Energy management in pulp and paper industry

RANGAN S.G.,

Introduction :

Industrialised nations have been enjoying a plentiful supply of cheap energy for the past four decades. The cheapness of this energy has encouraged the replacement of human labour by energy intensive process and discouraged expenditure on energy conservation measures. Due to this, there has been an exponential growth in demand of energy which has now reached such a proportion that it is severely straining capacity of the energy supply systems in most of the countries.

Global Trend Vs India :

A world bank survey on energy efficiency using annual growth of energy intensity (energy consumed per unit of industrial out put) as an indicator reveals that it was negative in developed countries (i e.) improvement in energy efficiency. In contrast the energy intensity growth was positive in the case of India.

Energy Scenario in Our Country :

In India for the seventh five year plan outlay for energy sector is staggering Rs. 54823 Crores which is 30.5% of total plant outlay. Pulp and Paper Industry is a heavy energy consumer using process steam, electrical power..

Energy Consumption Trend of Various Industries

S No	Industry	Energy Consumption Thermal %	Electrical %	Annual Energy Cost Rs Crores	% Energy Cost of Manufacturing Cost
1.	Textile	67	33	680	11
2.	Cement	92	8	395	40
3.	Paper	90	10	187	18
4.	Glass	—	—	70	30
5.	Tyre	83	17	35	15
6.	Edible Oil	84	16	35	12
7.	Jute	72	28	32	6.3

Pulp and Paper Industry :

In tnis process heating, cooking, evaporation and drying need steam. Pumps, fans, blowers, agitators and refiners use electrical energy. Energy costs contribute between 16%to 40%of the production costs in our country. Cost of production for various material inputs in a very efficient Indian Pulp and Paper mill is given below ;

COST OF PRODUCTION

S No.	Material Inputs	Rs/T	%On Total
1.	Raw Materials	2362	31.3
2.	Chemicals	2040	13.8
3.	Stores & Spares	449	5.9
4.	Power & Fuel	1236	16.4
5.	Repairs & Maintenance	100	1.3
6.	Handling	167	2.2
7.	Salaries & Wages	604	8.0
8.	Admn. Selling & other Expenses	470	6.2
9.	Depreciation	570	7.6
10.	Interest & Finance Charges	550	7.3
	Total	7548	100.0

The specific consumption of energy in Indian mills is very high based on the age of the mill, furnish used, in house measures adopted, and conservation strategies in vogue compared to energy consumption in mills in developed countries, energy consumption in India in the paper industry is very high.

*President
Indian Pulp and Paper Technical Association
Adviser
M/S. Seshasayee Paper & Boards Limited,
Madras-600 034

When viewed at the Industry level, the specific energy consumption in high energy intensive industries in India should be comparable to develop nations whereas it is much higher as given below :

A Comparison of Break-Up Energy Utilisation of a Typical Indian Integrated Kraft Paper Mill Viz. A Swedish Integrated Kraft Bleached Paper Mill

S. No.	Description	Indian Mill	Swedish Mill
1.	PURCHASE ENERGY (M-CAL) :		
	1. Fuel	9.37	3.53
	2. Power	0.76	0.76
	TOTAL	10.13	4 29
2.	FUEL SOURCE (M-CAL) :		
	1. Purchased Fuel	9 73	3 53
	2. Internal Fuel	4.48	4.65
	TOTAL	13.95	8.18
3.	FUEL UTILISATION (M-CAL) :		
	1. Steam Cycles & Processes	11.47	7.38
	2. Back Pressure Power	2 48	0.80
	TOTAL	13.95	8.18
4.	ELECTRICITY KWH :		
	1. Purchased Power	918	902
	2. Back Pressure Power	658	787
	TOTAL	1576	1689
5.	BACK PRESSURE POWER :		
	Generation efficiency	22 80	85

Energy Utilisation in Selected Industries in India And in Developed Nations

S. No.	Industry	Unit	India	Developed Nations
1.	Iron and Steel	Million KCal/Ton	9-9.5	4-6
2.	Cement	Thousand KCal/Kg	1-1.4	0.6-0.9
3.	Aluminium	Thousand KWH/Ton	16-20	13-15
4.	Pulp & Paper	Kg Steam/Kg	12-15	5-8

Processes : A Schematic diagram of the Pulp and paper making process is enclosed which gives an idea of all operation involves. Power and steam consumption in a typical 100 TPD integrated pulp and paper mill using bamboo/wood as raw material is given below :

