Optimum Energy Consumption and Cost Reduction at The West Coast Paper Mills Limited.

Masand J.R., Jayasimha K.

ABSTRACT

The Indian Pulp and Paper Industry, the fifth largest energy consumer in the core industrial sector, offers tremendous cushion for energy savings. it must be relized as an opportunity to grab without loosing any more time and to see the phenomenal scope of improving profits and achieve global competitiveness.

As a result of the above actions taken by WCPM from time to time on various energy savings measures it can be observed that the company has achieved good reduction in energy bills resulting in substantial savings with marginal capital investment. This will be a continuous effort for the company and others areas will also be tapped which have so far been ignored so that further savings could be achieved on a continuous basis.

The proven experience of paper technologist and experts having worked in various large integrated paper mills indicates an average energy saving potential of 20% plus in monthly energy bills. The most easiest and quick method of realising the investment is by employing variable frequency drives for the loads having scope of variable speeds like fans, blowers, conveyors, pumps.

Indian pulp and paper mills in general and WCPM in particular should adopt TEM, the "Total Energy Management" policy on the lines of quality policy in the very near future.

INTRODUCTION

Energy Scenerio in an Integrated Pulp and Paper Mill

In today's competitive scenerio, a well planned "Total Energy Management" strategy is one of the major survival factor for industries. It is an established fact that paper manufacturing is an energy intensive process and energy is one of the major elements in the cost of production. After the raw materials, energy is the single largest component contributing approx. 25% of the cost of production. Our energy bill at full capacity utilisation is around Rs. 50 Crores. The WCPM has been investing from time to time on

The West Coast Paper Mills Limited
P.B. No. 5, Bangurnagar,
Dandeli-581 325,
U.K. Distt. (Karnataka)

almost all possible energy saving measures- both in - house and by engaging the energy consultants. Such implementation has yielded appreciable results. As we are in a very competitive market today, and the situation is likely to be more stringent in the coming years, it is imperative that the cost of productions is brought down the minimum possible level to enhance the performance. WCPM is not exception and planned further investments to go for a modern 500 TPD chemical recovery boiler - one of the largest single boiler in the paper industry - which will envisage substantial saving by way of increasing steam generation and reduction in coal consumption. In order to emphasize importance of energy conservation at all levels, WCPM had also convened an one day "Total Energy Management" conference on 14th December 1999, under the auspices of "National Energy Conservation day" which facilitated wide participation of all managerial and supervisory personnel and enegineers. The management of WCPM is equally committed to implement all worth while projects on energy conservation which result in quick pay back.

WCPM had also formulated their "TOTAL ENERGY MANAGEMENT", (TEM POLICY) on the lines of quality policy. WCPM is also in the process of introducing TEM CIRCLES in which the maximum awareness and whole hearted participation from all levels of employees is assured. The following paper highlights the various attempts made by the WCPM on optimum power consumption and cost reduction, considering the upcoming emerging trends in energy management in the Pulp and Paper industry for the new millennium.

MILLENNIUM 2000 - THE EMERGING TRENDS IN ENERGY MANAGEMENT ADOPTED BY WCPM

Following projects on energy saving are under active implementation.

1. Energy Saving under Low Cost SCADA (Supervisory Control And Data Acquisition) Solution and various automation options at WCPM.

WCPM has conceived a properly designed integrated control system, which helps in improving the business performance as a result of:

- Improved energy efficiency
- Reduced process losses
- Improved Product Quality
- Higher machine availability
- Improved labour productivity
- Improved customer service.

At WCPM we have been consistently upgrading the control systems through following actions:

- Simple electro mechanical controllers in 60's.
- Pneumatic independent/partially integrated in 70's.
- Electro-pneumatic in late 70's.
- PLC's in 80's.
- QCS in late 90's.
- DCS in 2002.

