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TO STUDY ENERGY CONSERVATION IN FOUNDRY BY USING PROCESS PARAMETERS OF CUPOLA FURNACE.

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ABSTARCT

Cupola furnace is having greater melting efficiency compared to induction furnace. Recent day's duplexing operation is best option in order to achieve energy efficiencyin this paper we had done design and experimentation related to cupola furnace.. There are various zones in the cupola furnace and reactions. Material size is also important factor because it will level of melting zone and preheating zone. Various melt ratios can be obtained by varying coke ratio and amount of air. Also analysis is done on Design, on the basis of floor space required, volume of air flow required, cost and working conditions. Quantity of heat required for melting is depends upon characteristics of raw material used for furnace charging. In this paper it is suggested that cupola could further assist manufacturers who wish to build larger furnaces for commercial application with reduced cost implication.Metal to coke ratio was about 7:6. It generally depends upon quality of coal i.e. particle size, coke strength, porosity, ash content, sulfur content, moisture used for cupola furnace and it also depends upon preheating zone height of cupola. In order to improve coke to metal ratio stringent material specifications implemented and increased preheating zone height of cupola furnace.

KEY WORDS: Cupola furnace, Melt rate, Preheating Zone

INTRODUCTION

Cupola furnace is having greater melting efficiency compared to induction furnace. Recent day's duplexing operation is best option in order to achieve energy efficiency. By design and experimentation related to cupola furnace[1,2].

In experimentation on building of small cupola furnace there are various zones in the cupola furnace and reactions[1]. Material size is also important factor because it will level of melting zone and preheating zone. Various melt ratios can be obtained by varying coke ratio and amount of air. Oxygen enrichment is also way to reduce energy consumption. Oxygen enrichment can increase melt rate, temperature of tap and reduction in the coke and sulphur at the tap. Cupola height depends upon well depth and height above tueyeres. He has given procedure of sequence of operations for starting of furnace.

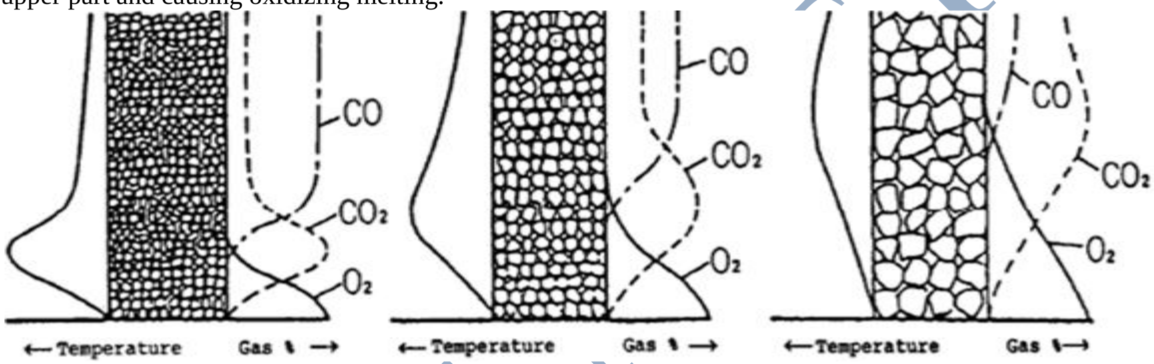
By modification in the existing furnace found 16.98% increase in the efficiency of furnace in most cases. After analysis of raw material used for furnace charging[2]. Design on the basis of floor space required, volume of air flow required, cost and working conditions. We calculated heat loss by conduction and radiation. This thermal approach used for calculation of refractory thickness. Calculation is amount of material required for melting on the basis of volume of furnace and density of furnace and rate of heat transfer through cupola furnace wall. Also calculated critical radius of insulation for furnace and volume air supplied through blower. Quantity of heat required for melting is depends upon characteristics of raw material used for furnace charging. Suggestion is that cupola could further assist manufacturers who wish to build larger furnaces for commercial application with reduced cost implication [3].

