Energy conservation in pulp and paper industry

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The oil crisis that was experienced in recent years has brought about a global awareness on the need for the conservation of energy. The tremendous growth of industries, transport and agriculture has further worsened the energy position. This has given rise to a grave situation where the fittest can only survive and those industries which do not manage their energy requirements properly will suffer to a great extent. The industrial sector constitutes a major user of energy in different forms. Conservation of energy can be best effected by this sector due to bulk nature of energy utilisation and expertise availability for better energy management.

The Paper Industry is considered to be falling under energy intensive sector as energy constitutes a very important input. The cost of energy in paper industry comprises 20–25% for mills having captive power generation and 25–30% for mills not having captive power generation. Thus the energy bill runs to a substantial amount and even small savings in the energy will result in appreciable profits, particularly in the case of mills where margin of profit is low. As an example 1% saving in the energy bill for a new mill like ours will result in an increase of profits by about 17%.

The Paper Industry requires about 85% low grade energy and 15% high grade energy. The low grade energy is required in the form of steam for process heating. The high grade energy is in the form of steam for process heating. The high grade energy is in the form of electricity which is mostly used as motive power for drives. This is an ideal situation for co-generation.

The following alternatives are available for co-generation :

1. Back pressure turbine.
2. Extraction cum back presure turbine.
3. Double extraction and condensing turbine.

The medium pressure steam requirement is of intermittant nature where batch digesters are used for cooking. In addition the low pressure steam demand in paper machine and evaporators is also subject to variation depending upon the process rate. Similarly the electrical load on the turbine is subject to variation depending upon the plant running condition. When the turbo-alternator is operated in isolation, the balancing of power generation with the steam demand is not possible due to the above reasons and a substantial quantity of process steam has to be by-passed in order to maintain stable operation of the turbo-alternator. Where parallel operation with grid is permitted this difficulty can be got over and optimum power generation can be attained. However there is a reluctance on the part of Electricity Boards to permit parallel operation. Where parallel operation is permitted, an extraction cum back pressure turbine is most idealy suited. An alternative arrangement would be to have a double extraction cum condensing set. The condensing turbine should be suitably sized to take care of the variations in the medium pressure and low pressure steam demand. This will work economical where the difference in the cost between purchased power and self generation in the condensing set is not very high and the overall benefit by way of incresed co-generation over rides the increased cost of generation in the condensing set.

The quantum of co-generation can be increased by increasing inlet steam pressure of the turbines. The following table gives the approximate theoretical levels of co-generation for different inlet steam pressure at the turbine. However the actual output will be decided by the efficiency of turbine, which in turn depends upon the design aspsects.

Inlet steam pressure (Kg/Cm^2)		% of co-generation
30	—	100%
42	—	110%
60	—	130%
100	—	150%

Some of the factors affecting efficient generation of steam are discussed below :

The most serious problem

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facing the industry is the poor quality of coal with very high ash content. The operation of the boiler is further complicated due to the variation in the ash content of the coal, ash fusion temperature, volatile content and the variation in the process steam demand. There being no hope of any improvement in the quality or the type of coal received by the mills, the only alternative for the mills is to improve their systems to take care of the eventualities. The boilers should be suitably designed for burning the coal with high ash content. The old type of chain grate stoker boilers are not able to meet the requirements. The alternatives available are spreader stoker, stepgrate, and the fluidised bed. A study reveals that at lower ash fusion temperature, the combustion is more improper because the fused ash does not permit free passage cf air under the coal bed. To some extent this problem can be taken care of by the above type of stokers.

In Indian Paper Industries the efficiency of boiler is ranging from 60—70%. A mere increase of 5% in thermal efficiency of the boiler will result in substantial savings.

For example a 20T/hr. boiler operating at pressure $31 Kg/Cm^2$ and an efficiency of 60% will consume coal at the rate of

$$\frac{20 \times 675 \times 1}{0.6 \times 4800} = 4.66 \text{ T/hr.}$$

If the efficiency is increased to 65% the consumption coal will be

$$\frac{20 \times 675 \times 1}{4800 \times 0.65} = 4.20 \text{ T/hr.}$$

For a boiler operating for 7000-hrs. a year, the net saving per year will be

$7000 \times 0.46 \times 450$
$= 14.4$ lac. rupees.

The process chosen should be such as to give the best steam utilisation efficiency. For example in the paper machine dryers, cascading system of drying gives much higher efficiency than the conventional form of drying. For proper heat transfer in the drying cylinders, about 15% blow through steam is required. In the conventional form of drying, this steam gets condensed in the condenser. By having a properly balanced cascading system it is possible to utilise the blow through steam in successive stages, thereby reducing the over all steam consumption. In addition, about 6% of flash vapours are re-utilised by the cascading system.

