Energy management in pulp and paper industry

Including Co-generation of Electrical Power

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ABSTRACT

Perhaps never before the pulp and the paper industry felt the necessity for scrupulous energy management as it is feeling now. The cost of coal and other fuels are soaring high. The electrical energy tariff is revised more often and the increase is so high that it cuts into the profit of a company. In Karnataka 10% hike in electricity tariff every year is mooted. The conventional raw material is scarce for the paper industry and the profit is already just marginal. Survival itself is difficult unless all major inputs are controlled and wastage minimized. There will be a wide scope for ferreting out operational and design practices that are wasteful of energy. Therefore energy management has become an essential and a perpetual exercise. In MPM the primary objectives for energy management are :—

a) Energy Conservation

b) Enhancement of competitive position

c) Good energy reporting and monitoring system

Large integrated mills incur 25-30% for energy as direct cost. It was around 30% in 1991-92 at MPM. So a saving of even 5% in energy, enhances the profit considerably. Further, energy efficiency is one of the criteria used to evaluate a mills modernity.

The integrated pulp and paper mill is a large consumer of electricity and steam, for process. The needs vary continuously as the unit operations start and finish. Some batch operations also have varying demands. Therefore the implementation of an effective energy management system requires a multi-disciplinary approach. The approach contemplated in MPM is

— A Plan for Energy substitution.

— A comprehensive energy audit to identify and quantity energy saving opportunities in different plants and processes.

— Developing an effective organisational system for implementation of energy saving schemes and for monitoring improvements.

— Training at Senior/Middle/Junior management levels to appreciate, contribute and to disseminate information to workers level about the conservation measures,

This paper is presented to explain in detail the efforts made in the Mysore Paper Mills Ltd., at Bhadravati. The desire is to disseminate the knowledge and share information with the fraternity.

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Introduction :

The Mysore Paper Mills Ltd is an enterprise registered in 1936. The mill is situated 250 Km away Bangalore in the district of Shimoga in Malnad area. The river Bhadra flows on the eastern side of the mill and is the source of water. The Sharavathi power generating station is 100 Km away and therefore the voltage condition is good at the mill though it is handicapped by unscheduled & scheduled power cuts as any industry would have, in this power starved state. The railway link is through metre gauge and this line is also proposed for conversion to broad gauge shortly. Presumably after this conversion the mill will be in an advantageous position as regards railway transport.

The mill is unique in its kind having a synergy in paper & sugar production. This also makes the energy scene complex. The bagasse got from the sugar mill is used for chemical pulp manufacture to be used in paper mill. The capacity of the sugar mill at present is 2500 TCD crushing of cane. The paper mill has a licensed capacity for 75,000 TPA newsprint manufacture and 30,000 TPA writing and printing paper manufacturing. The mill has grown in stages from 4,000 TPA sustained production to 1,00,000 TPA now.

The growth has seen many changes in the electrical and thermal energy fronts. Power was received in the days prior to 1980-81 at 13 2 kv from electricity board and there were only medium pressure boilers. There was a 500 KVA diesel generator set to cater the emergency electrical needs at the mill. The scenario has changed now. The power is received at 110 KV from the electricity board and the contracted demand is 40 MVA There coal fired boilers generate steam at 63 kg/cm^2 and 60 T/hr is the capacity of each boiler. Two 12.5 MVA T G. sets produce electricity at 11 KV and the concept of cogeneration has been thus introduced. The power distribution inside the plant is at 11 KV through cables and usage is at 3.3 KV or 440 V or 230 V as the case may demand.

Energy management in MPM :

The structure existing in MPM for energy management is informal and the manager at each plant controls the input. The organisation is large and energy is a common input among departments and sections. A central unit has to initiate and follow-up actions with outside agencies for consolidation and making the effort productive. This activity is carried out by a task force. Considerable effort is put in for monitoring raw material consumption, production and energy consumption.

The task force is expected to remain up-to-date on national energy matters and co-operate with the top management of the company in energy related matters. By convention the task force is impermanent in nature. But the energy management is not a one time affair. It has to be a continuous programme. The overall objective remains in variant with focus and strategies changing from time to time. The task force which was set up in 1987, therefore has not been a temporary arrangement so far.

A two pronged approach got adopted for energy management in MPM—the energy substitution and energy conservation.

a) Energy substitution :

This mainly concerns with replacing costly fuel by more abundant or cheap fuel. The primary fuel used is coal and the quality has not been consistent these days. The furnace oil is a secondary fuel. Certain solid wastes are generated in the mill which have sufficient calorific value when dry. They are pith, effluent sludge and wood/bamboo dust.

