"Energy conservation in small and medium size paper industries" Need for conservation of energy

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The concept of energy is one of the most significant ideas in all sciences to understand the operations of nature. Energy appears in many forms in nature like wind, heat, water and steam. It is primarily possessed with an ability to produce a dynamic effect. It is one of the necessities of life as there can be no life without energy.

In the modern industrial concept, the demand for the energy is mainly in the form of electrical and heat energy which goes on increasing rapidly due to industrialization and agricultural development. Though many Hydel, Thermal and Nuclear power projects have been installed, yet the total generation is not enough to meet the demand by the industrial and agricultural sector. Hence energy crisis booms everywhere.

Apart from this, the cost of production per unit of energy is increasing exponentially from time to time due to enormous increase in fuel costs. The availability of natural resources of fuel fossils is also decreasing day by day as the usage rate of fuels is increasing in multiples of million tonnes in terms of coal.

Pulp and paper Industry is considered as one of the large power consuming industries, the need for conservation of energy in Pulp and paper Industry has become a vital necessity for survival of the industry.

COMPARATIVE STUDY OF ENERGY CONSUMPTION IN LARGE AND SMALL PAPER MILLS

There are differences in specific energy consumption in forest based integrated large mills and small mills. It is mainly due to the differences in raw material usage, mill design, choice in selection of suitable process and process equipment, product mix and capacity utilization. The capacity utilisation in large mills is about 75-90% whereas in small mills only 50-60%. The power consumption in large mills varies from 1300 KWH to 1800 KWH per MT of paper whereas in small mills it varies from 700 KWH to 1500 KWH per MT of paper (Table No. V). Steam consumption differs from 9 MT to 15 MT per MT of paper in large mills and 5 MT to 9 MT per MT of paper production in small mills (Table No. VI).

Water consumption also varies from 225 M^3 to 450 M^3 per MT of paper in large mills and 100 M^3 to 350 M^3 per MT of paper in small mills. The basic advantage in a large mill is co-generation of power and steam to the extent of 50-60% of their needs as well as recovery of 85-88% of process chemicals, this leading to substantial energy savings.

CONSERVATION OF ENERGY IN SMALL PAPER MILLS

In general, small paper mills use energy in two forms namely electricity and steam. They get power from state grid power and steam from their own generation in boilers using coal, wood, husk or alternative fuels Reduction of 10% to 20% of total energy consumption can be made possible, provided necessary steps are taken at the point of utilisation of energy, in each section of the plant and also by achieving 100% installed capacity in the plant.

Table No. I & II shows the monthly paper production and consumption of coal, steam, power and water for a period of 1983 and 1984 and Table No. III & IV shows the production and specific consumption of coal steam, power and water and the energy cost per MT of paper for the years 1983 and 1984 for a unit with an installed capacity of 9000 TPA. Due to increased operational efficiency in raising machine production from 74.6%

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TABLE NO. 1

PULP AND PAPER PRODUCTION AND CONSUMPTION OF COAL, STEAM, POWER AND WATER FOR THE PERIOD 1983 IN A SMALL PAPER MILL 30 TPD CAPACITY BASED ON AGRICULTURAL RESIDUES LIKE STRAW, BAGASSE WASTE PAPER, COTTON AND GUNNY