Now in the millennium year 2000, WCPM plans to install a modern dedicated integrated system for the semi automation of batch digester operation and also looking forward for various options to incorporate a centralised integrated DCS with MIS/CDS with fuzzy logic. Also on the anvil are the new technology options for the following:

- Belt press for washing and screening
- Slotted angle high efficiency screens for screening.
- High efficiency cetricleaning systems (Low pressure drop).
- Low load refiners/refiners operation automation.
- Modification of paper machine press parts-brinip press/trinip press.

This being still in proposal stage the expected returns on investments are being worked out.

2. Commissioning of the falling film evaporator.

The project has been commissioned in March 2000 with the captial cost of Rs. 9.0 Crores.

- Annual saving - Rs. 3.52 crores.
- Net pay back - 3 Years 6 months.

3. 500 TPD chemical recovery boiler for high specific steam generation.

- Expected commissioning - May 2001
- Annual savings - 8.00 crores.
- Net pay back - 4 years, 4 months,

The existing 330 TPD Chemical Recovery Boiler is continuously operating on overload, resulting in frequent breakdowns. With the envisaged expansion, the existing boiler is not adequate to handle the total black liquor solids generated from pulp mill. In view of this a most modern recovery boiler with ESP to handle 500 TPD black liquor solids has been ordered. In which will also comply to environmental regulations.

4. Installation and commissioning of 2 Nos. 4 MW & 1 No. 3.8 MW multifuel DG sets due to which WCPM is self sufficient in power.

- Annual savings for each DG set - 2.86 crores.
- Net pay back - 48 months.

Prior to this the power was drawn from KEB grid at approximately 50% higher cost.

Commissioning of 3 Nos. waste heat recovery boilers for each of above multifuel DG sets. Before installing these boilers the exhaust gases coming out from the above three multifuel DG sets at an average temperature of 300°C to 350°C were let out into atmosphere through chimney, which was resulting in great heat losses. It is common practice in all large DG set installations to utilise advantageously the waste heat from these exhaust gases for generating steam through such waste heat recovery boilers, as an energy conservation measure, before the gases are finally let out through the chimney at minimum temperature after utilising the waste heat. These boilers designed to generate about 3x2.0 = 6.0 TPH which correspondingly has reduced the steam load on our old stoker fired boilers, and consequently saving of 25 of 39 tonnes coal every day. It is evident that utilising waste heat from DG sets to generate steam will be very economical involving only nominal cost for operation and regular maintenance, resulting in corresponding saving of coal due to less steam demand from the uneconomical and old coal fired boilers.

- Annual saving - 44.5 lacs
- Net pay back - 14 months.

6. Step towards improvement in quality of power by installing filter reactors with required power factor correction capacitors to neutralise the evil effects of the DC thyristorised loads for sectional drives of paper machine, resulting in improvement of wave form distortion on industrial power systems.

Datails of investment for typical requirement of harmonic filter banks are as follows:

	Rs.
- 5th Harmonic filter bank	- 75 kVAr.
- And 7th harmonic filter bank of	- 50 k.VAr.
	5.0 Lacs.
- Automatic power factor control panel-	
350 kVAr rating	5.1 Lacs.
280 kVAr rating	4.6 Lacs.
175 kVAr rating	3.3 lacs.
Taxes etc.	0.9 lacs.
	18.9 lacs.
Interest during project implementation	1.6 lacs
Total estimated imvestment	20.5 lacs
- Annual saving due to reduction in copper losses of transformers, cables, and savings for harmonic distortion.	62 kW
- Annual savings-Assuming @ Rs. 3.75 per KWH	18.69 lacs
- Net pay back	13 months. (approximate)

WCPM has initiated action to measure the harmonic contents through two different expert agencies in this field and harmonics measured are to the neutralised by providing such well designed capacity filter reactors.

7. Replacement of energy intensive pneumatic blowers by high side wall Cleated belt conveyors for

conveying wood chips from silo to digester.