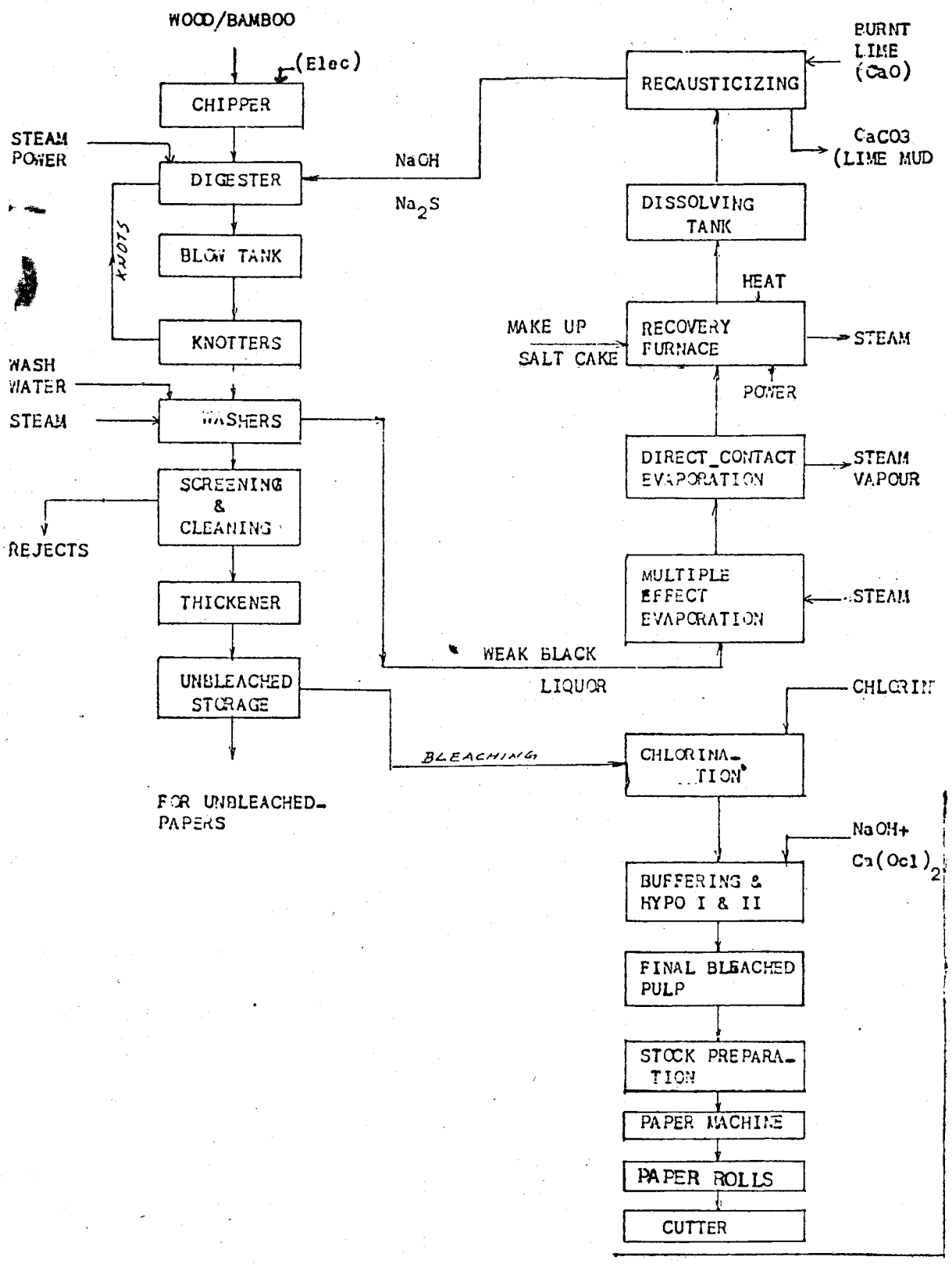
S. N.	Power	Power KWH per Tonnes
1.	Chippers	74
2.	Digester	37
3.	Rag Plant	54
4.	Washing/Screening	120
5	Bleach Plant	94
6.	Stock Preparation	276
7.	Paper Machine	366
8.	Boiler (Including water Treatment)	205
9.	Recovery	115
10.	Others including losses	160
	TOTAL	1501

