An Energy Conservation Opportunity in Paper and Pulp Industry

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Abstract

Industrial growth is a vital factor for economic development of the country. Electric energy is the reason for Industrial Production. Sparing electrical energy intends to enhance generation and lesser energy utilization, in this way diminishing expenses without losing productivity and nature of administrations at any occurrence. This demand can’t be met with production alone. The produced energy must be used in a compelling way. This paper point is the energy preservation openings in Tamilnadu Paper Ltd (TNPL) by actualizing the blow down water recuperation to moderate the energy as far as cost subsequently limiting the use of the water utilization, chemicals used to treat the water and finding different opportunities in different areas of the paper plant like paper machine, pulp plant. In this paper, lighting is additionally more significance so as to diminish the energy utilization as far as cost.
**Keywords**: Blow down water recovery, Energy Conservation, Efficiency, lighting systems, Paper and Pulp Industry

1 Introduction

The industrial sector is the biggest consumer of energy in India. The pulp and paper industry was liable for about 6% of the world all out of the industrial energy utilization, being the fourth biggest modern energy client overall. A few energy inspecting studies have been accounted for pulp and paper industry as of late. The expanding demand for paper and paper-board items prompts a craving to speed up paper machines. The motivation behind great lighting in a pulp and paper industry is to give energy proficient illuminance in quality and amount adequate for well being to upgrade visibility and efficiency inside a wonderful situation [1]. The utilization of the inexhaustible sources prompts the non-renewable energy source sparing and decrease of the pollution discharges. Pulp and paper factories are heat and power independent by utilizing the warmth estimation of the dark alcohol, bark and wood waste [2]. The power utilization in pulp and paper mills have been demonstrated with an exponential recovery. The probability of disengaging load can somewhat be utilized as a substitute for gas turbines and will in this way give financial advantages for both the pulp and paper industry [3].

Energy proficiency improvement is a significant approach to reduce the expenses and to increment unsurprising profit in the face of continuous energy value unpredictability [4]. Emphasize that the speed up for example generation, brought about abatement of energy utilization per ton of paper. As per the theory of energy conservation, “Energy can neither be created nor be destroyed but can be transformed from one form to another”. By this statement it has been cleared that to run a system effectively and economically it is required to prevent the unnecessary loss of energy.

- TNPL comes under Grade “A” or large size paper unit, as the capacity of paper production is above 100TPD, annual production accounting for 2, 30, 000 tonnes.
- TNPL comes under the grade “A” or large size industry on the basis of capacity. On the basis of raw material used, it is in the “B” category i.e. Agro – Residue based units as it is using bagasse as raw material for making paper.

Thus the importance of conservation of energy is focusing on energy conservation by using Blow down Recovery System and various other opportunities such as power boilers, header, lighting system and other electrical equipment’s that consume more energy.
Energy utilization in the paper and paper industry is noticed that the wide image of energy required and fuel sources utilized parts with a reasonable sign of a development from oil as an energy source [5]. The paper mill, in contrast to different mills, produces the significant bit of its all out power necessities, really 70 percent when contrasted with a national normal of as it were 30 percent [6]. The energy used to vanish water can be diminished by expanding the temperature in the dryer. A progress in dew point from 55 C to 70 C diminishes vitality utilization of water dissipation with over 8% [7]. Energy utilization information were accessible, separating among paper evaluations would empower progressively express thought of the structure and specialties in the paper mills [8].

Er. Harpreet Kaur and M/s Kamaldeep Kaur (2012) states that energy safeguarding finally prompts money related points of interest as the cost of creation is reduced. In some vitality, genuine undertakings like steel, aluminum, concrete, manure, mash and paper. The cost of energy outlines a colossal bit of the outright cost of item. Energy cost as a percent of hard and fast cost of thing in the entire present day division in India changes from as low as 0.36% to as high as 65% [9]. Using vitality successful advances will reduce the amassing cost and lead to generation of more affordable and improved quality things.