- Energy consumption in the existing pneumatic blowers. - 2070 KWH/ day
- Expected energy consumption with the side wall cleated belt conveyor - 117 KWH/ day
- Estimated investment for one conveyor - 53 lacs
- Estimated annual savings - 16 lacs
- Net pay back - 5 Years, 8 months (Approximate)

8. Proposed, modified and effective Blow heat recovery and clear condensate recovery from digester house.

- Estimated investment - 100 lacs
- Estimated annual savings - 53.2 lacs.
- Net pay back - 27 Months (Approximate)

With the gradual increase in number of digesters from 6 to 10 Nos, the digester blows have continuously increased upto 30 blows per day for which the present equipments/facilities for blow heat recovery are not adequate. Also the clear condensate from digester preheaters is being utilised to raise the water temperature for process requirement in brown stock washer and bleach plant. Although we are utilising the heat but we are losing DM water which other wise can be utilised in boilers. Modification of this system will result enormous energy saving.

9. Variable speed dirves (Inverters) : A Case Study

In the paper industry most of the electrical energy is consumed by motors. At WCPM there are 1600 motors installed with connected load of about 78,000 HP. These have been categorised as per the installed HP in Table - 1.

Obviously all energy conservation efforts have to start with motors. The use of microprocessor controlled AC variable speed drives (VSD) so called inverters in the paper industry has rapidly increased in the recent past because of the tremendous energy saving potential due to variable speed operation of fans, blowers and pumps. AC variable speed drives further enjoy the advantages offered by the squirrel cage induction motors. Here we give a case study of a 280 kW, VSD installed for our ID fan of the 330 TPD chemical recovery boiler.

BACKGROUND

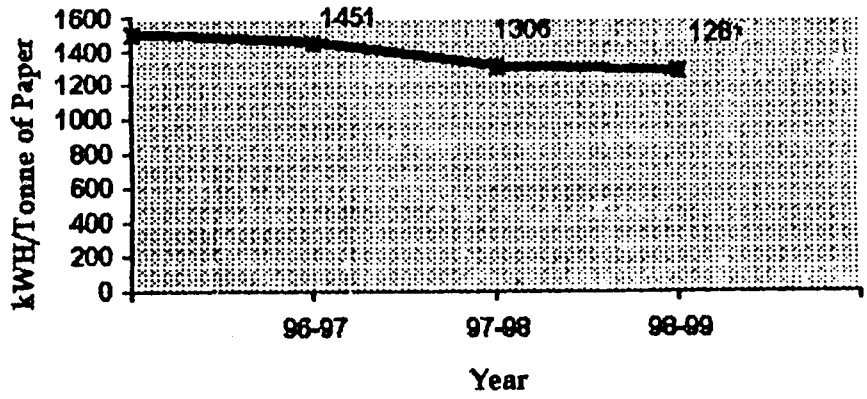
The 330 TPD chemical recovery boiler has two Nos. 280 KW ID fans each of which were earlier driven by fluid coupling at different speeds. The arrangement was such that ID fan No.1 has been always run at maximum speed and ID fan No.2 run at lower speed just to meet additional firing requirement. The fluid coupling is also referred to as slip drive because the out put shaft speed was lower by the means of "slip" between that input shaft and the output shaft. Such system usually operate at higher efficiencies at higher speed ranges. The coupling losses at lower speed will be very high and draw high amount of power when running at lower speeds. Instead of damper control in the ID fan, if the speed of the motor is varied to get the different outputs, then all that energy can be easily saved.

