Energy Conservation in Pulp and Paper Industry—Some Thoughts

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SUMMARY

Pulp and Paper Industry is highly energy intersive. In view of the spiralling fuel prices and rising power costs there is an urgent need to conserve energy through better management of various operations in the industry, from the optimal utilisation of the forest residues to the despatch of final product.

The present paper touches upon the total energy concept, viz. energy generation, distribution and utilisation in Indian Paper Industry. The need for an energy audit cell is emphasized and the formats of energy reporting forms are included. The paper out-lines short and long term measures to be enforced to achieve energy savings in the Pulp and Paper Mills Some important energy conservation approaches are also discussed in the paper. The paper also deals with the factors affecting energy efficiency in a pulp and paper mill. Some areas where sustained R & D efforts should be focussed to make the Paper Industry nearly self-sufficient in energy generation and utilisation are also given. It is essential to have a National Energy Policy clearly defining achievable targets of energy conservation for industry. Indian Paper Industry could advantageously form its own committee to review the working of the various mills in the country and come out with concrete solutions for higher efficiency and more effective conservation of energy.

INTRODUCTION

General :—The world is getting through an unprcedented energy crisis today. The energy crisis is all the more menacing for less affluent countries like India, because low energy availability considerably dampens the much needed economic growth.

Development is highly sensitive. It is calculated in a study, that for an Indian population of 1034 Million and a per capita GDP (Gross Domestic Product) of Rs. 1025 (1970 figures are 579 Million and Rs. 630/-) by the turn of the century, the energy demand will go by from 392 MTCE (Million Tonnes of Coal Equivalent in 1970 to 1150 MTCE by 2000 AD[1].

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Though optionals like Solar energy, wind power, nuclear fusion, hydrogen as fuel and wave energy hold bright promise, there are so many technological and economic problems that remain to be solved before they will start contributing significantly to the world's energy requirements only in the next century. Therefore, the immediate alternative is to make the most of available energy, i.e. to embark on energy conservation. The goal of energy conservation, as spelled out by the World Energy Conference of 1978, is to achieve acceptable economic growth with a minimum increase in total energy consumption. The conservation measures, must of course, be technically feasible, economically justifiable and environmentally acceptable.

Energy Conservation entails a broad three pronged approach :

a) More efficient use of energy through modernisation of plant and machinery, and technological change.

b) Reduction in waste of energy through better house keeping, quality control and increased recycling.

and

c) More effective use of energy by reorganising and streamlining systems.

Considerable energy economics can be achieved by simple experiments like tightening maintenance, utilising waste heat, reducing rejects, smoothening and streamlining systems, and substituting materials needing lower energy to produce and process, for those requiring higher energy. All this can be done with minor changes in the existing plant and equipment and little capital expenditure.

PAPER INDUSTRY

Pulp and Paper Industry is highly energy intensive. An average ton of paper has a purchased energy requirement of 0.8-1.0 ton of coal (1 ton of coal $=26\times10^6$ BTU). Compared to this an average ton of plastics represents the energy equivalent of six tons of coal, and a ton of aluminium ingot represents an energy equivalent of nine tons of coal. Although Paper Industry is energy intensive it is at a very comfortable position when compared to plastics and aluminium which are at a disadvantage to replace cellulosic fibers[4].

The forest products industry is blessed with ownership of a renewable energy source. The forest convert Solar energy to a readily usable form. Much of the resulting vegetation has been left in the forests because it has been uneconomical to recover in comparison with alternative fiber supplies and alternative energy supplies. In the present context of galloping energy costs, this material represents a valuable source of energy and fiber, which must be recovered. This renewable source of energy plus the opportunity for greatly reduced energy consumption for our production processes, present greatest potentials for lessening energy crisis impacts in the long term.

The total demand of heat and electrical energy of a pulp and paper mill depends on the basic concepts of the mill design and choice of processes and equipments, as well as on the product mix and the process adopted. Hence the variation, in the figures, often reported in the literature for different mills.

Paper Industry is 40—45% self-sufficient in energy. The inputs of energy from external sources are from coal and fuel oil. Some mills use bark and chip residues also as fuels in their multi fuel boilers. Electrical energy is purchased from outside, depending upon the power generation inside the mill in turbines. On an average, the consumption of thermal energy varies from 15—20 MBTUS per ton in non-integrated mills to 25—40 MBTUS per ton in integrated mills. Electrical energy varies from 1200-1500 KWH per ton of product. Water consumption varies from 30,000-90,000 gallons per ton of product. The energy costs are about 15-20% of the product cost. Newsprint consumes about 25 MBTUS, Writing-Printing Paper 30 MBTUS, Duplex Board 20 MBTUS, and Kraft Paper 27 MBTUS per ton of product.