S. No	Steam	Per Tonne of Production
1.	Pulp Mill	2.69
2.	Evaporators	2.18
3.	Soda Recovery Plant	1.05
4.	Bleach Plant	0.20
5.	Paper Machine	3.64
6.	Deaerator	0 97
	TOTAL	10.73

Causes For Energy Losses in Pulp and Paper Mill :

1. Low ffiiciency of steam genarator (Boiler) and lower back pressure generation.
2. Low efficiency motors and over sized motors.
3. Poor housing keeping, leakage's of steam, water air etc.
4. Lower capacity utilisation of power intensive chippers and refiners.
5. Use of less efficient equipment like bodies and wide angle refiners.
6. Higher liquor to chips ratio and direct heating in batch digester.

SCHEMATIC FLOW DIAGRAM OF THE KRAFT PROCESS



7. Inadequate thermal insulation and steam trapping systems.
8. Low solid content in black liquor fed to evaporators.
9. High degree of water content in paper leaving the press.
10. Poor condensate return from points of steam usage.
11. Poor waste heat recovery from blow heat, boiler, blow down etc.
12. Use of obsolete pressures and equipments which are energy intensive.
13. Lack of proper control of various process and energy parameter.
14. Poor capacity utilisation of equipments.
15. Absence of effective cogeneration systems.

Methods of Energy Conservation in Pulp and Paper Industry :

(a) Generate steam at its peak efficiency and at highest possible parameters so that the back pressure power output is maximised.

(b) Reduce distribution losses within the mill.

(c) Incorporate optimum waste recovery systems.

(d) Technology upgradation by modernisation and use of equipment with high Productivity design's.

(e) Capacity Utilisation

(f) Resorting to better instrumentation for optimisation of resources and energy.

Urgent Remedial Measures To Be Undertaken By Individual Mills For Improving The Energy Efficiency :

CHECK LIST : (WITHOUT INVESTMENT)

(a) Chips fines that are thrown along with dust from the screens in chipper mouse should be recovered for cooking.

(b) Continuous and uniform feeding to chippers at almost as rated capacity.

(c) Preventing idling of chippers during, tea break for workers and shift changes.

(d) The size of logs or bamboos can be brought up to suit the mouth of chippers by bundling of thinners ones.

(e) Better maintenance and knife change at optimum number of hours with investment which can pay back in less then two years.

(WITH INVESTMENT)

(a) Replace low capacity chippers with higher capacity ones (20-30 tonnes per hour). The energy consumption can be almost half.

(b) For conveying chips, the old practise of blowing should be stopped and belt conveyors and elevators should be used.

(c) Increase chips storage capacity for higher capacity utilisation of chippers.

(d) Mechanical handling of wood and bamboo to feed high capacity chippers should be introduced.

DIGESTERS : (WITHOUT INVESTMENT)

1. Use bath ratio not more then 1:2.5. Care should be taken to see reblow are not increased. If bath ratio is increased to 3 form 2.5, the energy consumption would increase to 25,000 KCal/ADT.
2. Dilution of white liquor should be with semi concentrated black liquor. TAA in white liquor itself should be of high concentration say about 110 gpl (NAOH+Na2s).
3. Use of indirect steam in digester should be encouraged. There is hardly any justification for use of direct steam in digester at all.
4. Stop the circulation pump for one hour atleast during cooking time.
5. H-Factor should be calculated after bringing digester to pressure and cooking time should be adjusted suitably.
6. Do not employ high cooking temperature. A reduction by 5°C may save at lot of energy at acceptable quality levels.

(WITH INVESTMENT)

1. Use of continuous digesters inplace of batch digesters.
2. Insulation of digesters should be checked and corrected for lowest heat loss.
3. Utilise blow heat recovery.

Brown Stock Washing, Screening & Bleaching :

(WITHOUT INVESTMENT)

1. Use optimum dilution on the last washer.
2. Make frequent checks for air leakages in barometric legs and seal them.
3. Avoid frequent start—stop. Run the plant for for less number of hours at full capacity.
4. Use 70°C hot water for washing brown stock, pulp in last washer and see that wash nozzles are interspaced properly for covering the entire mat.
5. Stop agitaters of all storage chests and towers whenever the pumps are not in use. Tuners can introduced to prevent setting of pulp.
6. White water from paper machine can be used at appropriate place.

