

Avenues For Increasing Productivity In Chemical Plant Of A Large Integrated Pulp & Papermill

MAHESHWARI M.P.* SATYANARAYANA A.** Dr. VENKOBA RAO G.***
SRINIVASA RAO P.****

It is the constant endeavour of any industry to improve its efficiency and economise operations through well planned modernisation and expansion schemes ultimately aiming to maximum productivity. This paper deals with mainly increase of productivity through unitisation and upgrading of technology in an already existing large Integrated Pulp & Paper Mill. The newly installed large units are however exempt from such considerations since such concept is the basis in the planning stage itself.

Particularly for the mills which have undergone stepwise expansion for increasing the production through balancing schemes, it is often not possible to go in a big way induction of new technology as this calls for higher capital outlay in a particular section, which does not fit in the concept of productivity increase through balancing schemes.

Andhra Pradesh Paper Mills have been continuously striving for modernising and induction of new technology through well planned balancing programmes in the different sections of the mills ever since it went in for an expansion programme from 3,000 TPA to the present installed capacity of around 90,000 TPA. Further programmes are under way to achieve the licensed capacity of about 1,00,000 TPA. The theme has been mainly in getting over the obsolescence and replacing a number of small units by higher capacity ones and maximising the production by way of balancing programmes in certain other areas. Chip Preparation plant and black liquor evaporation system in the chemical plant are the two areas where such concept of unitisation and induction of new technology has come on the fore and in particular projected in this article.

The mill operated till 1980 with a number of small capacity disc chippers arranged in two streets for

chipping bamboo and tropical hardwoods separately. The industry is aware of the fact that there has not been any suitable chipper developed exclusively meant for chipping bamboo and the same disc type chippers basically designed for chipping wood are used for bamboo as well. Bamboo being hollow and bulky material and inconsistent in quality, the chipping of the same poses several problems. While green and yellow bamboo generates high amount of slivers, dead and dry bamboo give rise to higher generation of dust; only seasoned bamboo provides uniform chip quality within the tolerable limits of slivers and dust generation.

Attempts made to mechanise the feeding of small capacity disc chippers did not meet with any success as jamming of feed chutes and discharge system was frequent. Apart from these limitations there are several inherent drawbacks experienced with disc type chippers when handling bamboo, notably being higher maintenance cost, higher power consumption and deployment of more labour force. With so many units in operation, it has not been possible for any dust extraction system and this posed serious problems as the whole area often becoming highly dust laden. Manual feeding of such raw material has also given rise to higher accidents.

Somewhere in 1976 drum chippers came to lime-light in the Indian Pulp & Paper Industry with the first installation at West Coast Paper Mills. Though drum chippers are basically developed in Europe for

*Sr. Vice President

**Manager (P&D)

***Chief Chemist

****Sr. Engineer (P&D)

The Andhra Pradesh Paper Mills Ltd., Rajahmundry

Particle Board Mills to chip waste from Saw mills and veneer from Plywood Mills, surprisingly it gave very good performance when operated on bamboo. Because of the positive feeding, vertical cutting and recycling in built-in screen, the generation of slivers and over size has been just minimal. Higher chipping rates could be achieved on such type of chippers because of full length contact of the fly knife and wider feed chute suitable for bulky material. Drum chippers could overcome practically all the constraints which were faced with the operation of small size disc chippers. The chip quality from drum chipper however suffers when compared to that from disc chipper in following two aspects;

- (a) the chip size from drum chipper falls on the lower range of acceptable limits
- (b) the chips are subjected to more damage at both the ends because of the impact load which also contributes to higher generation of the fines.

Impressed by such overall good performance of drum chipper for handling bamboo, Andhra Pradesh Paper Mills installed the higher capacity drum chipper in 1981 with the mechanised feeding arrangement. The chipper is able to handle on a sustained basis of 25 TPH of bamboo which almost equivalent to the operation of 4-5 disc chippers in the past. The net saving due to lower power consumption, lower maintenance and mechanisation is around Rs. 40 lakhs.