Evaporator station is another bulk steam consuming point. It is the general practice to provide 4 effects vaporators. Increasing the number of effects from 4 to 6 can considerably reduce the steam consumption. For Indian conditions with the present coal price even 6 effects is found to be quite economical when compared with the investment. But in the case of long tube evaporators in view of boiling poinr elevation the differential temperature comes down since the boiling point elevation for the required hydrostatic head is to be subtracted from the differential temperature. In view of this even if more effects are to be provided the sizing becomes very big and uneconomical. By having falling film evaporators the reduction of differential temperature due to boiling point elevation contributed by the hydrostatic head can be eleminated in the zone of heat transfer and more effects can be provided economically. However this technology is not introduced in an effective fashion in India as yet. In multiple effect evaporators the last stage vapours are condensed in the surface/barometric condenser. The latent heat and the sensible heat of the vapours are not effectively utilised since it is cooled by cold water which is having limited applications. By having thermo compressors this vapour can be recompressed back. The energy needed will be only differential total heat between the last stage to the first stage and the latent heat for the last stage vapours will be saved. Wherever thermo compression is adopted the number of stages also can be reduced considerably. Generally 3 stages are sufficient as against 6/7 stages in the conventional design, thus reducing the investment cost. The thermo compressor can be either in the form of simple ejector utilising high pressure steam as motivating medium or multiple stage turbo compressors. The ejectors are utilised beneficially where co-generation is either not exsiting or inadequate and HP steam is available. Turbo compressors can be utilised advantageously where the purchased power cost is low

In the paper machine proper selection of the presses has a bearing on the energy requirement for drying With modern presses capable of high nip loading, the moisture of the paper web can be reduced from 82% to 58% (a reduction of 24%) as compared with 82% to 64% (reduction of 18%) in the conventional presses. This improves efficiency and reduces the steam requirement in the dryer sections.

By using proper quality of machine clothing like synthetic felts in presses and screens with PV ducting in dryer section, efficient moisture removal can be achieved.

While selecting the centric-leaners, care should be taken to choose the one which gives lower pressure drop so that the pumping load is minimised.

The seclection of the pumps is another important area where lot of care is to be excercised. The general tendency is to provid data to pump suppliers with excessive safety margin both in quantity and head, taking into consideration maximum production and future requirements. If the pump is selected for the best efficiency at the given duty conditions, the efficiency will be much lower when actual operating quantities and heads are lowered. Additional safety margins considered by the pump suppliers will further reduce the actual operating efficiency. The result of all these is wastage of power. There are however certain applications where the quantity and head required will be varying for different process conditions. In such cases a variable speed drive should be selected. This will avoid throttling of delivery valves of pumps or outlet dampers of fans. In certain cases if the variations in the head and quantity will be in specific ranges, the application of a pole changing motor may be a more economical alternative. For conveying chips mechanical conveying system (Belt conveyors) should be used as against pneumatic blowers as substntial power can be saved.

Not withstanding the various points discussed above, a mere awareness of the importance of economising on energy and proper controls will bring in some amount of reduction in the energy consumption. The first step for a running mill energy conservation is to initiate the following management actions which will not involve any investment.

1. Establishing daily reliable energy reporting system.
2. Assigning meaningful overall responsibility of energy consumption at all levels.
3. Adopting daily energy audit and displaying of energy consumption charts to bring in consciousness at all levels.
4. Maintain loads of constant nature no co-generation where parallel operation with grid is not permitted.

The second step would be to initiate measures where the expenditure involved will be very marginal. For example in Sree Rayalaseema Paper mill, by trimming the impellers of the pumps and by reducing the pulley diameters of drive motors, a total saving of 300 KW has been achieved.

A general check list for energy conservation is enclosed in the Annexure – 1

Although the individual measures of conservation may look insignificant in nature, all of them put together can result in substantial saving of energy.

Annexure-II & III indicate the pattern of energy consumption and energy costs of Sree Rayalaseema Paper Mills.

In conclusion the approach to energy conservation should be one of continuing nature. The guiding spirit behind the energy conservation programme should be the realisation that there is always scope for improvement.

ANNEXURE – 1

The following are some of the measures to save energy :

1. Careful planning and layout of electrical and steam distribution system.
2. Providing adequate size of conductors for electrical distribution system and pipes for steam distribution ststem.
3. Avoiding use of higher capacity transformers than required.
4. Maintaining proper voltage level by extensive use of OLTC at key sub-stations.
5. Limiting the length of LT distribution feeders.
6. Improvement of P.F. by installing capacitors of right size and quality.
7. Illuminations are to be properly designed and monitored.
8. Installing high efficiency and high PF AC induction motors.
9. Replacing the motor generator sets with modern solid state drives.
10. Use of conveyors instead of blowers for conveying material.
11. Use of level switches for dewatering pumps to reduce running hours.
12. Use of high pressure sodium vapour lamps in place of incandescent and mercury lights to have more luminery output for the same rating.
13. Minimise the variations in the electrical maximum demand by staggering of batch operations.
14. Selecting of centrifugal vaccum pumps for low vaccum applications instead of liquid ring vaccum pumps.
15. By providing proper insulation to the steam pipe lines and valves.
16. Locating steam generating stations nearer to the major steam consuming centres.
17. By providing adequate steam traps and vents at suitable locations.