PP. O’Callaghan (1992) the most noteworthy development in the energy the board technique is the unmistakable confirmation and assessment of energy conservation openings, along these lines making it a specific and the administrators work, the inside being to screen, record, examine, fundamentally look at, adjust and control essentialness travels through structures so imperativeness is utilized with most prominent efficiency [10]. Each mechanical office in a specific area is novel in itself; henceforth an orderly approach is very fundamental for diminishing the power utilization, without unfavorably influencing the profitability, nature of work and working conditions.

(Lee W. furthermore, R. Kenarangui, 2002) with the expanded utilization of reducing type energy assets, they are exhausting exceptionally quick than the evaluated time. Then again, we could scarcely produce 5% of complete power production with sustainable power source assets like Solar Power, Wind Power and Geothermal Power with the accessible advances [11].

2 Energy Conservation Opportunities

The specific energy consumptions of the plant might be assessed from the following expressions.
### 2.1 Automatic Blow Down Control System

Cost Saving in Boilers – 1, 2, 3:
- Total Dissolved Solids before blow down = 12 p.p.m.
- Total Dissolved Solids after blow down which is done manually (B1) = 6 p.p.m.
- Silica content desired for boilers 1, 2, 3 (B) = 9 p.p.m.
- Silica content present in Feed water (F) = 0.02 p.p.m.
- Sensible Heat of water at Pressure 47 Kg/ Cm$^2$ (H) = 269 Kcal/Kg
- Gross Calorific Value of fuel (G.C.V) = 4750 Kcal/Kg
- Avg. load of water Circulation (L) each = 1000 TPD
- Efficiency of boilers 1, 2, 3 ($\eta$) = 77 %
- Cost of fuel (C) = Rs. 2.8 / Kg.
- Cost of treating water = Rs.0.0163/Kg.
- Number of working days = 330 days.

**Calculation:**

Existing Blow Down Rate (E) = \( \frac{F \times L}{B1 - F} \)

\[ E = \frac{0.02 \times 1000}{6.0 - 0.2} \]

\[ E = 3.345 \text{ TPD} \]

Required Blow down Rate (R) = \( \frac{F \times L}{B - F} \)

\[ R = \frac{0.02 \times 1000}{9.0 - 0.2} \]

\[ R = 2.227 \text{ TPD} \]

Net saving in Blow down water = E – R

\[ = 1118 \text{ Kg/ day} \]

Fuel cost saved due to installing Automatic Blow down valve

\[ = \frac{[(E-R) \times (H-25) \times C]}{G.C.V \times \eta} \]

\[ = \frac{1118 \times (269-25) \times 2.8}{4750 \times 0.77} \]

\[ = \text{Rs.208.84 / day / boiler.} \]

Cost minimized in treating the saved blow down water (T) = (E-R)*(Cost of water treatment/Kg)

\[ T = 1118 \times 0.0163 \]
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Cost minimized due to non-consumption of raw water because of the saved blow down water (W) = Rs. 1.72 for 1.118 tonnes

Total savings = A+T+W= 208.84 + 18.22 + 1.72 = Rs. 228.78 / day / boiler

Savings in all the three boilers = 3 * 228.78 = Rs.686.34 / day.

Annual Cost saved in all the three boilers = Rs. 2, 26, 492.20

2.2 Cost Saving in Boiler – 4

Total Dissolved Solids before blow down = 12 p.p.m.
Total Dissolved Solids after blow down which is done manually (B1) = 6 p.p.m.
Silica content desired for boilers 1, 2, 3 (B) = 9 p.p.m.
Silica content present in Feed water (F) = 0.03 p.p.m.
Avg. load of water Circulation (L) each = 1000 TPD
Sensible Heat of water at Pressure 47 Kg/ Cm² (H)= 275 Kcal/Kg
Gross Calorific Value of fuel (G.C.V) = 4750 Kcal/Kg
Efficiency of boiler (η) = 78 %
Number of working days = 330 days.
Cost of fuel (C) = Rs. 2.8 / Kg
Cost of treating water = Rs.0.0163/Kg

Calculation:

Existing Blow Down Rate (E) = (F*L)/ (B1-F) = (0.02 * 1000)/ (6.0-0.2) = 3.345 TPD
E = 3345 Kg/ day

Required Blow down Rate (R) = (F*L) / (B-F) = (0.02 * 1000)/ (9.0-0.2) R = 2227 Kg/ day

Net saving in Blow down Water = E – R = 1118 Kg/day

Fuel cost saved due to installing Automatic Blow down valve (A) = [(E-R)*(H-25)*C] / [G.C.V * η] = [1118*(275-25)*2.8] / [4750*0.78]
A= Rs.211.23 / day / boiler.