The company has 2500 TCD capacity sugar mill and 750 tons of bagasse get generated from here. The three main constituents of bagasse are :

a) Fibrovascular bundles—has short fibres

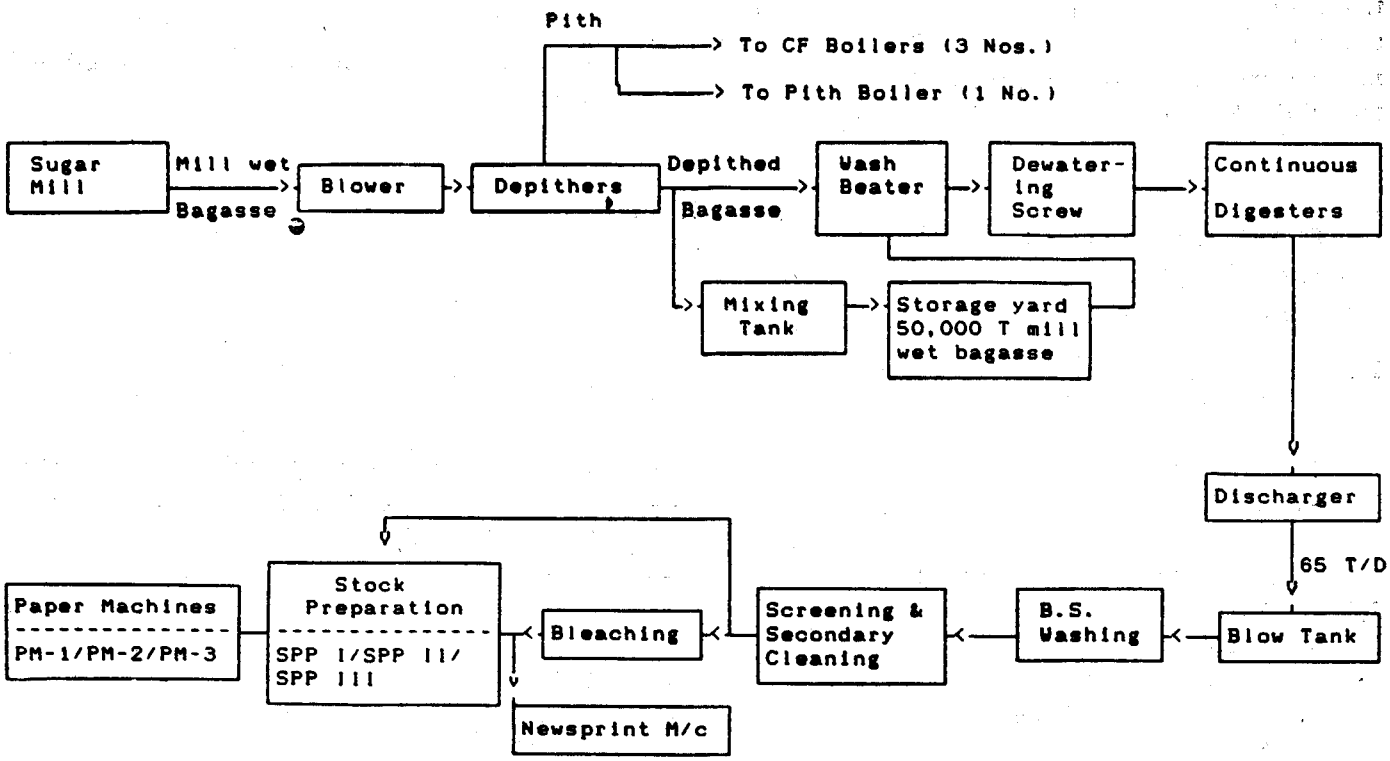
b) The rind fibres—having long fibres

c) The pith—a non fibrous structure amounting tc 30% of bagasse.

The non-fibrous structure makes pith unsuitable for paper making. Depithing of bagasse is essential since it has a greater impact on chemical consumption, cleanliness, yield and the quality of pulp made out of bagasse. The pith so removed being a solid waste is difficult to dispose of and is a fire hazard too. It is now used in MPM as a primary fuel in a boiler of 33 TPH capacity which can generate steam at 12 kg/cm^2