Sl. No.	Year and Month		Own pulp Production MT	Waste Paper Pulp Production MT	Machine Production MT	Coal Consumption MT	Steam Consumption MT	Power Consumption KWH	Fresh Water Consumption M^3
1	January	—1983	120.0	272.0	445.6	500.0	—	4,60,000	1,52,800
2	February	—1983	78.7	213.8	322.5	368.8	—	4,23,605	1,25,700
3	March	—1983	296.2	203.8	550.0	596.1	—	4,90,220	1,62,750
4	April	—1983	155.0	417.0	635.0	687.5	—	6,10,150	1,66,800
5	May	—1983	330.6	38.0	441.4	516.3	3163 0	6,10,690	1,46,100
6	June	—1983	174.6	258.9	484.0	573 0	3161.0	5,96,110	1,62,900
7	July	—1983	455.9	79.6	584.2	793.9	3871.0	6,34,010	1.42,644
8	August	—1983	381.9	201.7	628.0	593 2	3513.0	8,67,420	1,52,859
9	September	—1983	298.9	174 4	624.4	838.9	3751.0	7,99,430	1,52,554
10	October	—1983	309.8	399.0	785.0	666.7	3605.5	8,56,750	1,36,453
11	November	—1983	55.3	370.1	512.0	620.0	2969.0	7,73,060	1,37,284
12	December	—1983	292.9	320.2	702.0	651.3	3598.0	8,79,820	1,55,912

TABLE NO.—II

PULP AND PAPER PRODUCTION AND CONSUMPTION OF COAL, STEAM, POWER AND WATER FOR THE PERIOD 1984 IN A SMALL PAPER MILL 30 TPD CAPACITY BASED ON AGRICULTURAL RESIDUES LIKE STRAW, BAGASSE, WASTE PAPER, COTTON AND GUNNY

Sl. No.	Year and Month		Own Pulp Production MT	Waste Paper Pulp Production MT	Machine Production MT	Coal Consumption MT	Steam Consumption MT	Power Consumption MT	Fresh Water Consumption M^3
1	January	—1984	173.6	468.5	715.0	774.0	3669.0	7,82,060	1,55,484
2	February	—1984	191.8	551.5	750.0	885.0	3944.8	7,66,220	1,43,261
3	March	—1984	352.3	192.5	582.0	836.0	3539.7	7,69,820	1,88,753
4	April	—1984	329.0	218.5	640.0	833.8	3678 0	8,64,520	1,98,618
5	May	—1984	265.9	419.0	790.0	645.7	3757.0	8,16,100	1,95,454
6	June	—1984	270.1	354.8	731.0	832.0	3709.0	8,39,400	2,23,448
7	July	—1984	399.2	362.4	844.0	1134.0	4630.0	9,80,080	2,38,888
8	August	—1984	394.6	402.7	857.0	977.0	4396.3	10,03,900	1.96,000
9	September	—1984	405.3	280.9	782.0	920.0	4302.5	9,09,708	2.10,116
10	October	—1984	360.2	325.2	726.0	704.3	3794.7	8,61,746	1,96,000
11	November	—1984	242.2	410.3	666.0	620.8	3183.0	7,33,161	1,77,348
12	December	—1984	400.1	380,3	817.0	803.1	4231.1	8,95,520	2,04,993

TABLE No.—IH

SPECIFIC CONSUMPTION OF COAL, POWER—COST OF TOTAL POWER FOR MANUFACTURING OF PAPER FOR THE PERIOD OF 1983

Sl. No.	Month	Paper Machine Production MT	Coal Consumption MT	Steam Consumption MT	Power Consumption KWH	Water Consumption M^3	Cost of Total Power and Fuel (Rs. in lacs)	Energy Cost Per MT Rs
1	January	445.6	1.122	—	1032	343	5.35	1200
2	February	322.5	1.143	—	1314	390	4.96	1538
3	March	550.0	1.084	—	891	296	7.02	1276
4	April	635.0	1.082	—	961	262	6.55	1031
5	May	441.4	1.169	7.166	1384	331	6.30	1427
6	June	484.0	1.183	6 530	1232	337	6 43	1328
7	July	584.2	1.359	6.626	1085	244	8.51	1457
8	August	628.0	0 945	5 594	1381	243	7.74	1232
9	September	624.4	1.343	6 007	1280	244	8.86	1419
10	October	785.0	0.849	4.592	1091	174	8.49	1081
11	November	512.0	1.210	5.798	1510	268	7.88	1539
12	December	702.0	0.927	5.125	1253	222	9 33	1329