Cost minimized in treating the saved blow down water 
(T) = (E-R) *(Cost of water reatment/ Kg)
T= 1118 * 0.0163 = Rs. 18.22 / day.

Cost minimized due to non consumption of raw water because of saved blow down water (W) = Rs. 1.72 for 1.118 tonnes
Total Savings = A+T+W= 211.23 + 18.22 + 1.72
= Rs. 231.17/day
Annual Cost saved = Rs. 76,286.

2.3 Cost Saving in Boiler – 5

Total Dissolved Solids before Blow down = 8 p.p.m.
Total Dissolved Solids after blow down
Which is done manually (B1) = 2 p.p.m.
Silica content desired (B) = 5.2 p.p.m.
Silica present in feed water (F) = 0.03 p.p.m.
Avg. load of water Circulation (L) = 2000 TPD each
Sensible Heat of water at Pressure 47 Kg/ Cm^2 (H)= 300 Kcal/Kg
Gross Calorific Value of fuel (G.C.V) = 4750 Kcal/Kg
Efficiency of boiler 5 (η) = 79%
Number of working days= 330 days.
Cost of fuel (C) = Rs. 2.8 / Kg
Cost of treating water = Rs.0.0163/Kg

Calculation:

Existing Blow Down Rate (E) = (F*L) / (B1-F)
= (0.02 * 2000)/ (2.0-0.2)
E = 20202 Kg/day

Required Blow down Rate (R) = (F*L) / (B-F)
= (0.02 * 2000)/ (5.0-0.2)
R = 8032 Kg/day.

Net saving in Blow down Water = E – R = 12170 Kg/day
Fuel cost saved due to installing Automatic Blow down valve (A)
= [(E-R)*(H-25)*C] / [G.C.V * η]
= [12170*(300-25)*2.8]/[4750*0.79]
A = Rs.2497.24 / day / boiler.

Net cost saved = Rs. 11, 98, 507

Cost minimized in treating the saved blow down
Water (T) = (E-R)*(Cost of water treatment /Kg)
T = 12170 * 0.0163= Rs. 198.37 / day.

Cost minimized due to non-consumption of raw water because of saved blow down water
(W) = Rs. 18.72 for 12.17 tonnes
Total savings = A+T+W = 2497.24 + 198.37 + 18.72 = Rs. 2714.33.
Annual Cost saved in Boiler 5 = Rs. 8, 95, 72

From this comparison, it is clear that blow down water quality is superior to the raw water. Hence it can be sent to the Water Treatment Plant for recycling. The electrical drives of paper board machine are presented in the Table 1 and Chemical Constituent in Raw Water and Blow down Water presented in Table 2.

**Table 1. List of Electrical Drives of Paper Board Machine**

<table>
<thead>
<tr>
<th>Section of the paper-board machine</th>
<th>Number of Drives</th>
<th>Installed Power [kW]</th>
<th>Minimum and Maximum Power [kW]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forming section</td>
<td>11</td>
<td>254</td>
<td>22</td>
</tr>
<tr>
<td>Press section</td>
<td>6</td>
<td>236</td>
<td>44-122</td>
</tr>
<tr>
<td>Pre-dryer section</td>
<td>8</td>
<td>198</td>
<td>13-53</td>
</tr>
<tr>
<td>Yankee cylinder</td>
<td>2</td>
<td>72</td>
<td>72</td>
</tr>
<tr>
<td>Drying sections</td>
<td>2</td>
<td>102</td>
<td>30-42</td>
</tr>
<tr>
<td>Calendar</td>
<td>1</td>
<td>52</td>
<td>52</td>
</tr>
<tr>
<td>In-line coating</td>
<td>14</td>
<td>302</td>
<td>12-28</td>
</tr>
<tr>
<td>Winder</td>
<td>1</td>
<td>48</td>
<td>48</td>
</tr>
<tr>
<td>Total</td>
<td>45</td>
<td>1264</td>
<td>12-146</td>
</tr>
</tbody>
</table>

