COST REDUCTION BY REPLACING STEAM WITH COKE OVEN GAS FOR HOT AIR DRYER UNIT IN THE ELECTROLYTE CLEANING LINE

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Abstract - *Globally, the manufacturing industries have incredible contribution in the global economic growth and it has wide recognition in the area of poverty alleviation. Development of any country is largely based on its magnitude of industrial growth. Steel industries in India took a leading role in the world after mid-sixties. During the last five decades, the steel industries all over the world made considerable developments in new methods for productivity improvement & cost reduction. The study is based on of the leading steel company in Eastern India. The present paper suggests a modification in the layout of Electrolytic cleaning line with special emphasis on the hot air dryer unit which is used for drying cold rolled steel coils during the electrolytic cleaning process. Presently, steam is used for heating air. Replacing the steam by coke oven gas provides better quality output and less cost to the industry. The research work highlights the cost reduction methodology due to modification in the electrolytic cleaning line.*

***Key Words*: Coke Oven Gas (COG), Électrolyte Clearing Line (ECL), Hot Air Dryer Unit (HADU)**

1. INTRODUCTION

1.1 Electrolytic Cleaning Line

ECL are used for the effective removal of any rolling oil, iron fines or grease remaining on the surface of cold rolled steel strip. The possible efficiency of Electrolytic Cleaning Lines may be very high (much more than 97% for the oil and much more than 95% for the iron fines), depending of the rolling mill operation. This is due to the combination of different processes to clean the strip: spray or dip cleaning, brushes, electro-cleaning section followed by a water rinse built into different stages. **[1]**

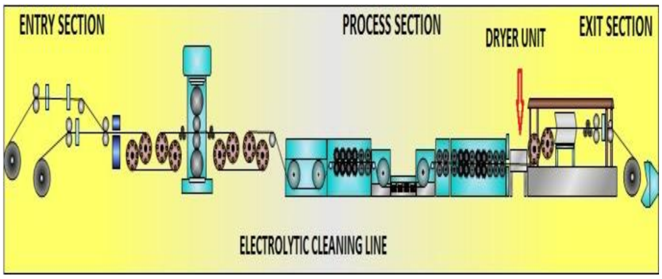

Figure 1: Overview of Electrolytic Cleaning Line

1.2 Hot Air dryer Unit

At the electrolytic cleaning line Hot air dryer unit is used for removing water from the strip. Strip is dried by hot air. Hot air is generated using steam in heat exchanger. Temperature of steam is controlled through steam control valve by controlling steam flow. Thermocouple with temperature transmitter is provided in duct after heat exchanger which senses the temperature of air and gives signal to steam control valve.

1.3 Coke Oven Gas (COG)

Coke Oven Gas is a by-product gas, produced during the carbonization of coking coal in a Coke Oven Battery for the production of coke. **[2]** This gas is known as Coke Oven Gas (CO gas). In coke oven plant, the evolved gas is removed as raw gas and is treated in a byproduct plant to give a clean fuel CO gas. Condensable and economically valuable component like tar is removed. During the cycle of coking, the gas is produced during majority of the coking period. The composition and rate of evolution of the CO gas changes during the period and the evolution of CO gas is normally complete by the time the coal charge in the battery reaches 700 deg C. The final yield of clean coke oven gas after treatment in the byproduct plant is around 300 N Cum per ton of dry coal. **[3]**

Table 1 below shows the percentage composition of CO gas with it density and calorific value.

Table 1: Typical analysis of CO gas

Methane	26.00%
Hydrogen	56.00%
Hydrocarbons	2.30%
Carbon monoxide	8.50%
Carbon dioxide	3.00%
Oxygen	0.40%
Nitrogen	3.30%
Density	0.4848 Kg / m3
Calorific value	4300 kcal / m3

2. STUDY OF EXISTING PROCESS (ECL)

a) Line is run daily as per material plan.
b) Steam is used for heating air in the hot air dryer unit at the pressure of 2.5 bar.
c) If steam pressure goes down, temperature drops.
d) Hot air dryer unit takes approximately 30 min. to reach 100 to 125'C after which electrolytic cleaning line starts.
f) During line running, if steam pressure goes down, line speed decreased (200-280 MPM to 150 -100 MPM), or line stops.
g) Water carry over problem occurs due to lack of adequate temperature.
h) Quality defects occur in finished product due to rinse water sometimes. (Black Patches)
i) Due to slow line speed WIP increased and shortage of space.