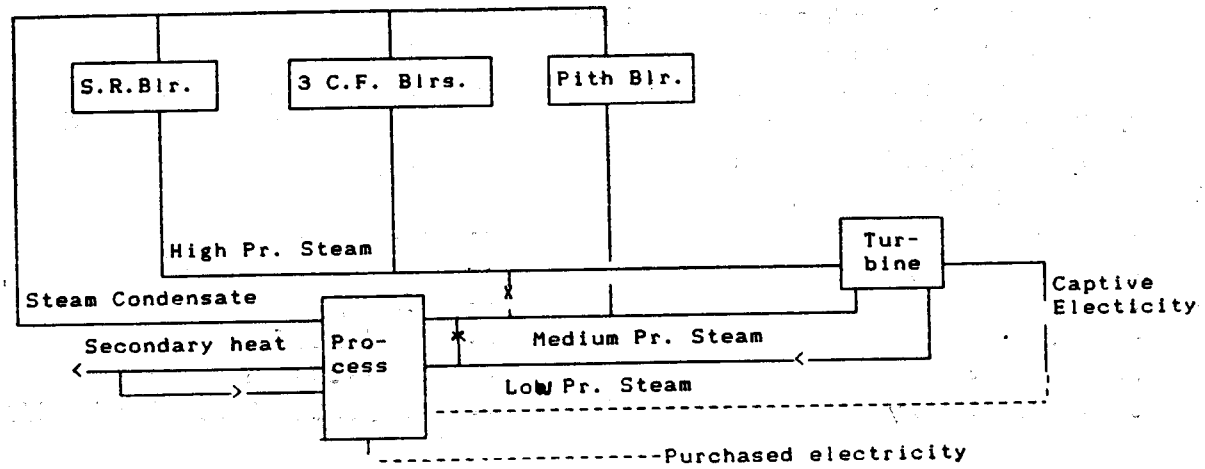
(MP). At 50% moisture content pith as a fuel has a gross calorific value of 2000 kcal/kg and some oil support is essential at the begining. The flow sheet appended in annexure—1 assists in understanding the scheme.

FLOW CHART FOR BAGASSE PULPING **ANNEXURE 1**



THE ENERGY SYSTEM IN MPM :

ANNEXURE 2



Why a M P boiler for burning pith ?

The medium pressure steam finds use in cooking in pulp plants of the mill. The demand fluctuates and this has the destabilising influence when tapped from the high pressure source through a PRDS With an intention of isolating the fluctuating demand and to make available steam at a constant pressure for power generation the pith fired boiler is operated. However L P steam becomes available through a PRDS from this medium pressure boiler also. Perhaps burning pith in the existing high pressure boiler itself may look as a viable alternative. The pith then becomes a secondary fuel. It is opined that secondary fuel burns less efficiently than primary fuel. Also more energy is required when utilized. It is therefore an opinion that dual firing is not energy conservation. But dual fire capability with stand by fuel utilization is certainly profit improvement, since the entire plant can be run during periods of curtailments This facility exists in the high pressure CF Boiler to take pith as secondary fuel. The salient design parameters of the pith boiler is given in Annexure-3.

ANNEXURE-3

PERFORMANCE DATAS :
Client : MYSORE PAPER MILLS LIMITED
Boiler/s IWT Nos 5085

1.1	**Performance Data :**		
	1. Maximum Continuous rating	—	33 T/hr
	2. Design pressure	—	26 kg/cm²g
	3. Pressure at superheater outlet	—	12 kg/cm²g (with future provision for 21 kg/cm²g.)
	4. Temperature at superheater outlet	—	210°C+15°C—5°C (with future provision for 300°C+/—15°C)
	5. Number of boilers in contract	—	One (1)
1.2	**Fuel :**		
	Bagasse		
	1. Net Calorific Value	—	1869
	2. Gross Calorific Value	—	2320 K. cal/kg
	3. Moisture	—	50% Max.
	4. Ash	—	1.5%
	Pith		
	1. Net Calorific Value	—	1617 K. cal/kg
	2. Gross Calorific Value	—	2000 K. cal/kg
	3. Moisture	—	Normal —50% Max. —50%
	4. Ash	—	2%
	Oil - Furnace Oil Grade as per IS : 1593 HV		
	1. Higher Calorific value	—	10,000 k cal/kg
	2. Lower calorific value	—	9,499 k. cal/kg
	3. Boiler rating on oil	—	16.5 T/hr. (with future provision for 33 T/hr
	4. Boiler rating on 90% pith and 10% oil	—	33 T/hr
1.3	**Boiler Water Conditions :**		
	1. TDS	—	1500 ppm
	2. Total alkalinity	—	300 ppm
	3. Oil	—	Zero ppm
	4. pH	—	10.4 to 10.5
	5. Phosphate	—	20 — 50 ppm
	6. Caustic alkalinity	—	10% of TDS but not less than 150 ppm.

How low grade coal is contemplated for use ?