ENERGYSAVINGS - COST CALCULATIONS

Brief details of achieving energy saving for ID fan application is furnished below. The ID fan is operated at speed N 1, Q-H curve, flow rate versus pressure characteristics are given in figure-2. When the system curve is R1, then fan's operating point is A1. Introducing the damper to regulate the flow rate

Table-1

Sl. No.	HP ragne	No. of motors	% of total Numbers	Connected load (HP)	% of total connected HP
1.	170-850	80	5%	25793	33%
2.	50-100	320	20%	27416	35%
3.	Upto 50	1200	75%	24791	32%



Production - Paper	91715	92889	92425
(MT) Paper Board	2932	18486	24219
Total	**94647**	**111375**	**116644**

Figure - 1

from Q1 to Q2 causes the system curve change from R1 to R2 and the operating point moves to A2. In other words it is possible to control the flow so that it changes from Q1 to Q2. The change in pressure from H1 to H2 however signifies loss in pressure. If instead the VSD is used and the speed of the fan is changed to N2, operating point becomes A3 and the flow rate is changed from Q1 to Q2. Also pressure decreases from H1 to H3, saves energy. The following relations holds good for variable torque loads such as fans, pumps and blowers.

- Flow/discharge is directly proportional to the speed i.e $Q \alpha N$
- Head (pressure) is directly proportional to the Square of the speed i.e. HN^3
- Motor shaft power is directly proportional to the cube of the speed i.e. PN^2
- Even if the damper/ valve is closed, 40% of the rated output is consumed by the motor (Refer figure 3)
- With damper control, power consumed is P=Pr (0.4 + 0.6Q)

Where Pr = Rated power/rated output and Q= Flow reduction rate. (Refer figure 3)

With VSD the power consumed $P=Pr\ Q^3$ Based on above points, we can estimate the energy saving by considering the typical energy saving calculation for 280 kW squirrel cage induction motor for ID fan. ID Fan 1 operating current = 326 A (Full open) Control position = 85%) 326 A corresponds to 60% load on the motor. (The power factor assumed at this load is 0.75). Therefore power consumtption by ID fan 1 motor is P1 =1.73 x 0.415 x 326 x 0.75 = 175.55 kW....(1) ID fan 2 current consumption =210 A (minimum) (Control position = 40%) 210 A corresponds to 40% load on the motor. (The power factor assumed at this load is 0.7) Therefore power consumption by ID fan 2 motor is P2 = (1.73x0.415, 210x0.70) = 105.55 kW....(2) If AC drive was to be used for ID fan 2 to get 40% flow :Assuming that 100% flow consumes 280 kW of power, 40% of control indicates 60% of flow output from the fan. Therefore power consumption at 60% flow = $(0.6)^3$x280 kW =60.48 kW.....(3)

Initial Energy Consumption Level.

Total ID fan No.1 + ID fan No.2 (Without AC drive) =175.55 +105.55=281.1kW....(4)

Total of ID fan No.1 = ID fan No.2 (With the AC drive) =175.55+60.48 =236.03 kW...(5)

The difference = 281.1kW-236.03 kW =45.07 kW. (Power Saved)

Energy saved = 45.07 x 8000 = 3,60,560 kWH per annum.

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ENERGY CONSERVATION MEASURES IMPLEMENTED
TABLE-2

Sl. No.	Measures	Investment made (Rs. in lakhs)	Recurring Annual Savings (Rs. in lakhs)
[1]	Variable frequency drive		
a.	Dumping chest pump PM II	3.80	2.04
b.	Soda Recovery Boiler FD Fan	9.00	4.37
c.	Rotary Lime Kiln Unit	2.50	1.57
d.	Induced Draft Fan SR Boiler	13.00	10.00
e.	Fan Pumps for Paper Machine-V	13.93	18.61
[2]a.	Convert 'V' Belt drive to flat belt & Reduce impeller die for identified vacuum pump	0.50	9.15
b.	Convert 'V' Belt drive to flat belt drive (Door oliver vaccum pump)		
c.	Reduce size of impeller of the identified pump i.e. Tower No. 6 to final hypo pump No. 2&3		
[3]	Replacement of existing lighting system by energy efficient lamps	1.00	6.91
[4]	Replacement of identified pump with smaller energy efficient lamps	1.27	28.00
[5]	Stopping of unwanted equipment	---	21.6
[6]	Installation of Energy saving devices for lighting circuits (Beblec P-20)	0.59	0.53
[7]	Thermal insulation of seal tank and blow tank	2.39	1.41
[8]	Stopping of condensate hot water pump by giving connection through condensate transfer pump	--	0.39
[9]	Pluging leakage of air heater tubes of 60 TPH BHEL Fluidised Bed Combustion Boiler	---	10.08
	TOTAL	**47.98**	**114.66**