These consumption figures are around 25% higher than those reported in advanced countries, mainly because of the plant size and not so modern technology governing our engineering and process operations.

DELIBERATIONS

TOTAL ENERGY CONCEPT

A. Energy Consumption :—

The thermal and electrical energies for an American, Scandinavian and two Indian paper mills are given in Table 1.

TABLE 1—TOTAL ENERGY BALANCE FOR AMERICAN, SCANDINAVIAN AND INDIAN MILLS

Item.	MWH/Ton of Pulp, Mill A	Mill S	Mill-I Partially-integrated	Mill-I Integrated
Thermal energy	4.3	3.6	6.3—10.4	7.7
Electrical Energy	0.6	0.7	1.32—1.91	1.4
Total energy	4.9	4.3	7.62—12.31	9.3
Electrical energy (as % total energy)	12%	16%	15.6—17.3%	15.1%

American and Scandinavian pulp mills represent good mills but not the best. Of the two Indian mills one is partially integrated and the other an integrated. It can be seen from the table that the Indian mills consume 75—100% more energy compared to either American or Scandinavian mills. The low energy consumption in the Scandinavian pulp mills is due to a more effective utilisation of secondary heat source. The energy consumption viz. thermal and electrical energy for operations in Indian paper mills are given in Table—2.

TABLE—2 THERMAL AND ELECTRICAL ENERGY CONSUMPTION FOR VARIOUS OPERATIONS IN INDIAN PAPER MILLS

Sr. No.	Section	Thermal Energy MBTUS/Ton	Electrical Energy KWH/Ton.
1.	Chipper	—	40—60
2.	Digester	3.5—5	10—15
3.	Washing	1—2	45—60
4.	Screening and Cleaning	—	50—100
5.	Bleaching	1—3	80—100
6.	Evaporator	4—5	8—10
7.	Recovery Boiler	2—4	75—100
8.	Cousticizing	1.5—2	30—50
9.	Paper machine	7—12	700—1100
10.	Power block	1.5—2.5	180—220
11.	Water supply	—	70—100
	TOTAL	21.5—35.5	1318—1915

The energy consumption per ton of product varies, depending upon the type of product and the raw materials in the product mix. The higher the percentage of waste paper in the paper making furnish, the lower the energy consumption per ton of product. This is because the recycled paper can take advantage of power that has been expended in developing the fiber when first manufactured from the virgin fiber. Furthermore, recycled paper requires less energy than does virgin fiber in the drying process because of its lower water consumption. As a general rule, recycling waste paper requires 40—60% less energy in producing paper.

The primary energy generation centre in the paper mill is the recovery boiler where concentrated black liquor is used as fuel. In addition to this spent liquor, the mills some time use bark and wood waste also as fuels for energy generation. For the maximum energy generation it is essential to bring down the boiler heat losses (often as high as 25%) to the minimum and to maximise the use of forest residues from the forest as raw material for paper and fuel.

IN-PLANT POWER GENERATION

In case of turbines in integrated process industries, the fuel chargeable to power (FCP) is 4040 BTU/KWH as against 8700 BTU/KWH in the efficient plants generating electric power only. The higher the turbine inlet steam pressure and lower the process steam pressure, the greater is the power generation. The Scandinavians make use of the principle of optimum heat and power balance in the mill and have a higher boiler steam pressure than do the Americans, which gives a better back-pressure power rate (BPP) in the Scandinavian countries leading to a superior energy conservation approach.

B. ENERGY DISTRIBUTION AND UTILISATION

Energy generated in the chemical recovery boiler and turbo generator is distributed to the various sections in the mill. Since energy losses, in the distribution of steam are much higher than the transmission of electricity over the same distance, it will be advisable to locate the chemical recovery boiler central to the various steam consuming centres of the plant. Such a step will minimise the heat loss through the steam pipe insulation, in addition to reducing the investment cost required for piping net-work. The break-up pattern of energy utilisation in a paper mill is given below :—

1) Harvesting and transport of raw materials to the mill site. Fossil fuels are used. Rail or water transportation will reduce the energy requirement.

2) Wood/Bamboo Chipper & Chip Classification.

Electrical energy is used. Chipper energy consumption can be decreased by minimising oversize and undersize materials in the chipper product.