2.1 Problem Identification

The following problems were identified during the process-

a) Cost

The cost of the steam generation and supply is too high app. 850 Rs/T, which causes high production cost **[4]**

b) Production

Due to low steam pressure many time line stop or go slow (200-280 MPM to 150 MPM), therefore at the end of the day expected production target not achieve, which causes production loss.

c) Quality

Due to steam pressure low less than 2.5 bar, required temperature for strip drying process not achieve to 100 'C, which cause for water contains and some time patches on strip surface.

2.2 Objective of the work

To arrange for an alternate facility to reduce the steam consumption and problems associated with cost controlling and Quality improvement

3. METHODOLOGY

Coke oven gas is a by-product gas from recovery coke oven plant can be utilized in place of steam to generate hot air and eliminate rinse water patches, thus enhancing the quality of product. Since the cost of COG is lesser than that of steam. There may be overall cost reduction in ECL process. Modification in the layout of hot air dryer unit for effectively use of coke oven gas. Fig. 2 shown below is layout of air dryer unit. **[5]**

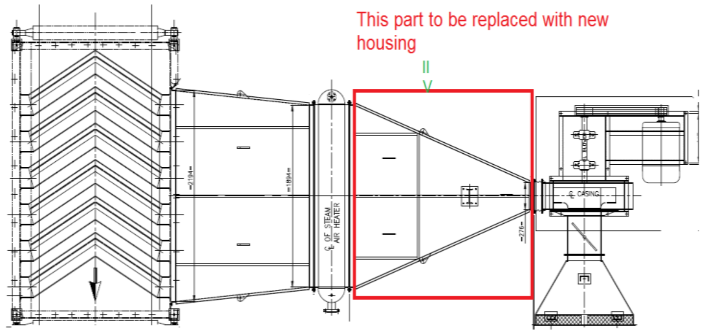

Figure 2: Layout of Hot Air Dryer Unit

3.1 Assembly of new housing and burner

New housing is fabricated with 3 mm hot rolled plate, in the shape of a box, having air inlet & outlet and one side window for fitting burner inside. The housing is designed to fit in old assembly without any trouble. All the required dimensions derived from Hot Air Dryer assembly unit drawing. After fitting of new housing, whole assembly is covered by glass wool to prevent from heat loss and accidents. (Fig.3)

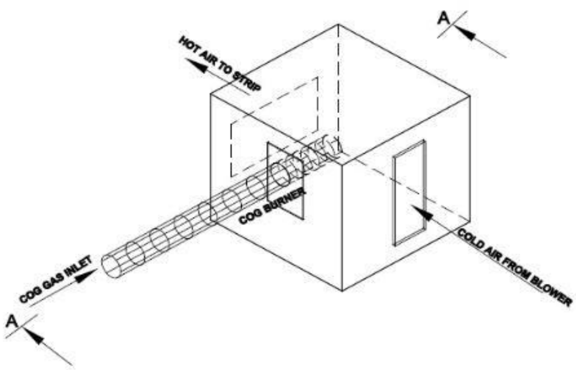

Figure 3: Layout of Burner Housing

COG burner is fabricated with the Stainless Steel plate of 5 mm thickness, to resist high temperature. This design is prepared for resisting flame from high air flow. CO gas inlet is from both sides in this design. (Fig.4) The pipe line is fabricated with Stainless steel pipe to prevent from corrosion. This pipe line assembly is provided with many important types of equipment like different types of valves for opening/closing the line (auto actuator butterfly valve for automatic open/close operation, gate valve, ball valve etc), filter unit to prevent from tar and other impurities in coke oven gas. Additional equipment like pressure gauge is connected to check line pressure.