TABLE NO.—IV

SPECIFIC CONSUMPTION OF COAL, POWER—COST OF TOTAL POWER AND FUEL FOR MANUFACTURING OF PAPER FOR THE PERIOD OF 1984

Sl. No.	Month	Paper Machine Production MT	Coal Consumption MT	Steam Consumption MT	Power Consumption KWH	Water Consumption M^3	Cost of Total Power and Fuel (Rs. in lacs.	Energy Cost Per MT Rs.
1	January	715.0	1.082	5.13	1094	217	9.38	1312
2	February	750.0	1.180	5.26	1022	191	9.31	1241
3	March	582.0	1.436	6.08	1322	324	8.97	1541
4	April	640.0	1.302	5.75	1350	310	9.86	1540
5	May	790.0	0.817	4.75	1033	247	9.48	1200
6	June	731.0	1.138	5.07	1148	305	10.12	1384
7	July	844.0	1.343	5.48	1161	283	11.85	1404
8	August	857.0	1.140	5 13	1171	229	10.91	1273
9	September	782.0	1.176	5.50	1163	269	10.31	1318
10	October	726.0	0.969	5.22	1187	270	8.74	1204
11	November	666.0	0.930	4.78	1100	266	8.23	1236
12	December	817.0	0.983	5.30	1096	251	10.59	1296

to 99% energy costs have been reduced from 1500 per tonne to 1300 per tonne inspite of an increase of 45% in the cost of coal and 15% in the cost of electrical energy during this period. The average power consumption and the installed HP is given in Table No. V. The average daily consumption of power for a 30 TPD paper mill varies between 30,000 KWH to 33,000 KWH and the break-up is given in Table No. VI. The various possible sources of energy saving are given below:

SAVINGS IN ELECTRICAL ENERGY

a Rawmaterial Preparation Section

Running of straw cutters, conveyors, blowers, dedusters etc. with full rate of feeding and avoiding idle running hours of any of these equipment. This can be achieved only when straw is fed to the cutters continuously with maximum designed feed rates. If the feed rates are very low due to faulty designs of the cutters, the cutters should be modified to increase the maximum output from rawmaterial preparation section. The disc type straw cutters are much better than drum type for trouble free operation and for comparing energy consumption per MT of straw cutting.

In a small paper mill, when the disc type straw cutters were not giving the rated output the speed of the rotating disc was increased by 25% by changing the motor drive pulley. After changing the pulley, the output

TABLE NO—V

INSTALLED HP AND POWER CONSUMPTION IN A MONTH FOR 30 TPD FOR A PRODUCTION OF 762 MT OF PAPER

S. No.	Section	Installed HP	Total Power Consumption-KWH in each section
1	Rawmaterial Preparation	158	45,860
2	Pulp Mill	1254	2,19,150
3	Stock Preparation	1152	1,71,990
4	Paper Machine	1227	2,44,410
5	Rewinder & Cutting	125	55,103
6	Boiler House	175	18,505
7	Water Supply	198	72,715
8	Effluent	372	54,820
9	Factory General	115	27,155
		4776	9,09,708

Average Power Consumption per MT of Paper—1194 KWH

AVERAGE POWER CONSUMPTION PER MT OF PAPER IN AN INTEGRATED LARGE PAPER MILL IN TWO MONTHS OPERATION

Sl. No.	Area	1 KWH/MT	2 KWH/MT
1	Chipper House, Rag Plant, Pulp Mill	323.0	342.0
2	Stock Preparation and Paper Machine	900.0	1064.0
3	Soda Recovery Plant	187.0	220 0
4	Utilities, Boiler and Water Supply	433.0	445.0
		1843.0	2071.0