3) Chip storage :

Electrical Energy is required to transport chips to the storage bin and digesters. Energy consumption depends on the size and height of the storage bin. Chip storage is required due to the continuous operation of chipperchip classifier and batchwise operations in the digester.

4) Digesters :

Digesters use both electrical and thermal energy. The steam demand in digesters can be decreased by using low liquor to wood ratio and indirect heating in batch digesters.

Digester blow heat (flash steam) can be used to :

a) Preheat boiler feed water

b) Evaporate black liquor.

c) Preheat evaporator condensate before steam stripping.

5) Pulp washing and Screening :

Uses mostly electrical energy.

Counter current washing of pulp with hot water requires fewer stages. This also reduces evaporation demand at the evaporators.

6) Bleach plants ;

Minimisation of bleach plant effluent will lower the heat losses and energy required to process the plant effluent.

7) Evaporators :

Recompression of the vapours from the evaporators processing weak black liquor improves the steam economy. Use of falling evaporators in the concentrated black liquor side reduces fouling and increases solids content of the black liquor discharged.

8) Recovery Boiler :

Forced and induced draft fans consume electric power. Substitution of compressed air for soot blowing results in considerable energy (steam) savings.

9) Paper Machine Section :

Use of hot and higher consistency stock in the refiners can cut down the consumption of electrical energy in refiners. Efficient press sections in pulp dryers and paper machines reduce steam demand.

Exclusion of noncondensible gases in the paper dryer hoods will result in increased heat recovery by vapour recompression.

10) Closed water systems require less fresh water heating and pumping. Also, the closed water system reduces mill effluent.

11) Recovery of sewered fiber :

This is of great importance considering the amount of energy spent in obtaining, the fiber through various operations, from the raw material stage.

12) Product Transportation :

Whether it be truck, rail or ship, fuel must be consumed to reach the market. Rail and water transportation consume approximately 675 Btu/ton/mile versus 3800 for trucks.

OVERDESIGN AND CAPACITY UTILIZATION OF THE EQUIPMENT

Uncertainty and lack of reliable performance data leads to overdesign of equipment. An overdesigned equipment often operates at less than its best efficiency because it has too high a 'safety factor' or spare capacity. This leads to wastage of large amounts of unproductive power. A few examples of overdesigning are discussed below.

1) Over-sized fan :—an oversized induced draft fan can increase the stack gas flow rate and therefore increase the stack gas heat losses.

2) Oversized pump :—Specifying higher heads for the pumps while a lower head is required. Such a pump would invariably develop a high discharge pressure necessitating throttling on the discharge side of the pump. Throttling the pump discharge across a valve means dissipating electrical energy across that valve.

A faulty process plant lay-out where a line connecting two units has too long a pipe with too many bends or involves unnecessary changes in elevation, leads to the design of a pump of larger size than is actually required in a properly designed plant lay-out.

3) Capacity under-utilization of centricleaners leads to improperly cleaned fiber stock coming out of the accept nozzle and some of the stock bypassing through the reject nozzle. Such operations require extra energy for reprocessing the stock.

4) Capacity under utilization of the washers, screens and thickners also involve wastage of electrical power.

5) A mismatch in the capacities of any two equipment in a processing scheme can lead to unnecessary storage chests and bins. The sizes of chests and bins are proportional to the mismatch between two equipment. Pulp storage chests require propeller stirrers, and storage bins require belt conveyors to transport the chips into and out of the bin.

6) A change over from continuous processing to batch processing or vice versa would also require intermediate storage. This often results in loss of thermal energy and dissipation of electrical energy during the storage. Blow tank between the digester (batch operation) and washing (continuous) equipment is an example.

Therefore, proper sizing of the electric motors, pumps, fans and matching the capacity of various units are of utmost importance to minimise the energy wastage. In

addition, if the digestion and bleaching processes are made continuous, maximum recovery of heat from the various streams and minimum dissipation of energy in the storage system can be realised.

ENERGY AUDIT

The paper mill will benefit from a well established energy audit programme with an energy cell having the active involvement of the Company's engineering, process, R & D, purchase, marketing and management departments. The ultimate goal of energy audit is to make the paper mill self sufficient in energy. To achieve this, paper making systems uses energy successively at lower temperature till it becomes practically non-usable.

The energy cell will continuously generate and review the information on the energy utilisation based on the following areas :

A. Maximisation of energy generating efficiency.
B. Economic energy transmission.
C. Optimisation of energy uses and
D. Minimising waste streams.

A typical chart for daily audit programme is given in Table 3.