**Table 2. Chemical Constituent in Raw Water and Blow Down Water**

<table>
<thead>
<tr>
<th>Chemical Constituent in raw water</th>
<th>Chemical Constituent in blow down water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silica = 20 – 50 p.p.m.</td>
<td>Silica &lt; 10 p.p.m.</td>
</tr>
<tr>
<td>Total Hardness = 80 – 150 p.p.m.</td>
<td>Total hardness &lt; 1 p.p.m.</td>
</tr>
<tr>
<td>Alkalinity = 250 p.p.m.</td>
<td>Alkalinity &lt; 50 p.p.m.</td>
</tr>
<tr>
<td>pH = 7.5 – 8.5</td>
<td>pH = 8.5</td>
</tr>
</tbody>
</table>
3 Cost Saving due to Raw Water

1000 tonnes of raw water consumption costs Rs.1524.17 tonnes of raw water are blown down daily from all the 5 boilers. Since blown down water is free from hardness and has less silica content than the raw water it can be mixed along with raw water and can be treated in water treatment plant.

As a net result, 13 tonnes of raw water consumption is minimized. 17 tonnes of raw water saves = Rs.25.909 daily
Assuming the number of working days as 330
Raw water cost saved annually = Rs.8550

4 Water Treatment Cost Saved

- Every 1000 tonnes of raw water treatment costs Rs. 16,389.
- But 75,000 tonnes of raw water is consumed daily and has to be treated further.
- 75,000 tonnes of raw water treatment costs Rs. 12, 29, 175 daily.

The 17 tonnes of blown down water, that is blown down daily is free from hardness and has comparatively lesser silica content than the raw water and hence the blow down water will not be consuming chemicals for treatment. Therefore the water treatment cost remains the same even after mixing the blow water (17 tonnes per day ) with raw water( 75,000 tonnes per day).

The revised cost is given below:
- 75,017 tonnes of raw water treatment costs Rs. 12, 29, 175 per day.
- Every 1000 tonnes of raw water treatment costs Rs. 16, 385.
- Before mixing every 1000 tonnes of raw water treatment costs Rs.16, 389.
- After mixing every 1000 tonnes of raw water treatment costs Rs.16, 385 only.
- Hence Rs.4 is minimized for treating every 1000 tonnes of raw water.
- Hence Rs. 300 is minimized daily for treating every 75,000 tonnes of raw water.

Therefore Rs.99, 000 is saved per annum in the form of reduced chemicals for treating the raw water.
5 Incandescent Lamp with CFL

Replacement of 60 Watts with 15 Watts CFL
No of Lamps = 700
Saving in power = 34,492 units / annum i.e. 45 watts (60 - 15)
Power \( P = 45 \times 700 \times 365 \text{ days} \times 3 \text{ hr/day} \)
\( = 34,492 \text{ units.} \)
Cost / unit = Rs. 3/ unit.
Total Cost = Rs. 3 \(*\) 34,492
\( = \text{Rs. } 1,03,477/ \text{ annum.} \)

Cost of installation:
Per CFL bulb 75 rupees
Therefore for 700 bulbs = Rs. 75 \(*\) 700
Cost of installation = Rs. 52,500
Pay back is around six months.

6 Interconnecting the Headers of De-aerators of all Boilers

Existing:
One pump 11Kw pump is operated to supply DM water to De-aerator of boiler 5 and two pumps are operated for supplying DM water to Boiler 1, 2, 3, 4.