TABLE NO.—VI

SECTIONWISE STEAM CONSUMPTION IN A SMALL PAPER MILLS FOR 30 TPD OF PAPER PRODUCTION

Sl. No.	Area	Steam Consumption in MT	Production
1	Digesters	37.0	12 MT of Straw Pulp 3 MT of Cotton Pulp
2	Paper Machine	78.5	Paper Machine Production 30 MT
3	Hot water, Pulp, washing and bleaching	19.7	
4	Rosin & Chemical Preparation in Stock Preparation	1.3	
5	Line losses and other losses due to leakages etc.	10.5	
		147.0	
Furnish used for paper manufacturing of plain ledger–56 Gsm with size press:			
1	Straw Pulp	1.2 MT	
2	Waste Paper Pulp	12.5 MT	
3	Long Fiber	3.0 MT	
4	Broke	2.5 MT	
		30.0 MT	

from the cutters improved substantially.

b **Digester Section**

In most of the small paper mills, pulping of agricultural residues is carried out in batch process in rotary spherical digesters. Optimising the pulping perameters like percentage of chemicals, cooking temperature and cooking time with less dilution and high packing density, the pulp output can be increased with reduction of steam per MT of pulp production. Modification in the existing design of the rotary digesters to provide indirect steaming helps in energy saving. If the process is changed from batchwise to continuous pulping PANDIA TYPE, lot of energy can be saved, as cooking time in batch process particularly in the case of agricultural residues like straw and bagasse pulping.

High yield pulping process like Mechano Chemical Digestion (M.C.D.Krassmaffei design) is to be introduced for pulping of straw and Bagasse. Steam consumption in this process is very low compared to pressure digestion in rotary digesters because of pulping in M C.D. is carried out at atmospheric cooking.

c. **Washing and Screening Sections:**

Two stage brown stock washing system can be used for agricultural residues like straw and bagasse pulps but the output of pulps in terms of kgs. per ft^3 per Hr is less compared to bamboo and wood pulps. Power consumption per MT of pulp production mainly depends upon the design of the vacuum washers (BSW) and it should be modified to suit straw and bagasse pulps. The filtrate from second washer can be used for dilution of the

plup in 1st washer. It is suggested that washing efficiency can increased by the external application of vacuum to the filters or by introducing forced circulation of the filtrate through the berometric drop leg.

Screening is the most improtant operation for pulps produced from straw, bagasse and waste paper in order to get better quality of pulps. There are several designs of screens, Biffar screens, Alphor screens, Vibro screens. Biffar screen is one of the best designs available for straw pulps with less power consumption. By introducing modern design of centricleaning system with less pressure drop, helps in saving of energy in stage centri-cleaning operation.

d. Multistage Bleach Plant

Straw or bagasse pulps can be fairly bleached to a good degree of brightness by conventional multistage bleaching C-E-H system with vacuum washers. Again the power consumption depends upon the design of the washers. Maximum utilisation of the washer capacity and recycling of filtrate from bleach plant within the plant will reduce fresh water consumption. This results in energy savings.

e. Stock Preparation

It is one of the maximum power consuming areas in the plant. Pulps obtained from agricultural residues require less refining compared to bamboo and wood pulps. Beaters and conical refiners can be replaced by a suitable double disc refiner which saves lot of energy in refining of per MT of pulp.

Deshiving of the objectionable bundles present in cooked pulps with hot stock defibration through a proper selection of disc refiner with minimum power input can reduce the rejection and thereby the power consumption will be reduced further in refining of the stock.

