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Innovative Approach on Reduction of Carbon Foot Print, Environment Impact and Enhancement in Productivity – A Case Study

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Abstract: *Energy contributes to about 12 % of total manufacturing cost and thus it is essential to focus on improving the efficiency, productivity, resource conservation, least environmental impact and carbon foot print. This paper summarizes the innovative approach adopted by our mill for reduction of carbon foot print by adopting the best technology to obtain the desired result. The objective is to replace the less efficient equipment with more efficient one to reduce for environmental and economic impact and increasing Plant efficiency. We have increased 3 MW Power Generation from almost same HP steam input.*

Key words: Carbon Foot Print, Environment Impact, Paper Industry

Introduction

Paper industry is highly energy and water intensive in nature. For sustainability and growth, it is essential to focus on improving the efficiency, productivity, resource conservation, least environmental impact and carbon foot print. For this, various innovative initiatives have been taken in our mill, some of them are -

(i) Revamping of 10 years old Turbo Generator (15 MW) to improve the power generation by 20% with reduced specific steam consumption thus lower fuel consumption.

(ii) Entire sludge from effluent treatment is used as co-fuel in the Power Boiler, thereby saving 35TPD coal per day and overcome land disposal problems.

(iii) Installation of UASBR up flow anaerobic sludge blanket reactor for treatment of effluent for efficient COD reduction to reduce load on blowers, hence 30% energy consumption reduced as compared to present Activated Sludge Process.

Energy consumption varies with type of process adopted for Paper making. Our mill being based on De-inking, recycled and purchased pulp, the energy requirement is in the tune of 15.70 MJ/Ton of Paper (0.373 TOE (Ton of Oil Equivalent)). To meet this energy requirement, we have three nos. of Captive co-generation Power Plant with capacity of 5 MW, 15 MW and 10.5 MW. For manufacturing 2,60,000 MT of paper per annum (2016-17), Coal consumed is about 3,02,000 MT of Indian coal at GCV of 3240 kcal/kg, thus specific consumption of about 1.16 T of coal / T of Paper.

Results and Discussion

a) Revamping of 10 Years Old Turbo Generator (15 MW)

CPP#1 (5 MW) was commissioned in 2000-01, CPP#2 (15 MWTG) in 2007-08 and CPP#3 (10.5 MW) in 2015-16. On commissioning of CPP#3 (10.5 MW in 2015-16), it was observed that efficiency of 10.5 MW is higher than 15 MWTG and 5 MWTG by about 7-8 % and 8-10% respectively due to technological advancement. In the event of increasing the efficiency of 15 MW, the energy saving (coal saving) expected was about 12000 tons per Annum. To make the business profitable, organization needs to reduce the production cost (reduction in energy cost) and make plant most energy efficient.

b) 100% Reuse of Effluent sludge back into Boilers

A large quantity of sludge is generated from Effluent Treatment Plant (ETP) which has some calorific value, the disposal of the sludge is a major issue as it contains large quantity of Ash and moisture. Emami focused on technology for improving the sludge condition so that it can be fired in Coal fired Boilers to use the calorific value and overcome the solid waste disposal.

c) Installation of UASBR up flow anaerobic sludge blanket reactor

Present system at ETP has activated sludge process, in which most of the reduction of COD in effluent is done by air from Blowers, Root blowers being highly power consuming equipment, high amount of power is consumed for reduction of COD.

Action Taken and its Progress:

a) Revamping of 10 Years Old Turbo Generator (15 MW)

In 2007, when CPP#2 of 15 MW was commissioned with 81 TPH HP steam inlet, 40 TPH extraction and balance condensation, it used to consume 5.73 Tons (Refer table A in page 3) of HP steam to generate 1 MW power. After commissioning 10.5 MW steam turbine in 2015-16, it was observed that efficiency of 10.5 MW is higher than 5 MW & 15 MWTG. After involving the OEM, it was understood that by adopting the newer technology we can generate 18 MW Power with almost same heat input keeping same extraction level which reduces the Specific steam consumption to 4.78 T/MW from 5.73 T/MW.