By calculating energy audit at cupola furnace and calculated heat input, heat losses. Found thatof recommendation for improvement in cupola furnace which includes operating practice used for charging, the dimension of cupola well depth, tueyere area and shaft height. They suggested retrofitting of existing conventional unit with divided blast would result in a coke saving of 25 %.[4]

IMPROVEMENT IN THE METAL TO COKE RATIO

SIZE OF COKE

The size of coke is recommended to be 1/5 to 1/8 of the inside diameter of the cupola. The coke particle size has a great influence on ventilation resistance and combustion in the furnace. When the particle size is small, the surface area becomes larger and the oxidation zone just above tuyeresbecomes shorter and hotter, accelerating deoxidation reaction, thus lowering furnace temperature. In addition, the position of the metal melting zone is also lowered, causing lowering of melting temperature. On the other hand, when the particle size is large, the oxidation zone is expanded, making CO_2deoxidation reaction insufficient, thus generating an atmosphere with a lot of CO_2 in the upper part and causing oxidizing melting.



a) Small Size b) Medium Size c) Large Size

Temperature and Gas Distribution For Various Sizes of Coke

C.I. Foundry having cupola inside diameter 36 inch which is equal to 914 mm so as per requirement the coke size should between 115 to 180 mm but initially we found that the coke size is not up mark it was varying between 70mm to 120 mm. As per our discussion we sent requirement to purchase department and we are getting coke between specified limit

Before	After
	

Coke Size Comparison

SIZE OF RAW MATERIAL

Toolarge chargedmaterials increase the speed of passage of combustion gas,lowering preheating effect. They may cause hanging sometime. On theother hand, too small materials prevent ventilation in the furnace,causing incomplete combustion or lowering melting speed. As per our cupola requirement the raw material size should between 152 mm to 304mm. We have started sorting of material before charging into the furnace.

Raw Material	After Sorting
	

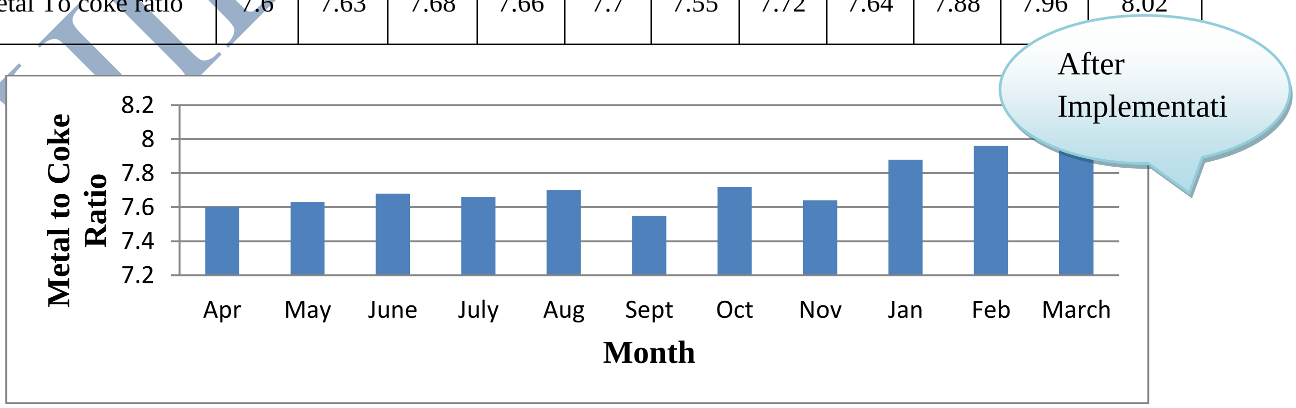
Raw Material Sorting

EXTENSION OF PREHEATING ZONE HEIGHT

Metal to coke ratio was about 7.6. It generally depends upon quality of coal i.e. particle size, coke strength, porosity, ash content, sulfur content, moisture used for cupola furnace and it also depends upon preheating zone height of cupola. In order to improve coke to metal ratio stringent material specifications implemented from purchase department and increased preheating zone height of cupola furnace. Earlier charge capacity of two layers which was containing 1000 Kg of metal and temperature of exhaust measured at charging door was about 250 °C. So amount of energy lost through exhaust, so action decided to increase preheating zone height about 2.44 m, hence capacity of charging zone increased to four layers .by changing position of charging door and utilization maximum energy for preheating of charge. Charge capacity now increased up to 2000 Kg in the preheating zone height and temperature at charging door is about 80 °C and effectively utilized exhaust heat loss through furnace. As a result of height extension and stringent material specifications metal to coke ratio improved up to 7.95.