(WITH INVESTMENT)

1. Better washers are available today in the market for squezzing out liquor from cooked pulp. Chemi washer, double wire press washer etc. These consume only 1/3 energy and are able to send to evaporate higher solid liquor.
2. Introduce proper screening equipment for filtering off fibre fines black liquor. This will improve heat transfer in evaporator.s
3. Replace steam doctors with simplified air doctors.

CHEMICAL RECOVERY :

(WITHOUT INVESTMENT)

1. As far as possible, use a ll the effects in evaporator street to get the benefit of maximum steam economy.
2. Firing of black liquor in furnace should be at 60-65% solids to get maximum thermal economy.
3. Flue gas temperature outlet of boiler should should be minimum 150°C to have optimum life of electro statistic precipitator.
4. Furnaces should be run without much stoppage by continuous lancing of passes, in addition to frequent soot blowing.
5. High quality lime should be used (min 70% CaO and the same should be allowed to get deteriorated in godown due to prolongod storage. First arrived loads should be used first.
6. Proper distribution of air of Primary, Secondary and Tertiary air ports, depending on liquor burning characteristic will help in good reduction of salt cake.

(WITH INVESTMENT)

1. It is a good practice to get a demister installed above the dissolving tank to get higher recovery.
2. Use of Free Flow Falling Film evaporators in place of rising film ones will reduce scaling problems and improve capacity of evaporators for a given number of effects.
3. Vapour recompression technology should be brought into conserve energy.
4. Use of vacuum pumps in conjuction with steam ejectors will be economical in many instances.
5. It is better to design the mud washers for lower percentage of Cao lime. For stage (3+1 Lime mud washer) washing has become now an accepted practise.
6. Increase in number of effects and even eight effects are justified based on expected steam economy of seven.
7. The older design evaporators of short tube natural circulation evaporators with M.S as material of construction needs replacement with stainless steel long tube vertical evaporators with forced circulation finishing effect.
8. Desilication of sludge and reburning of lime mud to lime can complete the cooking cycle. With utmost economy without depleting the lime stone reserves.
9. Insulate all weak and strong black liquor tanks.

STOCK PREPARATION :

WITHOUT INVESTMENT

1. Use effectively and judiciously the specific power of refiners available.
2. Chemical additives can be tried for. getting increased strength at lower freeness of pulp.

3. Brokes and waste paper should be proportionately added to the system.
4. White water from paper machine should be used for dilution in pumps.
5. Retention of China clay/soap stone powder should be about 60%.

(WITH INVESTMENT)

1. Install Tri disc refiners to reduce specific energy consumption to atmost 40% level.
2. Discard beaters and inefficient conical refiners.
3. Install efficient savalls fo recovery of fibres.

Approach Flow System & Paper Machine Section :

(WiTHOUT INVESTMENT)

1. Use the wet and effectively to get as much dryness as possible at paper web leaving the press section.
2. Avoid breaks and maintain runnability at 95% level.
3. Avoid frequent start-stops.
4. Whenever machine is shut for any reason, attend to leakages of water, pulp and steam (particularly through rotary joints.)
4. In non calendered papers/boards, maintain higher moisture than at present to the extent possible.
6. Performance of felts should be watched continuously-Felt changes should be taken up as soon as moisture content increases in paper web.

(WITH INVESTMENT)

1. Study and install double dilution systems to reduce 20-24% of power demand.
2. Use of low energy consuming central cleaning system which are widely in use today.
3. Most efficient pressing systems are available which can lead to almost nil breaks and up to 40% dryness in paper webs.
4. Thermal insulation covers for dryers can be introduced.
5. Revamp the steam and condensate system and use judiciously the flash steam and condensate in predryers.
6. Use of dryer screen with P.V. fans will resulte in 10% more productivity.
7. Installation of full width suction boxe for felt cleaning and changing of conventional felts with 100% synthetic content for conservation of energy.
8. Use flat belt drives instead of V-Belts as 15% energy savings are possible.
9. An on line computer control mechanism for correction of basis weight, moisture, caliper and ash should be installed.

PUMPS :

Nearly 40-50% of the total energy in a paper mill is spent in pumping of various liquors. It is necessary to select efficient pump for each operation. In many cases, it is worth while to install variable speed drives to keep optimum efficiency. High consistency pump should be used more liberally to save energy.