Boilers that are in service in MPM were designed in the seventies for an ash content in coal to the extent of 25–30%. The FBC technology was in its infancy then in this country and had not made the advent for high pressure steam generation. The boilers supplied to MPM by M/s BHEL were stoker fired boilers and were designed in the second half of the seventies. But from the eighties the coal made available to paper industries were of inferior variety-the ash content touching a 40 - 45% figure. The calorific value of coal is low being around 3000 kcals/kg and the cost has in addition increased. Further the stokers developed difficulty to burn this coal and the efficiency n sedived to 60%. The performance also deteriorated because of fast ageing process that got set in, since low grade fuel was continuously used for which the boiler has not been designed to operate. The mill steam requirement could not be met continously because of this siutation. Production slumped and paper production was adversely affected in the sugar season.

The condition monitoring of boilers and the feasibility study revealed a benefit by conversion. The consultants opined that a pay back is possible in 2 years from savings in coal alone. The production gains and extra power generation possibilities would further reduce this period. Excerpts from the relevant section is given below :

Estimated cost of the Conversion of each boiler to FBC : Rs 456 lakhs
(estimated in 1991 leaving expenditure for Chimney construction & CH plant changes)

For an out put of 60 T/hr superheated steam at 63 kg/cm² and 450° C with 150° C feed water temperature and firing of coals of 3500 kcals/kg the economics is as follows ;

i)	Coal fired in FBC with 80% efficiency	T/hr	14 60
ii)	Coal fired in stoker fired boiler with 65% maximum efficiency (65% efficiency is taken conservatively as the present 'n')	T/hr	17.90
iii)	Saving in fuel fired	T/hr	3.30
iv)	Considering 6500 equivalent hours per year, annual fuel saving per boiler	T/year	21,450
v)	Fuel cost at Rs. 1000 per ton	—	214 5 lakhs/yr
		Say —	215 lakhs/year
vi)	Pay back = Rs. 456 lakhs / Rs. 215 lakhs	=	2 years (approx.)

This prompted MPM to decide to proceed with conversion forthwith in all the three boilers. The work on these boilers will be completed by the last quarter of 1993 and the benefits accrued will be correctly known afterwards. Immense benefit is visualized and the thermal energy scenario is expected to be comfortable.

Energy Conservation Efforts in MPM :

In paper mills too, energy balancing is an effective tool for identifying areas of wastage or where excessive usage of energy is existing. Steam balancing is carried out every month in MPM It is possible to extend it to each segement of the process. Likewise, electrical energy is also balanced. The usage of water had not got the importance earlier but it has been given now. Providing water flow meters at consuming point is taken as the first step monitoring and conserving will follow.

Cold soda refined mechanical pulping plant (CSR-MP) is the major electrical load centre in the mill. Efforts were put in here to reduce specific electrical energy consumption and it is around 1500 Kwh per ton of pulp and has been reduced from 180 Kwh per ton some time earlier. Studies to further reduce this specific consumption is on hand.

However UNDP-GOI, project for energy audit for which CII (SR) was the lead agency enabled a comprehensive study to be undertaken for identifying in Dec. 1990 the Potentiality to conserve energy. The FBC conversion of coal fired boilers had not been conceptualized then. 26 energy saving proposals were formulated and classified under two headings - i) Proposals involving no expenditure or insignificant investment and ii) Proposals involving considerable investment. The identified savings potential was Rs. 293 lakhs The first category accounted for Rs. 19 lakhs savings and the second Rs. 274 lakhs with an investment of Rs.207 lakhs. The pay back was attractive.

The thermal energy saving related to boiler operations were deliberately linked with FBC conversion when that project was formulated. The proposals associated with writing and printing machines - PM-1, 2 & 3 were taken in the modernization programme under OECF assistance. These machines were earlier tied to the system based on the premises of cheap energy. The rest of the proposals have been taken for implementation at appropriate stages mainly focusing on recovery and reuse of energy. One proposal to improve P.F. from 0.85 to 0 9 or above needs further study. With the bonus stipulation having been taken out from the K.E B tariff schedule it is less attractive and needs capital expenditure to operate at a higher p.F. than 0.9. The expenditure estimated is 100 lakhs even to reach the 0.9 level from the present 0.85 stage. A detailed study by a energy consultant has been proposed to engineer the scheme and suggest a viable installation.

The conservation effort does not limit to the proposals given by consultants only. Energy engineers and process engineers carryout walk around audit voluntarily and come out with energy saving proposals one such action is cited below as an example.