The efficiency level has primarily improved by the following two main aspects in the design of the New Turbine.

a) Design: No of stage increased from 13 to 21.
b) Extraction steam temperature reduced from 225 deg C to 195 deg C as per actual process requirement.

It was also seen that instead of running two lower efficient Turbines (5 MW and 15 MW), it is better to go for higher capacity TG (Power requirement from both the TGs was about 18 MW only) so that the specific steam consumption (improvement of heat rate) can be achieved and also the internal power consumption can be reduced as only one Unit shall be in operation instead of 2 Units.

Table A: Comparison of Heat rate of Old and New Turbines

SN	Turbine	Power Generation	Inlet pressure	Inlet Temp	HP Steam		LP Steam		Condensing Steam		Heat Rate Kcal/KWh	Efficiency gain (%)
			ata	degC	Enthalpy (Kcal/kg	Flow (TPH)	Enthalpy (Kcal/kg	Flow (TPH)	Enthalpy (Kcal/kg	Flow (TPH)		
Case # 1 Straight Condesing												
1	PP # 2 (Old)	12225	64	485	808.197	50	0	0	52.144	50.3	3091	
2	PP # 2 (New)	11800	64	485	808.197	46	0	0	48.353	42.25	2977	3.672
Case # 2 Normal Operation												
	PP # 2 (Old)	14700	66	490	810.812	81	695.03	40	47.000	40	2417	
2	PP # 2 (New)	18000	64	485	808.197	86	679.35	40	48.181	46	2229	8.436
Case # 3 Full Extraction												
1	PP # 2 (Old)	15000	64	485	808.197	90	683.69	60	46.199	30	2022	
2	PP # 2 (New)	16400	64	485	808.197	90	677.79	60	46.940	30	1870	7.536

Thus, it was decided to change the old turbine with new turbine considering with increased efficiency and capacity of 18 MW so that it can cater the requirement of 2 TGs (5 MW and 15 MW). The OEM had agreed to design the Turbine, Gearbox and Alternator to accommodate in the existing place with the New set with little Civil Modification Jobs.

Challenges faced during the Project stage:

i) Shutdown Time: The Entire Change process including Civil work could be done in 15 days shut. This involved lot of planning, parallel works and various pre-shut activities.
ii) The New Gear Box offered originally required higher foundation and Centre line distances. EPM Organized meeting with all suppliers and in house Engineers and could convince the OEM to supply a tailor made Gear box which could avoid any Civil work and match the existing center lines.
iii) To check all auxiliaries, mainly Condenser and Oil system so that new Equipments match the existing one.

The equipments were successfully replaced within a record time of 15 days in May' 17 and the system was commissioned on 9th Jun' 17 and presently running at full load thus stopping inefficient 5 MWTG.

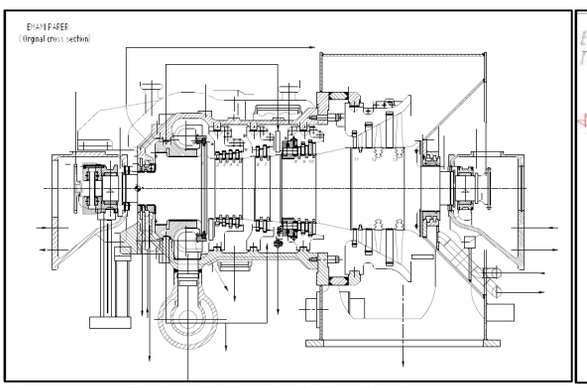

Fig.1. GA of 15 MWTG (Old Turbine)

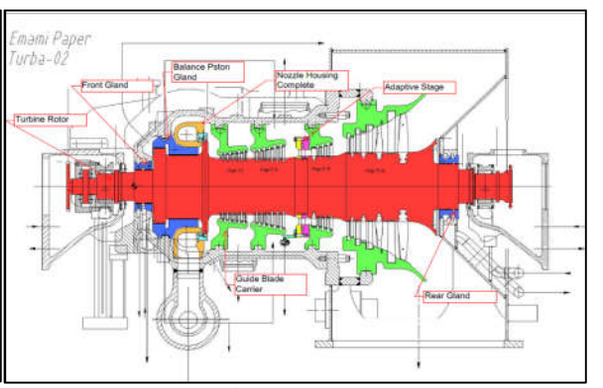

Fig .2. GA of New 18 MWTG (New Turbines)