UTILITIES :

1. It shoul be made compulsory for steam consuming section that 100% condensate must be returned by them.
2. Good house keeping by better maintenance canbring in large savings in Energy. Steam leakages through glands, trap should be plugged as and when they develop.
3. **Insulation** of all steam lines, digesters and strong black liquor tanks, evaporator bodies etc.
4. **Steam Traps** should be complete with necessary fittings such as stainers, stop valves, check valves, sight glass and by pass arrangements. When sight glass is blurred, it is better to measure the temperature before and after the trap. Equal temperature on both sides warrant a thorough examination of that trap.

   Line end traps and line traps should be preferrably of thermo dynamic type and float traps can be used in 90% of equipment, where the load during working does not vary very much.
5. Use oxygen monitoring portable equipment or oxygen percentage recorders to control excess air in boilers.

6. Install, fluidised bed boilers or bring in this concept in existing boiler by retrofit presently available in our country. Any fuel can be burnt with 80% plus efficiency. Also high ash coal (70%) can also be burnt without any problem.

7. Add instrumentation/Micro processor control to existing on new boilers to be ordered for proper consumption control.

COGENERATION :

8. Major portion of process heat requirement in a paper mill is at lower temperature and lower pressure than that of any other industry having favourable heat to power ratio, For cogneration 75% of process heat requirement is met with steam pressure of 3.5 kg/Cm^2 and the rest at 10 kgs/Cm^2. Power yield could be increased by maintaining a huge difference in pressure used and pressure of steam generated.

   A back pressure turbine with a single extraction can be an ideal choice. However, limitation of this system will be the poor flexibility to absorb variations in loaal demand.

9. Most of the paper mills operate their captive generation units in isolation from grid power supply. Parellel operation of self generation with grid supply will greately smoothen the fluctuations and effect a higher cogeneration efficiency.

10. In the absence of the above system, choice of a turbine with extration at two pressures and a condensing facility for accomodating fluctations would be ideal.

11. Conservation of use of fresh water is must. The most water efficient paper mills in our country still consume almost twice than that of an average American mill of 1970 standard.

12. Leakage and misuse of compressed air should be avoided.

13. Recovery of spent lubrication oil should be done. This is being practiced in some mills.

14. Bark, wood, bamboo dust, pith and dried sludge should be used for mixing steam Suitable boilers to burn these mill waste are readily available today. The economics of burning some of these waste materials with coal as such or as briquttes should be explored.

ELECTRICAL :

1. Power factor should be improved to at least 0.95. Capcitors shoud be added whenever possible to reduce line and transformer losses.

2. Replace the incandecent lights with fluorescent, mercury or sodium vapour lamps, which use fewer watts per lumen-

3. Install central control of lighting to limit use of eiectricity during not working hours.

4. Install spot lighting for machines whereever necessary so that unwanted lights on machines not working can be switched off.

5. Use photo cell control on out do r as well in door to minimise their use during day time.

6. Install timers on light switches in little used area.

7. Reduce the height of light fittings to give better illumination with minimum fittings.

8. Clean often the dirt and dust accumulated over the fittings and bulbs to improve the performance.

9. Reflecto lights may be used to avoid light wasted to roofs and other unwanted areas.

10. Put "TURN OFF when not required" stickers on room light switches.

11. Avoid "Over Motoring" pumps and other drives

12. Review cable sizing from energy loss particularly in low voltage high current application.

13. Consider using high voltage motors whereever possible especially in higher range.

14. Install meters for each and every section to moniter the power consumed by them individually. Individual meter readings when totalled should tally with the incomer meter readings.

15. Transformers should be located as close to power consuming centres as possible.

CONCLUSION :

Energy conservation is not without benefits. Savings of as much as Rs. 200-Rs. 500 per tonne can be made by constant monitering of consumption of energy and taking timely preventing action.

REFERENCES

1. Energy Conservation Hand Book Utility Publications Limited, Jan. '88'Secunderabad .
2. Energy Utilisation and Conservation in Pulp & Paper Mill
   By S.G. Rangan, In
   "WORKSHOP ON ENERGY" Paper and cement Industries
   ICICI
3. IPPTA Volumes June 1984
   March 1985
   March 18 & 19, 1985.
4. Energy Audit in Paper Industry
   By NPC
   For Inter ministerial working group