Modification:
Interconnecting the header of De-aerator Pumps of Boiler #1, 2, 3, 4 and Boiler #5 is to be done.
Cost savings:
Power consumption per hour = 8 KWhr
Power consumption per day = 8 \(*\) 24
\( = 192 \text{ KWhr} \)
Assume working days to be 330
Power consumption per annum = 192 \(*\) 330
\( = 63,360 \text{ KWhr} \)
Total Cost savings (@ Rs. 2.70 per unit)
\( = 63,360 \times 2.70 \)
\( = \text{Rs. } 1,71,072. \)
Total Cost Savings is Rs. 1.71 Lakhs / annum
7 Stopping of Hot Air Blowing System in Machine Bottom of Paper Machine-1

It was found that hot air is blowing from the pipe at the bottom part of the dryer to heat the air below the dryer screen. System uses blower, which takes air from atmosphere and passes through steam battery to increase the temperature to 100°C as shown in Figure 1. The area where hot air is blowing has many openings in the dryer panels from both sides and cold air from the surrounding is entering through open space, which reduces temperature of air by 30°C up to a height of 5 meters.

Proposal:

Now the machine is using synthetic screens with high air permeability, so there is no need of this system. Hence it must be stopped.

Cost savings:
Blower electric motor = 9.3 KW
Live steam Consumption = 0.8 ton / hr.
Steam consumption for 24 hours and 330 days
= 0.80 * 24 * 330 = 6,336 tons
Electricity Consumption for 24 hours and 330 day
= 9.3 * 24 * 330 = 73,656 KW
Savings in steam (@ Rs.741) = 6,336 * 741
= Rs. 46,94,976 per annum.
Savings in Power (@ Rs.3) = 73,656 * 3
= Rs. 2,20,968 per annum.
Total cost savings = Rs.46,94,976 + Rs.2,20,968

Figure 1. Dryer of Paper machine 1
An Energy Conservation Opportunity in Paper and Pulp Industry

= Rs. 49,15,944 per annum.

Total Cost Savings is Rs. 49.16 Lakhs.

8 Interlocking of UTM Pulper Agitator with Paper Break & Broke Feed

It was observed that UTM pulper at dry end of both paper machines have two agitators on each pulper (with 160 KW motor on each agitator).

It was observed that both agitators on each UTM pulper run continuously even when there is no broke. The pulper pump was interlocked with pulper level and runs only when required level of pulper is reached.

Proposal:

It is recommended that agitators should be stopped from running continuously. Proper ON/OFF switches should be provided at machine floor so that whenever some broke is fed in pulper or there is continuous break on machine, agitators should be started on by operator. This will save electrical energy and also reduce the consistency variation in broke tower due to pumping of low consistency pulp from the UTM pulper.

Cost savings:

Consumption of No.1 agitator of PM -1:
140 Amp = 88.55 KWhr
Consumption of No.2 agitator of PM -1:
145 Amp = 91.71 KWhr
Consumption of No.1 agitator of PM -2:
175 Amp = 103.14 KWhr
Consumption of No.2 agitator of PM -2:
175 Amp = 103.14 KWhr
Total consumption = 88.55 + 91.71 + 2 * 103.14 KWhr
= 386.54 KW/ hr.
Assuming that agitators would remain shut for 10 hours
Total consumption /day = 3865.4 KWhr
Total consumption for year = 3865.4 * 330
Total Cost saving (@ Rs.3) = 12,75,582*3
= Rs.38,26,746
Total Cost saving is Rs. 38.27 Lakhs / annum.

9 Summary and Conclusion

The scope of conservation of energy in process operations at TNPL has been discussed in detail in report. The implementation of the suggestions and
energy saving schemes will result in enhanced production with better quality. The blow down water is analyzed for its chemical composition.

• If minerals, silica and alkaline contents are within the acceptable limit, it is transmitted through pipeline to Water Treatment Plant, thereby minimizing the raw water consumption and chemical treatment cost of raw water.
• If it is not within the acceptable limit, it is used for miscellaneous purpose.

The paper presents two disparate systems for getting higher energy profitability of the paper generation process. It furthermore shows that the energy capability in paper and industry must be estimated as a multidisciplinary field. As the little enthusiasm for drives lead to tremendous venture assets in imperativeness and basically extended generation.

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References


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