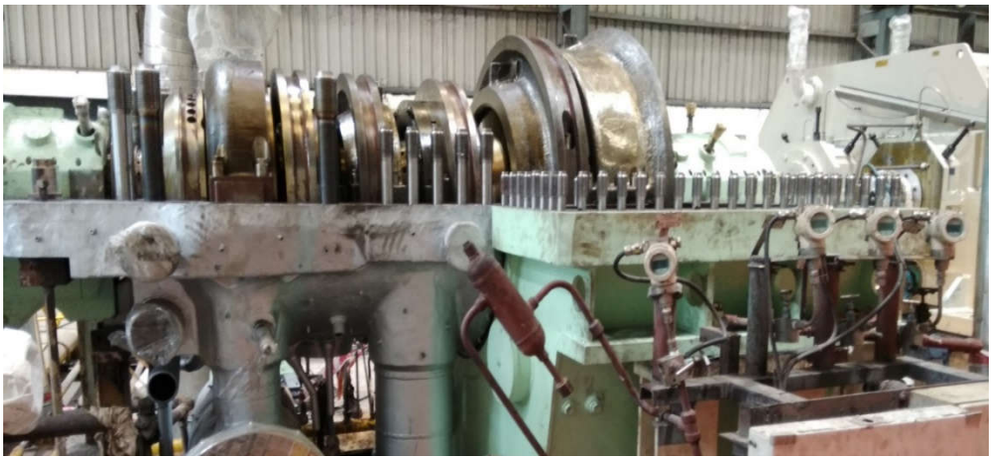

Fig. 3. Photographs of Replacement of Turbine in June' 17

Fig. 4. Photographs of minor Civil modification on Generator foundation

Fig. 5. Photographs of Generator Erection on New Civil foundation (minor modification)

Results

Now the New TG set is in operation at 18 MW generation at the same foundation and auxiliaries of 15 MWTG and presently, 5 MWTG is shut and the total power catered by 5 MWTG and 15 MWTG is met by the New 18 MWTG. From the table below it can be seen that with the installation of new TG with lower extraction temperature the power generation increased with reduction of about 10 TPH of condensing steam which counts to about 60 TPD of coal (@ 3200 Kcal/kg) thus saving of about Rs 65 lacs / month.

Table 2. Performance comparison before and after installation of 18 MWTG

		5MW + 15 MWTG Before Upgradation 2017				18 MWTG After Upgradation		Remarks
Month	Unit	Jan-17	Feb-17	Mar-17	Avg Before	Aug & Sep-17	Avg After	Difference
Power gen	MW	15.79	15.92	14.52	15.41	15.73	15.73	0.32
TG inlet	TPH	94.79	94.90	86.77	92.15	83.28	83.28	-8.87
Extraction	TPH	42.99	42.33	37.41	40.91	41.72	41.72	0.81
Condensing	TPH	52.27	53.02	49.29	51.53	41.57	41.57	-9.96
Coal cons	TPH	23.43	23.97	22.17	23.19	21.33	21.33	-1.86
GCV of Coal	Kcal/kg	3287	3188	3173	3216	3211	3211	-5

ROI Calculation

a. Total investment for 18 MW Turbine, Gearbox, Alternator : Rs 10.00 Crores
b. Shutdown Cost : Rs 2.00 Crores
c. Total Cost (a + b) : Rs 12.00 Crores
d. Coal Saving (1.86 T of coal x 24 hrs x 345 days x Rs 3700 / T): Rs 5.7 Crores / year
e. Power Saving of 250 KWh for 5 MWTG self-Power : Rs 1.0 Crore / year
(250 Units x 24 hrs x x345 days x Rs 5 / unit)

f. Total saving (d + e) : Rs 6.7 Crores / year
g. Simple Payback (ROI) (d / f) : 1.8 years (20 months)

b) 100% Reuse of Effluent sludge back into Boilers:

About 4000 M3/day of sludge is generated from ETP from Primary Clarifier which has about 3-4% consistency and basically consists of Ash and Fiber, due to which it has Calorific value of about 1600 Kcal/kg (ADB basis). Solid waste disposal of this sludge is a challenge for most of the plants. At Emami Paper, this sludge is mechanically processed (Thickener + Screw press) to > 50% moisture which is directly fed to Boilers through Belt conveyors and spreaders.

Fig. 6. Photographs of Mechanical de-watering machine (Screw press)

Fig. 7. Photographs of Dry sludge (53% dryness) be conveyed to Boiler for firing

Results

About 160 – 180 MT /day sludge (@ 50-53% solids) are fired in the Boilers which counts to about 36 – 38 MT of coal per day.

Coal Saving per Day : 36 TPD
Coal Cost per MT : Rs 3700 / MT
Saving (36 x 345 x Rs 3700) : Rs. 460 lac / Annum

c) Installation of UASBR up flow anaerobic sludge blanket reactor:

Inlet COD load : 20 MT/day (2000 ppm x 10,000 M3/day)
Quantity of Compressed air (@ 0.6 bar) : 15000 M3/hr (Root blowers)
Power consumed by the Blowers : 600 KWh

By installation of UASBR, the air requirement for treatment of COD shall be only 10000 M3/h, thus reduction of about 33% (about 200 KWh), but few more addition of equipment shall consume about 100 KW thus net Power saving shall be about 100 KW and better reduction of COD and use of recycled water back to process.

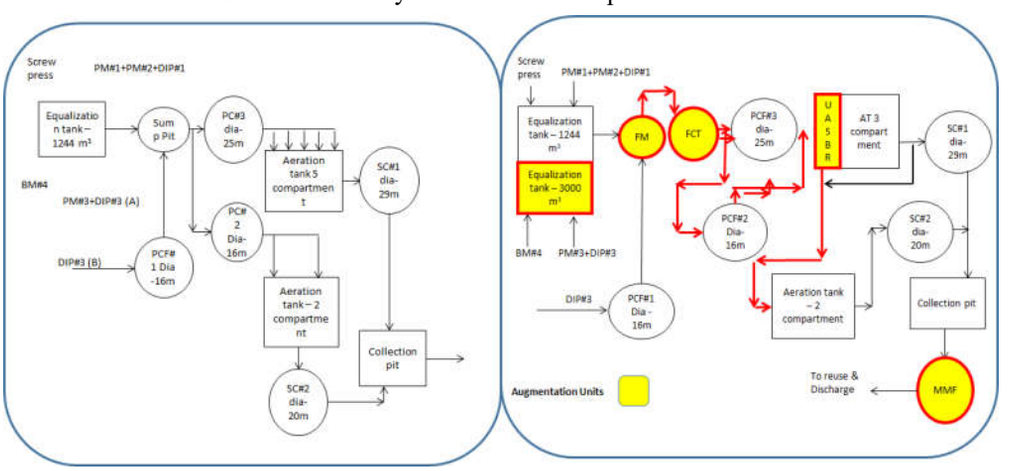

Fig. 8. Schematic of ETP Process before and after modification

Project Status: Presently under construction and expected to be commissioned in Mar'18.

Table 3. Characteristics of Final Discharge of Effluent (Before and after upgradation of ETP)

Parameters	Present final treated water	AfterETP Augmentation, Target of final treated
PH	7.0-7.5	7.0-7.5
TSS	< 50	< 30
COD	< 250	< 150
BOD_3 at 27°C	< 30	< 20

Conclusions

By carrying out all the above activities and many other energy conservation schemes, we have successfully reduced specific energy consumption from 15.7 MJ/T of paper (2015-16) to 12.82 MJ/T which is equivalent to 21000 MT of coal per annum. Emami is running with full Own Generated Power and Grid supply is availed only as Emergency.