Metal to Coke Ratio

Month	Apr	May	June	July	Aug	Sept	Oct	Nov	Jan	Feb	March
Metal To coke ratio	7.6	7.63	7.68	7.66	7.7	7.55	7.72	7.64	7.88	7.96	8.02



Metal to Coke Ratio

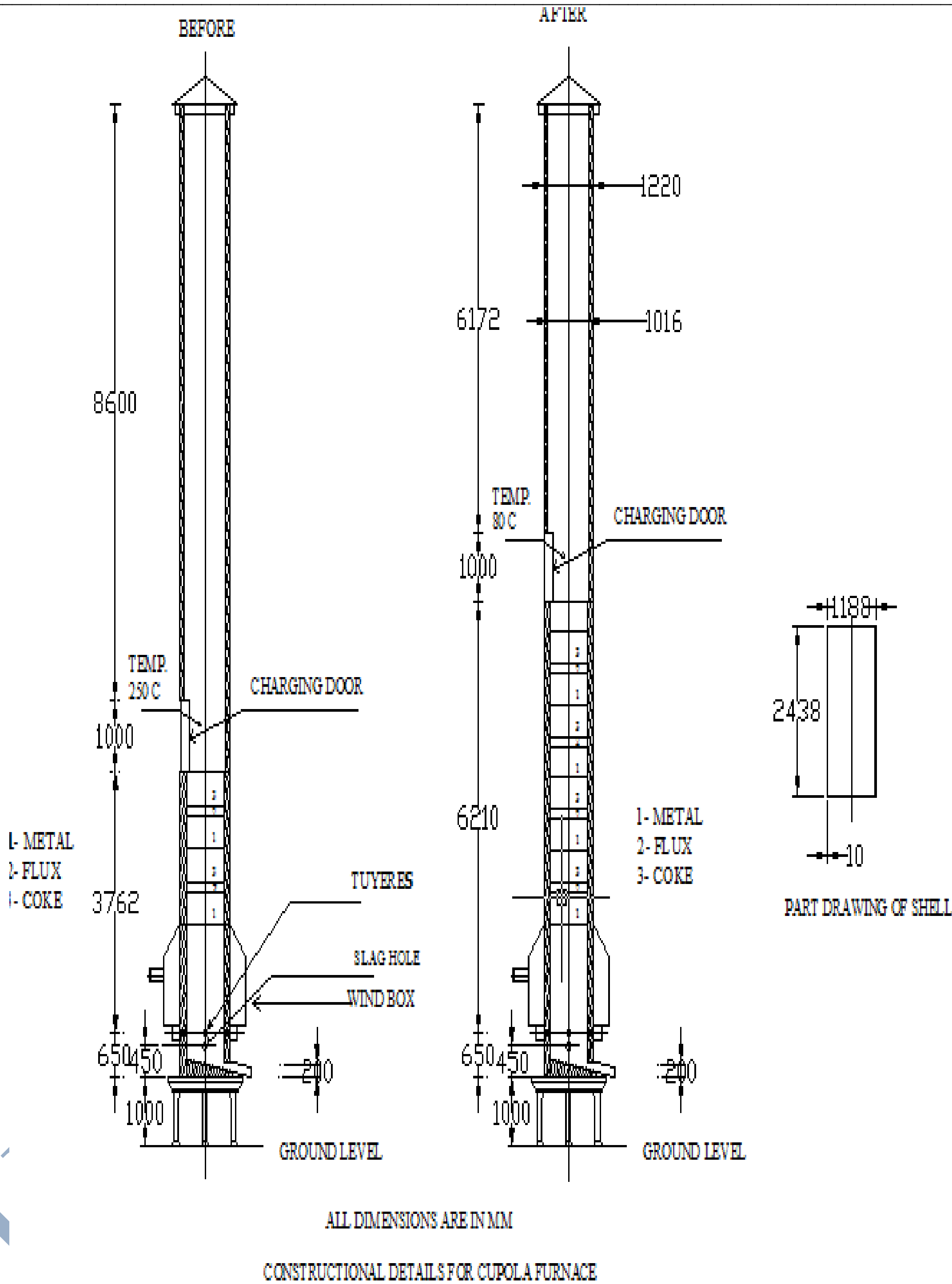


Fig. 3.17 Cupola Height Extension Melt rate

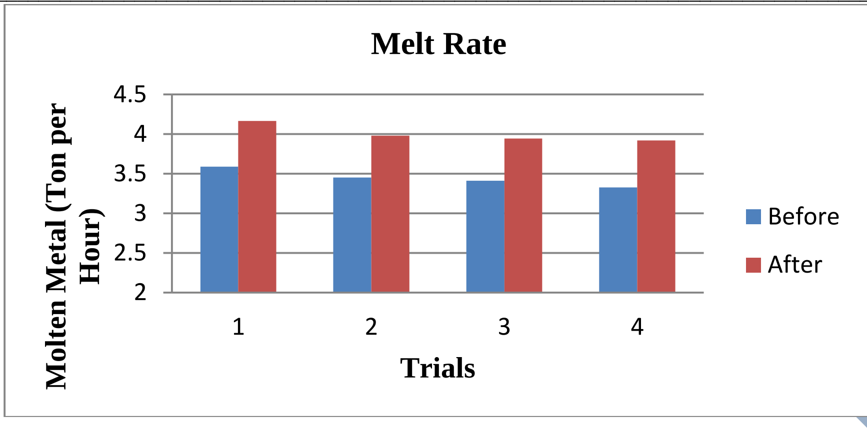
After implementation of extension of preheating zone height, recommended sizes for coke and raw material melt ra e improved from 3.3 -3.6 to 3.9 -4.1 ton per hour.