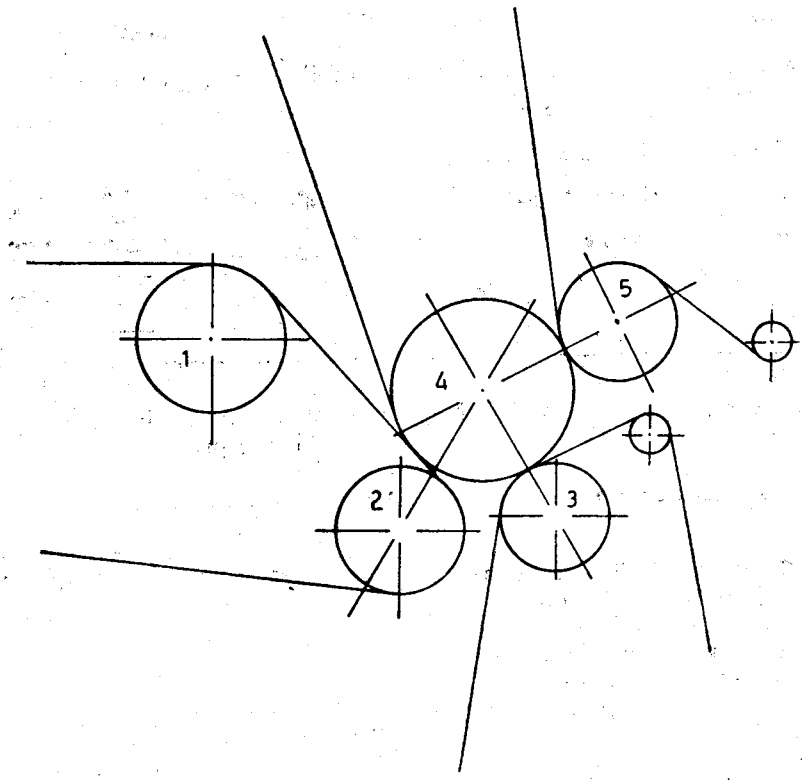
f. Paper Machine and Converting Sections

Production of papers from agricultural residues is a difficult phenomena in the operation of paper machine when compared with bamboo and hard wood pulps because of the basic difference in its fiber characteristics like wetness, low wet strength, fines and fiber debris etc. Hence the design of Paper machine should be modified to suit to agricultural residues.

Power and steam consumption is high in Paper machine, where maximum saving of energy can be possible by modernization of fourdrinier section, press part, drying section and calender stack. By inroducing more dewatering elements like Hydro vacuum foils with various degree of angles from 0°–4° and increasing the wet suction box etc. dewatering efficiency on wire table can be increased reducing load on vacuum pumps. By modifying the design of vacuum pumps with lower HP motors lot of energy can be saved.

Modification in the press part design by incorporating a bi-nip press (Fig. No. 1) consisting of

BI NIP PRESS



1—Sction Couch.
2—Wire Turning Roll.
3—Microrock Roll.
4—Multi zone Pick up Press Roll.
5—Granite Roll.

the pick up 1st and 2nd press in one stack and providing a granite top roll as a 2nd press, open draw can be totally avoided and thus minimise the total number of presses. The moisture content in the web before entering into the dryer section can be minimised as much as possible in order to get more drying efficiency and reducing the steam consumption. By providing all the drying cylinders with antifriction spherical roller bearings in place of bush bearings can reduce the load on main motor and thus save electrical energy. This type of press not only saves the energy consumption but totally eliminates or reduces the press breaks of the web and ensures optimum production rates. Many of the small paper mills have got one rewinder and two cutters. By providing full width duplex cutter, to suit the machine size, energy can be saved and finishing losses reduced.

RFDUCTION OF STEAM CONSUMPTION

The steam consumption at various points sectionwise is given in Table no. VI. It shows the average consumption per MT of paper for a small mill is quite high. The reduction in steam consuption can be pooible in pulp section and paper machine by reducing the losses and improving the operational efficiency.

a. REDUCTION OF STEAM CONSUMPTION IN PULP MILL

In general, high pressure steam is used for pulping of agricultural resisdues in rotary spherical digesters and maximum steam is consumed at high temperature. The radiation losses the digesters are abnormally high at high temperature. To avoid all these losses insulation is to be provided for all steam lines and digesters.

