Paper machine productivity optimisation

THUSU N.K.*, RAO P.N.**, REDDY K.V.***

ABSTRACT

Paper Machine optimisation is of paramount importance & quite well justified by the direct results obtained in improved product quality & quantity, productivity and profits. Various avenues available in the Paper Machine area for optimisation have been discussed based on the experience gained on one of the Paper Machines at A P. Paper Mills. A case study of extensive upgradation programmes undertaken at the Mills has also been presented and results reviewed.

PAPER MACHINE PRODUCTIVITY AND OPTIMISATION :

Paper Machine operation in India, of late, has become increasingly complex due to acute fiber scarcity leading to increased usage of short fibers, increasing market trend towards utilisation of lighter substance papers, higher Paper Machine operating speeds for increased production levels; and very wide spectrum of quality product and substance ranges being manufactured on the same Paper machine.

Cost effective solutions like retrofits and upgrades have therefore become imperative, to successfully meet these challenges and achieve the objectives of energy conservation, product quality improvement, and improved operating efficiency.

Based on the experience gained at APPM, the authors have tried to highlight certain facts of productivity improvement in the Paper Machine area, which may be of interest of the readers.

APPROACH FLOW SYSTEM :

Most of the Indian Mills are still operating older design centricleaners with pressure drop of 2 to 2 5 kg/Sq cm. However centricleaners which work at same cleaning efficiency with 1.5 kg/Sq.cm. pressure drop are available. It is estimated that the resultant power saving per tonne per hour of production would amount to Rs. 1 00 Lac a year. If the same is accompanied by suitable trimming of fan pump, the investment would pay back in about 3 years' time.

Correct sizing and stream lining of the entire approach flow piping and provision of variable speed fan pump drive are some of the avenues which may be profitably explored for optimisation.

Some Paper makers still believe that wider bars and wider spacing in Refiner tackles result in better fabrillation of fibre whereas actually it leads to fibre cutting. No doubt it is true that fibre cutting is definetely required to some extent for control of sheet formation. But with the advent of higher hardwood content in the furnish, further cutting of fibre should be avoided. Attention must therefore be focussed on preservation of the fibre length for the development of optimum strength characteristics. Thinner bars with narrower spacing but with equivalent cross sectional area ought to be chosen for low intensity refining to achieve higher fibrillation with minimal cutting. In this connection, it may be mentioned that replacement of Conical Refiners with Disc type of refiners is highly desirable from power consumption aspect.

Installation of control refining is accepted as a general principle in all Paper Machine installations. However, it is observed that control refiners are operated practically unloaded most of the time. No load power for a 90 KW control refiner installation is

* The A.P.P. Mills Ltd.,
Rajahmundry 533 105

around 20 KW which means idle annual power cost of Rs. 1.5 Lacs. The flexibility afforded by the control refiner to the Paper Machines does not necessarily justify its installation on all machines. Bypassing of the control Refiner was successfully attempted and did not result in any adverse result in the operational fltxibility.

PAPER MACHINE :

The productivity of the Paper Machine and some times that of the sheet converting equipments can be improved through higher deckle utilisation. A thorough review is to be carried out for each individual Paper Machine together with suitable Market Survey to maximise the deckle width.

The trime allowance has normally been accepted as 4-5 cms. However, efforts can be successfully made to minimise the trim allowance to around 3 cms wherever possible, like in case of MG papers of higher substance range, resulting in increased production by 1 to 2% with nil investment.

WET END :

Optimisation of drainage factors of existing wire part for possible speed increase, such as introduction of free draining and vacuum foils; utilisation of retention aids and double layer fabrics; and introduction of ceramic foils etc, are extensively discussed in the past in the literature. Only a passing reference is made in this article.

Retention aids are employed in advanced countries even with long fibre furnish, whereas they have not yet been very popular in India. It is well established that higher first pass retentian reduces the two sidedness of the sheet besides improving strength as well as surface characteristics of the paper. Moreover, wash-off of Chemicals is also minimised. Introduction of synthetic forming fibrics, particularly of the double layer type, also produces identical results.

Replacement of synthetic stationary drainage elements by ceramic elements needs consideration inspite of high initial cost. It definitely pays back well, in terms of lower drag resulting in longer wire life, reduction of drive energy and savings in replacement cost of foils. The uniformity and stabilisation of the drainage conditions directly result in sustained higher operating speeds and improved productivity.

Other options of rebuild of fourdrinier section are introduction of a top wire former or twin wire formers resulting in better drainage, lower two sidedness, marginal reduction in overall power consumption and improvement in sheet formation. However, they are relatively highly capital intensive options and may be considered for machines of production capacities of 100 TPD and beyond. The pay back period for such options is around 3 to 4 years by way of increased production and higher contribution to the extent of 5% to 10%. At today's prices, investments would be of the order of Rs. 500 to Rs. 600 Lacs for a 100 TPD machine. However, there is need for indigenous development of cheaper top wire formers, for introduction as retorfits to existing fourdriniers.