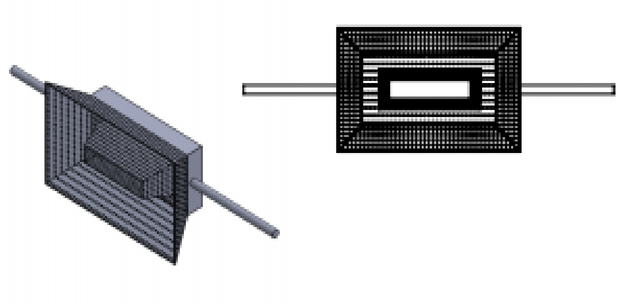

Figure 4: Layout of CO gas Burner

4. DATA COLLECTION

Annexure 1 contains the data from month of Sep. 2014 to Oct. 2015, collected from ECL operation MIS reports. This has consumption of steam and CO gas, cost of steam and CO gas and cost of production in Rs. per MT. Time from Sep. 2014 to Mar. 2015 show before modification and the time from Apr. 2015 to Oct. 2015 shows after Implementation of new modified process of hot air drying unit with coke oven gas.

5. RESULT & ANALYSIS

5.1 Result

Fig. 5 shown below clearly shows that the cost of production (Rs / MT) is decreased after the implementation of modified layout of hot air dryer unit in month of Apr 2015 seems low than earlier.

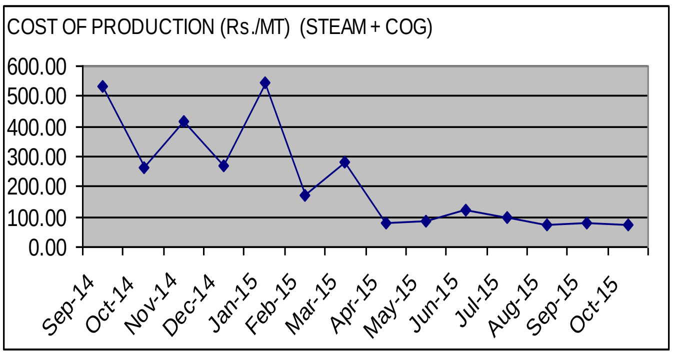

Figure 5: Cost of Production per MT

Table 2 shown below shows the comparison between costs of production Rs/MT (steam + COG) before and after implementation. The average cost between Sep.14 to Mar.15 (before implementation) was 354.58 Rs./ MT. But after the implementation between Apr. 15 to Oct. 15 (after implementation) reduced to 85.71 Rs./MT.

Table 2: Cost of Production Comparison

	Before Implementation (Sep. 2014 to Mar. 2015)	After Implementation (Apr. 2015 to Oct. 2015)
COST OF PRODUCTION (Rs./MT) (STEAM + COG)	535.56	81.5
	263.5	88.69
	416.5	112.65
	272	96.38
	544	70.53
	170	79.52
	280.5	70.7
Average Cost	354.58	85.71

5.2 Analysis (after modification)

a) HADU takes approximate 5 min. to maintain temperature approximate 100-125 °C.
b) Line speed maintain to 200-280 MPM
c) No Water carry over problem occurs due to proper temperature.
d) No Quality defects found in finish products. (Rinse Water Patches)
e) Due to standard line speed, less WIP inventory.
f) Cost of production is decreased as consumption of steam decreased in the HADU after implementation
g) Steam consumption percentage Calculation :-(see annexure 1)
During Sep. 14 to march 15 whole ECL process (Dryer Unit + Other process) use steam, so
Avg. consumption of Steam before Implementation (May 14 to Feb 15) = 1531 T
After the implementation During Apr. 15 to Oct 15 whole other process (except Dryer Unit) use steam, so
Avg. consumption of Steam after Implementation (Apr. 15 to Oct 15) = 995 T
Avg. steam used only for dryer unit =

(Avg. steam used for Dryer Unit and Other process - Avg. steam used for other process)
1531 – 995 = 536 T
1531 T is assumed 100 % steam use in whole process (Dryer Unit + Other process.)
Then the percentage of steam used in operation of HADU:
= (995 x 100) / 1531
= 64 % steam used for other process after implementation
So this means 36% steam used only for HADU before implementation which is saved now.

