tundish : Tundish meas die, when casting of slab, bloom, billets produce by continuous casting method the particular shape die used is called tundish. The die (tundish) made of special raw material, for the strong casting material powered in tundish by ladle or pipe arrangement. There is a outlet given at bottom of tundish when the molten metal powered in tundish, the raw material itself take a particular size which flowt through outletof tundish as in the form of slab, or change the tundish size, get bloom or change the tundish size, get billet.

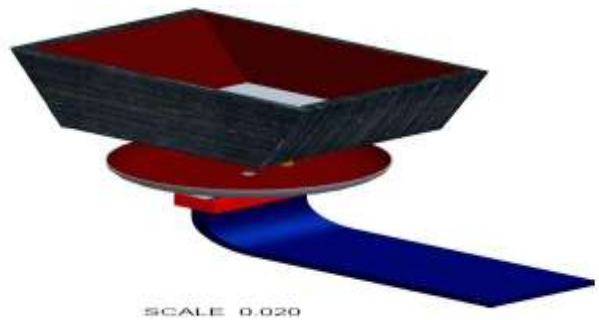


Fig.5 CAD Model of Tundish

8.4.3 Duct Result: - Design concept of duct: Below the continuous casting at Slab, bloom, billet when flow over the conveyor, the duct provide at the there in cross way. The air send through the air compressor through duct, output gets heated warm air. The warm air sends to the economizer. After air economized send to boiler. In this way more consumption of coal save in boiler.

Fig.6 Duct Result

9. CONCLUSION & RESULT

9.1 : Results and Discussion: -In NECO, Nagpur industry photo, indicate that how practically temp rise of electric furnace when metal melt. The person show on metal 1626 0 C temp through sensor but again need to raise up to 1662 0 C for complete melting purpose. But theoretically consider 1549 0 C temp on near about.

Objective

1) To finding the heat energy loss is in the search work.
2) Details takeout for research work from BSP, Bhilai.
3) To identify the effectiveness of thermal conductivity by simulation method.
4) Use mathematical model

CAD modeling Conclusion

After making CAD model in creo-parametric 2.0 (Assembly Design) in (top down approach), the real wire frame model and solid frame model shows, how to view is in front, Top, Side and back side.

Energy saving method conclusion

Financial loss of steel plant saves.

Use here strength, weakness, opportunity & Threat analysis i.e. SWOT model also success here

% energy saving and method

Energy saving method CAD model: in simulation of different products which use in BSP plant, its optimization value Flow method: When the heated material flow over the conveyor collect heat by duct method, it is succeed collect the reading

Conclusion & Result Cost worth affect: After using all above method, the research success & financially losses saving in the firm of coal, electricity which directly help to government.

Power Generate In parametric analysis chapter [8] there is calculation given for collection of heat a) Heat energy form collect from continuous casting method in steel melting shop. b) Heat energy collected from furnace. c) Heat energy collects from exhaust gas. d) How to generate electric power numerical value & fig given. Hence parametric analysis result also success.

9.2: Result: - Heat collected = 5,965, 622 KW

Heat Energy loss in compressor = 14.30 KW

Original Heat Collected

= 5,965, 622 – 14.30 KW

= 5,965,607.7 KW

= 5965.607 MW.

Recommendation future work :-

Heat Energy loss remain study, in lots of industries such as Textile industry, paper industry, chemical industry, workshop

Heat energy loss in cast iron plant.

Heat energy loss in copper manufactory plant.

Heat energy loss in Aluminum.

Heat energy loss in alloy industry.

10. Future Scope: Is in future From rolling mill, collect the huge amount of energy & generate the electrical power. To satisfy the human electric power need.

Abbreviation:

CNC= Computer Numerical Control

FMS= Flexible Manufacturing System

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Ethics approval & consent to participate:

Not applicable.

Funding:
Self experience based visited in Ferrow Alloy Corporation Limited in MIDC, Nagpur. Maharashtra, India & actual performance experimentation

Availability of Data & Materials:
Data collected from practically performance on slab experimental set up.

Author Contribution:
I have teaching, Research, Experimentation & field base work experience.

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