Before Implementation
Date: - 16-07-2015

Ticket No.	Sr.No.	Time	Weight (Kg)	Observations
1	1	9.45	420	Cupola Start
	2	9.5	480	
	3	9.56	510	
	4	10.05	565	
	5	10.11	530	
2	6	10.17	458	
	7	10.23	586	Stop for10 min
	8	10.4	480	
	9	10.48	495	
	10	10.56	463	
3	11	11.03	501	
	12	11.09	487	
	13	11.19	435	
	14	11.28	495	
	15	11.34	516	
4	16	11.46	395	
	17	11.55	545	
	18	12.03	496	
	19	11.15	590	
	20	12.24	488	
5	21	12.33	520	
	22	12.45	493	
	23	12.56	520	
	24	1.06	595	
	25	1.19	512	
6	26	1.26	495	
	27	1.35	598	
	28	1.45	523	
	29	1.56	562	
	30	2.09	468	
	31	2.15	495	
	32	2.26	523	Stop for 5 min
7	33	2.4	453	
	34	2.55	565	
	35	3.08	595	
	36	3.19	546	
	37	3.28	576	
8	38	3.4	478	
	39	3.55	490	
	40	4.1	585	
	41	4.16	530	

After Implementation
Date 26-02-2016

Ticket No.	Sr.No.	Time	Weight (Kg)	Observations
1	1	9.45	432	Cupola Start
	2	9.51	456	
	3	9.58	458	
	4	10.04	578	
	5	10.12	527	
2	6	10.19	564	
	7	10.28	546	
	8	10.41	629	
	9	10.52	598	
	10	11.01	563	
3	11	11.09	534	
	12	11.18	656	
	13	11.27	645	
	14	11.39	587	
	15	11.46	461	
4	16	11.58	598	
	17	12.07	490	
	18	12.17	687	
	19	12.27	538	
	20	12.35	657	
5	21	12.46	564	
	22	12.58	583	
	23	1.07	406	
	24	1.19	523	
	25	1.26	548	
6	26	1.37	659	
	27	1.48	607	
	28	1.57	586	
	29	2.05	659	Stop15 Min
	30	2.22	567	
	31	2.29	570	
	32	2.38	489	
7	33	2.46	637	
	34	2.55	583	
	35	3.06	546	
	36	3.15	549	
	37	3.26	481	
8	38	3.35	567	
	39	3.47	643	
	40	3.55	564	
	41	4.06	657	
	42	4.12	534	
	43	4.18	546	
	44	4.23	576	
	45	4.3	643	



Melt Rate at Cupola Furnace

Coke to metal ratio and melt rate is increased with stringent material specification like coke size, raw material size and waste heat utilization in the furnace. This is because if the particle size is bigger, then surface area becomes smaller and the oxidation zone just above tuyeres becomes bigger and hotter, decelerating deoxidation reaction, thus increasing furnace temperature. If raw material used for charging is not in the specified range then chances of hanging of furnace. Similar trend observed in Energy conservation Center, Japan [5].

COST ANALYSIS FOR CUPOLA HEIGHT EXTENSION

Investment Cost
Material Cost = 2, 18,384
Erecting Charge = 1, 04, 500
Other Expenses = 70186
Earlier Coke to Metal ratio was about 7.6 assume melting of 300 ton metal per month coke consumption about 39.47 ton after implementation of we are getting coke to metal ratio about 7.95for 300 ton metal per month coke consumption about 37.74 ton, which results in saving of 1.73 ton coke per month. Cost of 1 ton coke is 20300 rupees hence we can save 35119 per month total investment cost is about 393000. Hence payback period is about nearly 12 month.

CONCLUSION

With stringent material specification and extension of cupola preheating zone height by 2.34 m metal to coke ratio improved to 7.95 which was earlier 7.6 and payback period for investment is about 12 months
When the particle size is large the surface area becomes small and the oxidation zone above tuyeresbecomes large and cool, accelerating oxidation reaction, thus improving furnace temperature

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