At the juncture, it may be mentioned that printing technology has become highly sophisticated demanding better and more uniform sheet quality, whereas paper making in India has not matched the above pace. The introduction of top wire would perhaps bridge the gap considerably.

The cost of water removal in the Paper Machine is of the order of 16% in the wire part, 7% in the press part and 77% in the dryer part. Efforts are therefore required to achieve highest dryness at wire part and at press part. Since the cost of water removal at the dryer section is the highest, efforts must be made to deliver the sheet at the highest dryness before entering the dryers. Similarly, the sheet must leave the dryers at optimum dryness.

Some of the possibilities which may be explored for reducing losses in machine operating efficiency in Press Section are listed below :

1. Possibility of further increase in nip loading at the press section. An increase in 1% dryness off the press section reduces corresponding steam requirement by 5% in dryer section.
2. Installation of closed draw press section improves the machine operating efficiency by 5% and allows operation at higher speeds by 10% if there is no limitation in drying capacity; and in some cases, allows installation of additioaal dryers. It is estimated that for a 75 TPD machine, the investment of around Rs. 400 to Rs. 500 Lacs would be paid back in two years' time.

3. Last but not the least, is the installation of wet web stabliser which should be considered for speeds beyond 600 mpm.

DRY END:

The consumption of steam normally varies between 1.7/1.8 tonnes per tonne in case of Newsprint to 4.0 tonnes and above for Writiag & Printing and Wrapping grades of papers. The impact of various factors which govern drying operation are worked out as:

Steam control & condensate drainage	70%
Dryer Fabrics	22%
Pocket Ventilation	7%
Hood Exhaust	1%

Installation of properly designed and balanced steam and condensate drainage system not only improves steam economy, but also reduces the dryer drive loads considerably. Good trapping practice with suitable air vents for each dryer in the case of conventional systems; maintaining correct clearance between syphon tip and dryer shell and maintaining correct pressure differentials in the case of Casade systems; introduction of thermocompressor system wherever feasible are some of the factors which would help to minimise the steam consumption per tonne of paper, besides reducing the drive loads.

Elimination of sheet flutter in the dryer pockets at the wet end consequent sheet breaks is possible by incorporating uni-felt run in the first group of dryers. It is also observed that the selection of very open clothing for the dry-end groups results in better air pumping into pockets resulting in more uniform profile.

Provision of a correctly designed pocket ventilation system and proper positioning of the ventilating boxes reduce pocket humiditise, promote drying and reduce profile variation. Marginal reduction in dryer drive load is possible by eliminating felt dryers Such dryers can be converted into paper dryers and they can be utilised machine extension, where situation permits. In case MG/Yankee Machines, installation of high velocity air hoods over MG cylinder contributes to 10-15% increase in production. In the case of conventional dryer parts, open hoods are found adequate for speeds upto 200 mpm; semi-closed hopds upto 600 mpm; and closed hoods are recommended beyond 600 mpm.

The economy of closed dryer hoods is yet to be established in India. The exhaust fan capacity is based on carrying capacity of 0.07 kg. moisture per kg. of air in the case of semi open hoods and 0.14 kg. moisture per kg of air in the case of closed hoods. It can therefore be seen that energy required to exhaust the air is almost half in the case of closed hoods. Apart from energy savings, the conditions of drying are more under control. This is a step to be taken after all possible measures to improve machine efficiency in all other areas have been incorporated, since closed hood may be a hinderance if sheet breaks are more and will further add to time loss in sheet threading. In this context mention may be made of minimising sheet threading time during breaks by employing efficient rope carrier systems.

CALENDER AREA:

Increase of number of nips for the same nip loading results in marginal increase in smoothness, but it is accompanied by higher power consumption, increased sheet non-uniformity with lower caliper & marginal increase in sheet threading time. The accent is towards more uniformity at higher caliper consistant with good smoothness and therefore the trend is towards installation of open type fixed queen stacks of 3 nips (4 rolls) as against closed stacks of 7 nips (8 rolls).

MONITORING AND CONTROL:

Through continuous measurements and proper record keeping, trends of variables are noted well in time and corrective action can be initiated manually/automatically before variables drift far away from the desired values.

Many tools are available now a days to the Paper Maker for continuous monitoring of different process variables iike consistency, flow, pH, freeness and drainage; and moisture in felts & paper at reel. On line measuring & controlling systems for moisture, basis weight, ash and caliper are also available. Installation of such computerised systems greately improves the productivity, apart from stabilisation of the quality and also results in the conservation of raw materials (fibre) and energy. A system for 75-100 TPD Paper

Machine costs approximately Rs. 300 Lacs and pay back period works out to about 1-2 years.

Various measures undertaken for improving the quality of sheet and improvement in the machine operating efficiency have also favourable impact on the converting and finishing operations. The losses get reduced considerably resulting in higher productivity, while associated problems like recirculation of dry broke, accumulation of fines, shade variation etc are also minimised.