TABLE 3—DAILY ENERGY AUDIT FORM

Generating/ consuming plants	Norm	Actual	Revenue loss (Rs.)	Detailed reasons for deviations	Preventive action (Time Bound) Department/ Outside

The data generated in the energy audit and energy report forms will be useful in drawing up meaningful short-term and long term action programmes for conservation of energy.

SHORT TERM – LONG TERM ACTION PROGRAMME

The necessary steps required to effect the energy saving programmes can be broadly classified as short term and long term schemes.

Short term Schemes

These will include schemes with marginal or insignificant investments, considering the savings visualised. An urge on the part of operating personnel as well as management is necessary to bring results. These schemes should be taken in hand on war footing without loss of time for respeetive areas of energy savings. Some of the schemes are detailed below.

Long term Schemes

These will generally involve either a large capital investment or considerable time or both. Hence need will arise for fixing priorities periodically. The situation will tend to change when such schemes will come up for reviews due to uncertainties in energy availability and its cost structure. The schemes which were non-viable previously may become attractive. It might become essential to keep abreast with technology advances and energy price structure. Such schemes are detailed below :

GENERATION

Short Term

1) Control the amount of excess air
2) Minimise the unburnt carbon percentage in coal ash.
3) Reduce infiltration of cold air in boiler flue gas passages.
4) Improve power factor.
5) Ensure perfect combustion of fuels.

Long Term

1) Installation of equipments and systems for usage of cheap fuels like bark, bamboo dust and slivers, wood waste etc.
2) Replacement of oil by producer gas in recovery boiler, flash dryers, lime kilns etc.
3) Usage of non-condensing turbines for captive power generation.
4) Installation of high pressure, high temperature steam boilers for using it in captive power plants.
5) Install multi-fuel using boilers.

TRANSMISSION

Short Term

1) Improve thermal insulation.
2) Improve power factor.
3) Avoid slippage in couplings.
4) Avoid super heated steam transmission.

Long Term

1) Locate the load centers as near the transformers as possible.
2) Equipment locations should be such so as to avoid long pipe lines.

UTILISATION

Short Term

1) Recycling of condensate to a full extent.
2) Quick start up of sections with minimum idle running time of equipments.
3) Giving stress on higher solid concentration of black liquor to be fired in recovery boilers.
4) Use optimum higher stock consistancies.
5) Achieve maximum dryness in paper web after press section.
6) Reduce fresh water consumption by utilising max.back water.
7) Proper usage and assessment of soot-blowers.
8) Run the sections systems and equipments at max. efficiency and capacity.
9) Stop all sorts of leakages viz, oil, water, gas liquors etc.
10) Prepare production schedules according to the energy availability.
11) Eliminate blows of liquor digesters.
12) Reduce non-productive usages of electrical power.
13) Select electrical motors sufficient for the needs.
14) The energy inputs should be adjusted when process condition changes.
15) Use refiners fully. Do not run them on partial loads.
16) Reduce headbox recirculation.
17) Minimise water usage in wire and press, section by having efficient nozzles.
18) Reduce gland cooling water flow.
19) Lower the compressed air pressure to a minimum.
20) Lower the system temp. to optimum levels required for the process.

Long Term

1) Avoid direct contact evaporators.
2) Indirect steaming in batch digesters.
3) Installation of closed hoods.
4) Installation of cascade systems in paper M/C. condensate removal.
5) Increasing fuel storing capacity.
6) Have computerised process controls.
7) Replace size presses with blade coaters.
8) Have continuous digesters.

WASTE STREAMS

1) Reduce to optimum level flue gases of the temperature.
2) See that waste streams have only non usable residual thermal energy.
3) Continuous blow down tank vent can be connected to deaerators.
4) Continuous and intermittant blow downs can be connected to hot water systems.
5) The heat from the exhaust hood fan in dryer section can be recovered to some extent.
6) Utilization of evaporator condensates.

1) Blow heat recovery system.
2) Install effluent treatment system so as to utilise all the water back into the system.

ENERGY CONSERVATION APPROACHES

The causes of energy losses and energy conservation approaches to correct them are given in Table-4.