18. By using right quality of steam with effective load management.

19. Segregation of high pressure air water and adopting boosting only for such points.

20. By adopting high consistency operation in pulp mill.

21. Add heat recovery system to boiler godown.

22. Installing hood over paper machine and pocket Ventilation to improve drying efficiency.

23. Recover heat from dryer exhaust.

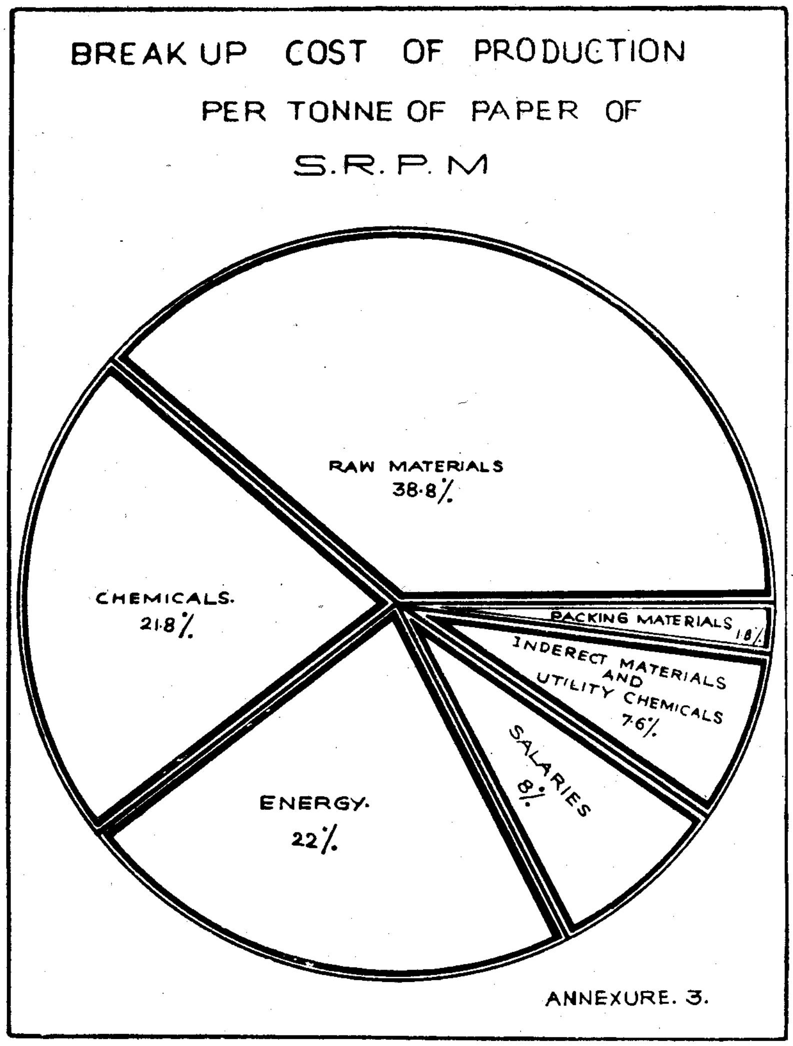
24. Layout plant by utilising natural gradients to reduce pumping loads.

ANNEXURE—II

THERMAL AND ELECTRICAL ENERGY CONSUMPTION OF VARIOUS OPERATIONS IN M/S. SREE RAYALASEEMA PAPER MILLS LTD.

Sl. No.	Section	Thermal energy MK.Cal./ Ton of paper (Machine production)	Electrical energy KWH/Ton of paper (Machine production)
1.	Chipper House	—	26.7
2.	Digester House	1.27*	30
3.	Brown stock washing	—	49
4.	Screening	—	83.2
5.	Bleaching	0.09	85.6
6.	Paper Machine	1.94	631
7.	Boilers	0.36	138.6
8.	Evaporators	1.18	28
9.	Recovery Boiler	0.42	41.9
10.	Causticizing	0.48	28.5
11.	Effluent	—	94
12.	Water supply	—	146
13.	Colony	—	5.2
14.	De-inking plant	—	68.7
	Total :	5.64	1372

Total energy consumption per tonne of paper production : 5.64+1.17=6.81 MK.Cal.
Note : *Out of the total pulp about 18.6% waste paper pulp is utilised.


BREAK UP COST OF PRODUCTION
PER TONNE OF PAPER OF
S.R.P.M
RAW MATERIALS
38·8%
CHEMICALS.
21·8%
PACKING MATERIALS
1·8%
INDERECT MATERIALS
AND
UTILITY CHEMICALS
7·6%
SALARIES
8%
ENERGY.
22%
ANNEXURE. 3.