Steam is flashed out to atmosphere during the time of pulp blowing to blow tank from each digester. The flash stam can be utilised to generate hot water by providing a shell and tube type heat exchanger near blow tank. This hot water can be utilised for pulp washing on washers. Thus direct steaming for hot water generation can be reduced,

b PAPER MACHINE

Introduction of steam cascade system in Paper machine drying section and efficient removal of condensate from drying cylinders will reduce specific steam consumption.

Modification in drying section by providing hood and pocket ventilation will improve produotion rate and reduce steam consumption. Direct steam losses can be arrested by proper selection of steam traps, and better maintenance of rotary joints, steam valves, condensate by-pass valves. All the steam lines, condensate lines, condensate receiving tanks should be properly insulated to reduce heat losses. It is suggested to provide insulation to the sides of the drying cylinders to reduce steam losses due to radiation.

BOILER SECTION :

All the steam lines, condensate receiving tank, the steam drum, economiser top covers and sides, pre-heater tanks should be provided with good insulation to prevent the heat losses. By providing good instrumentation for Feed water control, Main steam temperature control, combustion control and Furnance draught control with draft and oxygen monitoring, the operational efficiency of the boiler can be increased and it saves lot of fuel, Heat recovery from the flue gases by introducing the air pre-heater and heat recovery from the blow downs to generate hot water and which can be put into good use in the plant.

Analysis of flue gases, coal cinder and coal should be carried ous at gegular intervals to find out whether the combustion in furnance is taking place properly or not.

d. REDUCTION OF FRESH WATER CONSUMPTION

By reduucing fresh water consmption per MT of paper production, the power consumption for pumping of water can be reduced. This is possible by re-cycling of white water from Paper machine, sealing water and extracted water from vacuum pumps and back water generated from bleach plant. Thus the reduction of fresh water consumption is possible from 350 M^3 to 200 M^3 per MT of paper.

e. CONVERTION OF ALL SOLID WASTE INTO FUEL :

Waste fuels like straw dust, bagasse dust, bagasse dust, coal dust and the sludge collected from the effluent plant can be used in making small size briquettes in briquetting machine, these briquettes can be used in boiler along with coal for the steam generation or it can be separately used in a small furnace to generate hot water to use it as a feed water to the boiler. Thus all solid waste in the mills can be converted into fuel.

SUGGESTIONS :

1. Contiruous monitoring and recording of steam,power and water at various consuming points in the plant is necessary to exercise proper control in usage thereby optimum levels

of consumption of energy can be achieved.

2. Energy audit is to be done from time to time in order to checkup the various losses in electrical energy as well as steam and water.

3. Fuel consultancy services like National Productivity council and other private energy management services can be called for to assist in saving of the energy consumption in the plant.

4. By educating supervisory and operational staff in the plant on reduction in the consumption of water, power and steam, it can be possible to reach levels of optimum consumption of energy and thereby the cost of energy per MT of paper can be reduced.

5. Electrical energy can be further saved by introducing power capacitors and increasing the power factor from 0.85 to 0.95. Distribution losses can be minimised if the transformers are located near est to the consuming centre-

6. Development of small scale caustic soda plants with a capacity of 5 to 10 MT/Day saves lot of energy in small paper mills as the dilute caustic and chlorine gas can be directly used in the process without caustic evaporation and chlorine liquification plants.

7. Because of poor grid-power supply position, co-generation of power plants in small paper mills should be encouraged in order to get continuous rated production with much less cost of energy.

8. Long term and short term energy conservation schemes should be introduced in small paper mills to reduce the energy demand and cost of production.

9. All small paper mills should be given concessional long terms loans towards energy saving measures to improve the existing system.

10. Development of de-inking process helps in recycling of the lowest grades of waste paper at a cheaper price and minimum energy consumption per MT of pulp production. Government should encourage small mills to import the most sophisticated deinking plants from abroad duty free.

11. Development of suitable soda recovery process with minimum capital investments for small paper mills based on agricultural residues, effective utilization of energy with chemical recovery is possible from spent black liquor.

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