TABLE—4 ENERGY CONSERVATION APPROACHES

No.	Causes of energy losses	Approximate magnitude of losses (BTU/lb)	Energy conservation Approach
1.	Digestion of bamboo chips. Radiation and Convection.	100	Insulation maintenance.
2.	Vaporization of water in washer.	80	—
3.	Multi-effect evaporation Radiation and Convection.	75	Insulation maintenance.
4.	Heat in foul condensate	200	Design modification (Waste heat recovery)
5.	Heat in Water vapour leaving last evaporator.	1000	Design modification (consider additional effect)
6.	Direct heat evaporation recovery furnace Radiation and Convection.	100	Insulation maintenance
7.	Heat in flue gases	2600	Design modification (Waste heat recovery)
8.	Calcination Radiation and Convection.	120	Insulation, Design modification (housing of Kiln)
9.	Paper drying Radiation & conduction through hood.	100	Insulation
10.	Heat in hood exhaust gas.	1800	Design modification (Waste heat recovery)
11.	Overall process Drying of pulp in some pulp mills.	—	Process integration
12.	High degree of wetness of paper leaving presses.	1900	Improve drying efficiency of process.
13.	Lack of proper recycling.	4000	Waste utilization
14.	Inefficient evaporation of water in direct heat evaporators.	200	Design modification (replace direct heat evaporator with multieffect evaporator).

The energy conservation approaches may broadly be classified under the general headings of :—

i) Housekeeping measures which can be accomplished by alternative operating procedures without capital investment.

ii) Those involving capital improvements in the existing plants.

iii) Those involving the use of new, more energy-efficient capacity.

and

iv) Those involving the use of alternate fuels.

These approaches already referred to under short-term and long-term measures are energy ulilization, in the earlier part of the paper. A more thorough discussion of energy conservation approaches is given in[2].

FACTOR AFFECTING ENERGY EFFICIENCY

A) **Capacity Utilisation :**

There are several important factors effecting, energy efficiency. Some of the important factors are noted below :—

i) The efficiency of some equipment varies with loading Pumps, fans, blowers, air compressors, stream turbines and induction motors are all load sensitive.

li) Heating and lighting levels remain the same regardless of production rate.

iii) Heat loss through insulation remains the same regardless of level of production.

iv) Leakage of compressed air, steam, water and product vary little with rates of production.

B) **Product Mix**—Net energy consumption varies with the product mix. Some products require two or three times as much energy as others. For example, glassine and greasepeoof papers and electrical grade insulation papers.

C) **Fuel Mix**—Some fuels can be burnt efficiently than others, due to the inherent characteristics. Wood waste, bark and liquor are burned at lower efficiencies than oil or coal.

D) **Age of Facility**—Most equipment lose efficiency with age and wear. This is one reason why thermal and electrical energy efficiencies are lower in paper mills.

E) **Size of Facility**—Energy efficiency is related to mill size. The larger the unit size, under the same conditions, the better the energy efficiencies.

F) **Pollution Control Equipment**—Pollution control devices consume energy without contributing to production. Some of the devices such as scrubbers and electrostatic precipitators and aerators are very energy intensive. It is estimated that the pollution abatement equipment needed to comply with guidelines on pollution consume 5—10% of total energy.

The following equation is set to hold[3] for a range of capacity utilisation from 70—95%:—

$$E/P = 25.534 - 0.094\ R$$

Where E/P=fossil—fuel and purchased—energy use per ton, in MBTU'S.

R=operating rate, in percent.

The coefficient of determination was 75%, indicating that capacity utilization provides an acceptable explanation for the observed devitation in seasonally adjusted fossil-fuel and purchased energy use per ton.

Expressed in more general terms, the equation indicates that a 10 point reduction in paper and paper board capacity utilisation will result in an increase of more than 5% in the industries total energy consumption per ton of product.

RESEARCH AND DEVELOPMENT

1) **Measures :—**

In the design of the future pulp and paper mills :—It is necessary to evaluate the economics of (a) continuous pulping with hi-heat washing in place of batch pulping (where nearly 50% steam saving is reported for continuous operation), (b) Adoption of displacement bleaching in place of conventional bleaching (where substantial savings in power, steam, fresh water consumption and effluent load are reported), (c) Falling film type of evaporation in multiple effect evaporators for black liquor in place of present rising film evaporators (where the operating costs are said to be 10% lower)[6].

2) Reduction of make-up water per ton of product by suitable changes in washing and bleaching sequences :—Lower the quantity of fresh water used, lower the energy in pumping, lower the cost of water treatment with chemicals, lower the pollution load to the waste treatment plant and lower the heat requirement to keep process water at a particular temperature.

3) A more complete utilisation of the forest residues :—Substantial amount of trees are wasted while extracting the cellulosic raw material source for the paper industry. A judicious utilisation of these residues which are presently rejected as uneconomic for pulping, will restore near self-sufficiency to the pulp and paper mill from total energy view point.