6. CONCLUSION

From the above data it is concluded that the CO gas is used as substitute for steam as utility .the CO gas provided in this arrangement is much more profitable for the plant's economy. Thus, the above methodology fulfills the targeted objectives. Cost of production per MT is decreased. Following points are noteworthy:

- To generate hot air, substitution of steam with COG provides one time investment only and is economical.
- Skilled labor is not required. Semi skilled labor can operate easily which is easily available.
- To generate hot air, this is the most environment friendly method using by-product gas from coke oven plant.
- Reduced energy costs, and greater predictability and stability.
- Efficient and economic heat supply.
- High efficiency compared to other power generation technology (i.e. steam)
- Pressure required is considerably low
- Utilization of exhaust gas while simultaneously harnessing it as an energy source as a substitute to conventional fuels & environmental benefits by greenhouse gas reduction

6.1 Scope for future work

CO gas burner ignition is a manual process. In future burner ignition can be automatically controlled. This dryer operation can be handling by single person from operation desk.

7. REFERENCES

[1] CMI FEP, Electrolytic Cleaning Line, Operation & Maintenance Manual, Volume 1 of 2, Project 3062
[2] Tirodkar, R.B., Belgaonkar, V.H. “Use of chemicals derived from coal in surface coating Industry” Chemical Business No.4, April 1991, p.35
[3] International Energy agencies IEA 2007 P 111
[4] ECL operation MIS report 2014-15 & 2015-16
[5] GA of hot air dryer assembly, Drawing No. 306213500 A1, sheet 01 of 01, Rev. 00

ANNUXTURE 1 (see below page no. 1633)

MANAGEMENT INFORMATION SYSTEM OF ECL-2014-15-16			(Before Implementation)						(After Implementation)					
MONTH	Sep-14	Oct-14	Nov-14	Dec-14	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15
PRODUCTION TARGET (MT)	4000	5000	5000	5000	4000	8000	5000	5000	10000	15000	10000	10000	10000	20000
PRODUCTION OUTPUT (MT)	2841	4422	3009	4689	2391	7479	4715	5849	8858	10183	8053	8999	11639	11354
PRODUCTION RATE(MT/Hr)	19.23	40.69	21.23	20.61	24.07	41.28	29.77	30.21	29.78	30.17	38.14	43.61	43.63	40.69
DELAY (Hr)														
TOTAL DELAY	572.26	635.33	579.00	516.51	644.67	491.66	585.34	526	447	382	533	538	400.83	464.99
TOTAL RUNNING	147.74	108.67	141.00	227.49	99.33	180.34	158.66	194	298	338	211	206	319.17	279
TOTAL CALENDAR HOURS	720	744	720	744	744	672	744	720	744	720	744	744	720	744
CONSUMPTION														
STEAM (T)	1789.83	1370.82	1474.41	1500.48	1530.24	1495.8	1555.95	526.41	885.8	1425.62	885.83	719.92	1047.51	908.32
COG (m3)	0	0	0	0	0	0	0	4259.64	6545	7426.98	4644.42	45398.7	7021.74	6138.22
STEAM (T/MT)	0.63	0.31	0.49	0.32	0.64	0.20	0.33	0.09	0.10	0.14	0.11	0.08	0.09	0.08
COG (m3/MT)	0	0	0	0	0.00	0.00	0.00	1.86	1.89	1.86	1.47	0.50	0.50	54.00
COST														
STEAM (Rs)	1521356	1165197	1253249	1275408	1300704	1271430	1322558	447449	752930	1211777	752956	611932	890383	772072
COG (Rs)	0	0	0	0	0.00	0.00	0.00	29245	32725	37134.9	23222.1	22698.5	35108.7	30691.1
STEAM (Rs/MT)	536	264	417	272	544	170	281	77	85	119	94	68	76	68
COG (Rs/MT)	0	0	0	0	0	0	0.00	5.00	3.69	3.65	2.88	2.52	3.02	2.70
TOTAL COST OF PROD. Rs. (STEAM + COG)	1521356	1165197	1253249	1275408	1300704	1271430	1322558	476694	785655	1248912	776178	634631	925491	802763
COST OF PRODUCTION (Rs./MT) (STEAM + COG)	535.56	263.5	416.50	272	544	170	280.50	81.5	88.69	122.65	96.38	70.52	79.52	70.70