= 3.6x2.8=10.08 lacs per annum Say 10 lacs per annum

Net pay back - 18 months

ENERGY SAVING IN WCPM

In today's competitive scenario every mill is conscious to adopt viable measures to optimise the use of energy. The West Coast Paper Mill is not an exception, It has always accorded top priority for minimization of energy consumption by making consistent efforts towards optimisation of operating /process parameters, modernisation, up gradation of plant/equipment and machinery etc. The production levels of paper produced in last three years shown below in figure 1, through curve establishes the reduction trend in specific electrical energy consumption per tonne of paper produced.

Some of the major energy saving projects implemented successfully by WCPM are shown in Table-2. By referring the Table-2 we find that total recurring annual saving of Rs. 14.82 Lacs is achieved against one time investment of Rs. 47.98 Lacs. This has enabled WCPM continuously bringing down the

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Consumption per unit of production -

(per tonne of Paper & Paper Board)

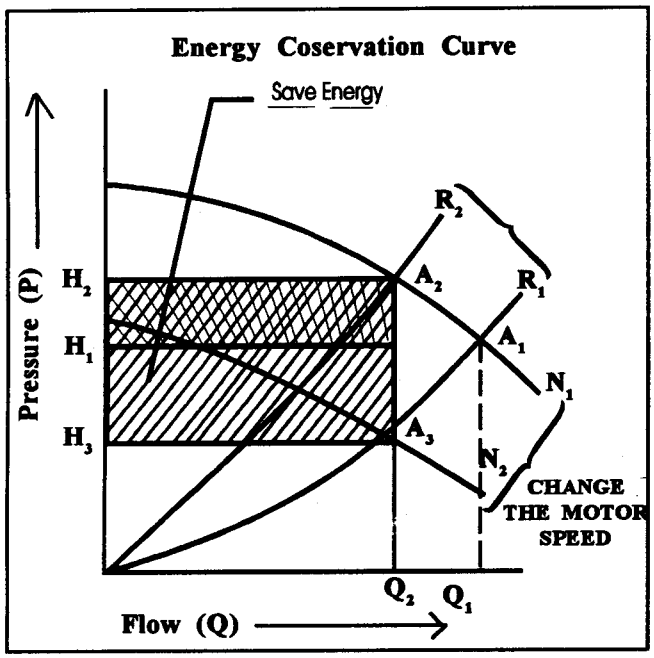
TABLE-3

	1996-1996	1997-1998	1998-99	Remarkds
Electricity (kWH)	1451.0	1306.0	1281.0*	*Reduction in purchase of power from KEB grid
Furnace Oil (Lts)	2.36	2.04	65.36*	*Multifuel DG sets operated with furnace oil.
Coal (MT)	1.46	1.33	0.99	
Diesel Oil	87.71	118.82	99.29	

NOTE:

The requirement of energy varies with the quality of the Paper/Paper Board made which fluctuates annually, depending on the product-mix and raw material-mix being utilised for manufacture of different qualities of paper/paper board.