4) Identification of more favourable heat to power balance :—The utilisation of secondary heat at the lowest pressures and temperatures and production of steam at higher pressures in the power and recovery boilers will not only help in achieving energy self sufficiency but will also substantially lower production.

5) Substitution of high-energy intensive chemicals with low energy substances :—The production of caustic, chlorine and chlorine dioxide is very highly energy intensive. Development of suitable pulping processess and bleaching sequences with lesser energy consuming chemical will facilitate in reducing the energy input per ton of paper.

6) Higher percentage utilisation of recycled fiber in new raw material mix :—Waste-paper utilisation cuts down energy consumption by 50—60% and also helps in running the machines faster, giving rise to better capacity utilisation and higher production. It is hence advisable to develop suitable methods for higher recovery of waste paper and higher utilisation of this recycled fibre without affecting process operations, product quality and the effluent system.

7) The need for developing new and more energy efficient recovery boilers :—In chemical recovery, black liquor at 60—65% solids is fired as fuel to generate steam. A considerable part of the energy available is consumed for the evaporation of water. Further, in this process a very high temperature is also required causing the chemicals to melt. Development of new soda recovery process should aim at eliminating these deficiencies.

8) Energy conservation in the dryer by vapour compression :—Steam in the machine dryer drums evaporates water from the sheet; that water vapour is then usually wasted to the atmosphere. A complicating factor in trying to reclaim this, and many similar, presently wasted streams is the contamination of the potentially usable water vapour with air or other noncondensibles. If the air or noncondensible gas could be excluded, the energy in these streams could be recovered by using electrical power to compress the vapour back up to a usable level. It is estimated that 3 BTU are reclaimed for 1 BTU of energy expended in the reclaiming process. Saving thermal energy increases the requirement for electrical energy. Hence the balance of forms of energy becomes critical[5]. An even better conceptual solution than reclaiming water vapour is the removal of water by mechanical means to avoid the vaporisation of water in the first place.

NATIONAL ENERGY PROGRAMME

Indian Paper Industry could take a leaf from the book of American Paper Industry, which set for itself an energy conservation goal of reducing fossil-fuels and purchased energy per ton of product by 10% between 1972—80, provided environmental requirements do not interfere. By 1977, American Paper Industry recorded an improvement in Energy efficiency by 12.1%, much ahead of the schedule.

After this, the federal energy Administration of United States issued modified Industrial Energy Efficiency target for the Paper and Allied Products Industry of a 20% reduction in fossil-fuel and purchased energy use per ton between 1972-1980. Government of India could profitably evolve a National Energy Programme for highly energy intensive industries like plastics, aluminium and paper and set realistic guidelines on energy conservation efforts to be made by these industries, providing them the necessary assistance in technical information sharing, training of technical personnel etc. in this context, it may not be out of place to quote the example of American Paper Institute whose energy monitoring system has been recognised as a model for other industry associations. IPPTA could probably take the lead in this direction for Indian Paper Mills.

SUMMARY AND CONCLUSIONS

After careful study of the information presented in the paper, the following conclusions emerge :

1) Paper Industry is highly energy intensive. Around one tonne of coal, equivalent to about 26×10^6 BTU, of energy are required to produce one tonne of paper.

2) The total energy concept viz. energy generation, distribution and utilisation in Indian Paper Industry is discussed at length. The energy consumption per ton of product in India is 20 MBTUS for Newsprint, 30 MBTUS for writing-printing paper, 20 MBTUS for Duplex Board and 27 MBTUS for Kraft Paper. These energy consumption figures are about 25—50% higher than in advanced countries using latest technology and equipments.

3) The need for energy audit cell is emphasized and the formats for energy reporting are given. Short and long-term measures to enforce energy discipline and achieve energy savings are outlined. Some important energy conservation approaches are also included.

4) Various factors affecting energy efficiency are also given.

5) Important areas where sustained R & D efforts are to be made on energy front are delineated.

6) Indian Paper Industry's ultimate goal should be to make the Pulp and Paper Mill self-sufficient in energy production and consumption. This can be achieved through, (i) judicious and total utilisation of forest materials and residues, (ii) achieving favourable steam to power ratios utilising maximum possible secondary heat at lowest temperature and generating power at highest possible steam pressure, (iii) reducing water consumption and effluent load to the barest minimum, (iv) adopting less energy consuming process techniques like continuous pulping with hi-heat washing, displacement bleaching and recompression of water vapour in the paper dryer section etc.

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