ENERGY CONSERVATION AND AUDIT :

Regular energy audit by itself helps in bringing down the consumption of power in different sections by identification of various loss points Energy Conservation measures undertaken in the Paper Machine area have been found quite rewarding.

Utilisation of vacuum pumps is advocated, through at the expense of flexibility. The air flow per BHP input at 500 mm Hg vacuum level is of the order of 0.55 cumet/min for indigenous pumps, whereas it is of the order of 0.65 cumet/min per BHP input for imported pumps. There is thus some justification for the import of technology and equipment in this area.

It is estimated that stock pumps consume 25-35% of the total power consumed in a medium sized Paper Mill having about 200 pumps and that the total energy cost can be reduced by 20% through new stock pumping techniques and proper pump dimensioning.

Considerable energy saving is possible through the introduction of flat belt drives to replace V-belt drives vacuum pumps, chest agitators, compressors etc.

Conscious efforts are to be made in analysing the down time and identifying ways and means to minimise the same, for improving the overall productivity. Regular condition monitoring and organised/planned shut downs help in the long run in minimising overall down time by reducing break downs and unplanned outages.

In the end, mention may be made of a very vital factor for improving the productivity viz; Development of Human Resources. Proper training of man power is of utmost importance for minimising the consumption of various inputs like fibre, power, steam, water and chemicals; and maximising the outputs in terms of quantity and quality which in other words mean improved productivity.

CASE STUDY AT A.P.P. MILLS:

Some of the principles of productivity improvement discussed earlier were successfully implemented at AP Paper Mills Ltd., during the course of expansion & upgradation programmes undertaken for Paper Machine No. 5.

The basic Paper Machine was installed in 1975 in its simplest form, with 60% dryers reclaimed from old Paper Machines No. 2 & 3, after converting the felt dryers into Paper dryers. The 3.6 meter wide fourdrinier machine had a pressurised head box, cantilever type of fourdrinier, unipress (suction pickup-cum-press) followed by straight through fabric press, 22 paper dryers, 2 coolers, calender and pope reel. Locally made stock pumps, cast centricleaners, vacuum pumps and calender stack were employed. MG SET drives were installed. The stock preparation consisted of small stock chests with conical refiners, and batch system of operation. It was designed to operate at speeds upto 300 mpm.

In 1982, the machine was extended by incorporating 10 additional drying cylinders, and a new open type fixed queen calender stack was introduced replacing the closed calender stack. The newly extended portions were provided with thyristor controlled sectional drives. Steam and condensate system was revamped and some of the low capacity vacuum pumps were replaced by higher capacity pumps.

Under Phase III in 1985, the batch type of stock preparation system with conical refiners was totally replaced by a continuous stock preparation system, with new Double Disc refiners and provision was made for parallel refining of two different pulp furnishes. Provision for continuous dosing and blending of chemicals was also incorporated. A separate broke street was designed with U.T.M. Pulper, dry broke pulp chest, high density cleaner and deflaker. The approach flow system was totally redesigned, with deaeration type of centricleaners and high efficiency fan pump. The design of stock piping layout incorporated the latest principles of approach flow piping. Besides the above, a number of small vacuum pumps were replaced by high capacity vacuum pumps.

Under Phase IV in 1988, a major rebuild of the Paper Machine was carried out. The old open draw press section was replaced by quadri-nip press and the drive of the entire machine was changed over to modern thyristor controlled sectional drives. In addition to the installation of 4 more dryers in the area vacated by the old press section, the steam and condensate system was further upgraded.

The Paper Machine operating speed was successfully increased from 300 mpm to 550 mpm, resulting in increase of production from 16,500 TPA to 33,000 TPA which may be seen from Table—1.

Reduction in specific steam and power consumptions achieved on the Paper Machine is presented in Table—2. As can be observed, the specific steam consumption reduced from 3.7 TPT to 2.4 TPT; and power consumption from 1050 KWH to 750 KWH over the course of various modifications.

The authors gratefully express their thanks to the Management of the A.P. Paper Mills for having granted permission for publishing the paper.

TABLE—1

PHASEWISE INVESTMENT & PRODUCTIVITY:

Sl. No.	Phase & Year of Completion	Investment (Rs /Lacs)	Machine Speed mpm	TPD	Finished Production TPA	Investment per Annual Tone in Rupees
1.	Phase-I 1975	310	200-300	50	16500	1900
2.	Phase-II 1982	110	300-350	70	Increased by 6600	1650
3.	Phase-III 1985	110	350-450	80	Increased by 3300	3300
4.	Phase-IV 1988	380	550	100	Increased by 6600	5800

TABLE—2

PHASEWISE IMPROVEMENT OF ECONOMY THROUGH PRODUCTIVITY AND CONSERVATION MEASURES :

Sl. No.	PHASE	Steam consumption per tonne of Paper	Power consumption per tonne of Paper
		Tonne	KWH
1.	Phase-I	3.7	1050
2.	Phase-II	3.4	950
3.	Phase-III	3.3	900
4.	Phase-IV	2.4	750