During the annual shut down in PM-4 from 20·4.92 to 25.4.92, the P-5 pump impeller was trimmed and put back to service. The load current for the same output prevailing prior to 20.4.92, the current dropped from 100 amps to 90 amps and this has been sustained.

$$\text{Energy saving} = \sqrt{3} \times 3300 \times 10 \times 0.85 \times 24$$
$$= 1282 \text{ units perday.}$$

For an year and at Rs. 1 38 savings = Rs. 5,83,822. 80 (330 days working)

The consultants (from CII) had identified certain lights to be switched off during day time. In Paper Machine 4 (Newsprint machine) and in stock room, the roof sheets became due for replacement for different reasons. This opportunity was taken and FRP transparent sheets were provided at appropriate places to make use of natural light. The switching off artificial lights during day time was thus avoided. On a conservative scale a saving of Rs 60,000/- on this account is visualized.

Cogeneration Concept :

The enrgy system in MPM is depicted in a block at annexure-2.

The concurrent generation of process heat and motive power (mechanical and electrical) has been in adaption in MPM since 1981. Two turbo-generators of 12 5 MW capacity operate generating power at all KV. They are extraction cum condensing turbines with extraction at low and medium pressures. The medium pressure extraction is uncontrolled and normally not used. This steam is got through a PRDS from high pressure steam for process use. Here the thermodynamic cycle employed is the rankine cycle, adopting, of course, the topping cycle of co-generation.

Many improvements in arrangements have been made since the co-generation system has been put to use since 1981. the condensing capacity has been enhanced to 45 tons from 30 tons an hour for flexibility in power generation from the two TGs. Sophisticated relays have been incorporated to delink the generators from the utility tie, when the grid power supply becomes unstable. A double bus system has been introduced for running the TG's in solo. Only a higher steam pressure when made avilable will substaintially improve the power generation situation at the mill Perhaps the conversion of existing boilers to FBC will provide improved conditions for more captive generation by enhancing the thermo dynamic efficiency.

Further improvements have been contemplated and the required approvals have heen sought for financial concurrences. The AVR"s are being planned for upgradation to make them highly sensitive. Installing a back pressure turbine of approximately 8 MW capacity is planned, for depending more on own generation. Perhaps this scheme will be implemented when the fourth high pressure boiler is installed under OECF assistance.

Training and Motivation Aspects :

The management has recognised the need of training and motivation for an effective energy management. It has also appreciated that the publicity and promotion play a vital role in energy management and considerable efforts are bestowed in these directions.

The senior and middle level officers have participated in discussions with foreign consultants to get to know the practice prevailing in those countries in energy management. Some are deputed to attend seminars on the subject. They are required to give an account of the deliberations in formal and informal gathering. Video cassettes are played periodically in the training hall for the benefit of the functional managers. Upper level management is also informed of overall energy situation, energy costs in relation to other costs and the goal of energy management programme.

Creating awareness among workmen and staff has been a challenging task. Many of them have a faint idea of the amount of energy consumed within their plants. It is a difficult task to present the information in a manner which facilitate comprehension. For operating personnel training is imparted at the plants on the job and is integrated in to organisation's other training programmes. It is the endeavour to bring in their total commitment and sense of personal accountability at all stages from idea to implementation of energy management programmes.

The management believes that operators and maintenance personnel should get involved actively as they are ultimately required to execute the activities in the programme. They will be in a better position to identify & recommend areas for improvements. Therefore they are being talked to by energy managers of each plant regarding goals, achievements, problems and progress. It is hoped that this action will demonstrate to them that energy conservation programme is real and their role is important. This action and the training programme in the training department is helping to percolate the theme down to the workman level. For publicity, articles on energy conservation are published in the in house magazine "Kagada" for the benefit of all the employees.

Conclusions :

Energy future is laden with opportunity—so we believe. A course of energy decisions can propel the enterprise ahead and save the economy.

Energy Management in a mill having machines of 1936 and 1964 vintage is a challenging task. Accurate characterization of process and operation is essential. Energy balance or energy audit makes the excercise informative and helps to look for cost effective options.

In MPM the overall objectives of energy management remain invariant, perhaps the focus and strategies change depending on conditions. Energy management programme is reviewed periodically to determine the status. Aggressive efforts have been contemplated to improve the economic well being and competitiveness. It has been the firm conviction that energy efficiency is the easy way to enhance the earning capacity of the firm. The energy reporting system will also be made an integral part of the existing management system. It is also the endeavour to sustain employee motivation. It is the conviction that sustaining the momentum and efforts in the mill will only enable energy savings to accrue.

Acknowledgement :

The authors thank the management of the Mysore Paper Mills for permitting to present this paper in the seminar and for readily agreeing to share the knowledge with the participants.