Figure - 2

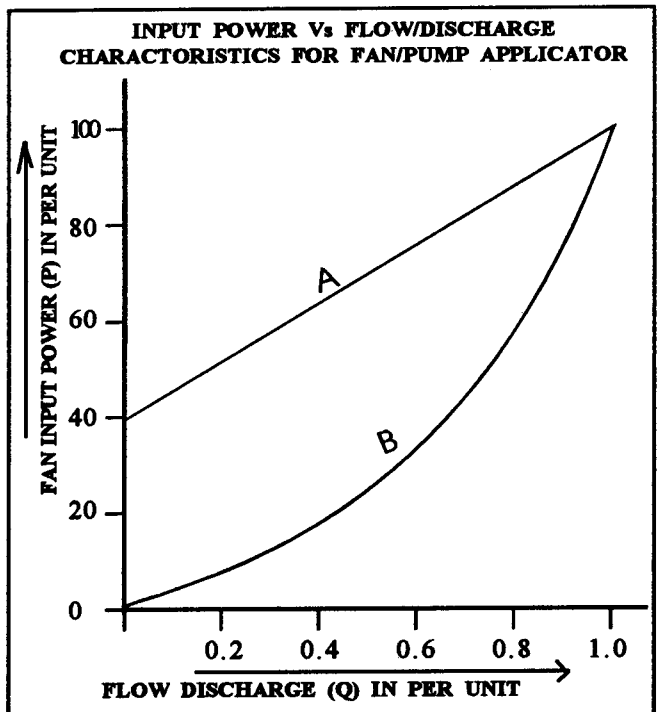


specific consumption of electricity, coal, diesel oil and further drastically reduced the power purchase from KEB grid as summarised in table -3.

ANNEXURE -1 BIO-DATA OF SHRI.J.R. MASAND.

Shri. J.R. Masand FIE, is an Electrical Engineer, fellow member of the Institution of Engineers (India) Calcutta, specialised in Training and Development

Figure - 3



A = Damper Control [P=0.4 + 0.6 Q]

B = Inverter control [$P=Q^3$]

Assumption:-

1) **Statics head on the fan/pump is negligible.**
2) **Fan/Pump input is 0.4 per unit under flow/ discharge is zero i/e Damper/Valve fully closed.**

Where P = Input Power Consumed

Q = Flow/Discharge

with a Post Graduate Diploma awarded by the ISTD New Delhi.

He has specialised in execution of large power projects, commissioning of 70 MVA, HT/LT substations, utilities services in various large process plants of repute like Hindustan Copper Ltd., Khetri Nagar Copper, refinery, fertilizer complex.

He has also worked in large process plants and light engineering industries as head of engineering /Maintenance departments in the capacity of chief

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He has also worked in large process plants and light engineering industries as head of engineering/ Maintenance departments in the capactity of chief engineer and Divisional Manager (Maintenance.) for more than 10 years, visited Germany and other European countries for attending training programme on DG sets and solid state Dynamometers.

Prior to joining The West Coast Paper Mill Ltd. he was employed as a General Manager (Production and Maintenance) at Fort Gloster cable Industries Ltd., Calcutta.

Presently he is Incharge of Energy Conservation Cell, Coordinator (Energy Management) at the West Coast Paper Mills Ltd. and also looks after the planning and coordination of executing new electrical projects related activities for the ambitious expansion programme to increase the production mix to 1,65,000 MT / Year by December 2001.

ANNEXURE-2- BIO-DATA OF SHRI. K. JAYASIMHA

Shri. K. Jayasimha is a Chemical Engineer graduated from Indian Institute of Technology Bombay, Specialised in the PERT/CPM project management techniques with a certificate course awarded by NITIE Mumbai.

He worked at WCPM from 1965 to 1975 and again from 1984 to till date, he has vast experience of our 30 years in execution of large integrated pulp and paper projects. He successfully executed all the expansion and modernisation programmes at WCPM within the plan, budgets and targets set which has enabled the WCPM to increase the paper production from 24,000 MT/Year to 1,20,000 MT/Year.

He is also actively involved in the ambitious expansion programme of WCPM to increase the production further to 1,65,000MT/Year to be completed by December 2001. He also has to his credit rich experience of Consultancy engineering services for the period of 10 years (1975-1984) at Bhargwa Consultants New Delhi, where he had executed a large number of pulp and paper projects. He has also visited abroad a number of times as part of his consultancy assignments.