Encouraged by successful unitisation adopted in bamboo chipping by installing a high capacity drum chipper, the mills is now planning to instal a higher capacity disc chipper for its chipping operation of wood. The selection of chipper with adequate feed chute opening would directly handle almost 90% of the logs and tops of the tropical hardwoods received from the forest without any need of sawing operation. Looking to the future trends in the Social Forestry where large scale plantations of Eucalyptus is being taken up practically all over the country, the availability of the uniform size raw material such as Eucalyptus and Casuarina will be progressively more and this will put the Indian Pulp & Paper Industry at equal footing with those operating wood as the basic raw material as far as the chipping operations are concerned.

The mill was operating till 1981 two streets of 5 effect short tube natural circulation evaporators for a total designed water evaporation capacity of 72 TPH. The performance of the evaporators by and large was satisfactory when handling 100% bamboo black liquor. But with the steady increase of the usage of mixed tropical hardwoods to around 50%, actual evaporation fell short to as low as 65% of the designed capacity. To tie-over the situation, forced circulation concentrator was installed operating the multiple effect evaporators at lower concentration i.e. from an earlier level of 48% to 42% for improving its performance and bring up the concentration to a level of 48% which is the feed concentration to cyclone evaporator.

The Paper Industry is aware of the fact that the evaporation of black liquor of tropical hardwoods poses serious problems of scaling and jamming of the tubes which is more acute at higher concentration. To keep up the performance and output of the evaporator plant, frequent water boil-outs are necessary and periodically the bodies are to be bypassed for mechanical cleaning. There are several problems associated with such type of operations, some of them being the drop in capacity, higher outages of the plant, and chemical losses due to entrainment during boilout/washing cycle. Much worse is the drastic reduction of steam economy.

The mill was for quite sometime thinking of modernising the evaporator plant aiming essentially for higher steam economy, handling of more difficult black liquor to a concentration of as high as 62% for direct firing and to reduce stream pollution which so often takes place during boil-outs. As the mill's production also being raised step-wise, this was providing good opportunity to entirely replace the existing plant by a single street unit of a more modern design.

LTV rising Film Evaporator works well with liquor of medium viscosity and for achieving an end concentration of around 50% solids. However, handling of difficult black liquor from mixed hardwoods, eucalyptus, bagasse etc., serious problems are encountered even in achieving a concentration of around 45%. The present day selection and operation of the evaporator plant is much more complex on environmental considerations and energy costs. A study was made of the Evaporator plants in operation in Japan, Taiwan,

Australia and in several other countries where Black liquor from eucalyptus and other more difficult hardwoods was being handled. The studies revealed that Falling Film Evaporator system should be the most obvious and apt choice and therefore, APPM took a bold step in deciding for a 7-effect Free Flow Falling Film Evaporator system (FFFF) of M/s Rosenblad.

This new generation of evaporator system which is being installed in India for the first time in the Paper Industry differs mainly in the use of heating surface. While the heating surface in conventional evaporator is tubular, the one of Rosenblad's design is of plate type. The elements have convex dimples at a pitch of 3" square with 43° angle to the vertical which serves redistribution of liquor as it comes down from the perforated tray mounted on top. The entry of the steam/vapour and the exit of the condensate is at the bottom of the heating elements and the venting of non-condensable gases is from the top. The vapour generated during evaporation escapes horizontally from the heating surface, passes through the vane type entrainment separator and thereafter enters the succeeding effect to serve as heating medium. Spacing of the heating elements are such that the velocity of vapours generated have little effect on the liquor film.

The salient features of Rosenblad's FFFF evaporator system have appeared time to time in several Pulp & Paper Journals and also in IPPTA Convention Issue of the year 1983, which makes the study very interesting and the approach exciting.

The problems while evaporating more difficult black liquors to higher solid concentrations, are

related to viscosity, scaling, boiling point rise and local over concentration.

Since the viscosity of black liquor at higher concentration is a function of temperature and that the heat transfer is the function of viscosity, it is advantageous to operate at higher temperature to minimise the heating surface. To overcome the problems of viscosity it is necessary either to install forced circulation tubular evaporator or a Falling Film Evaporator system. The power cost in operation of Forced Circulation tubular evaporator would be much higher and also it is not possible to achieve concentration to a level for direct firing.

Minimising of scaling and local over concentration can be achieved by positive circulation which is best possible in a Falling Film Evaporator. These evaporators have fixed flows to the heating surface regardless of throughput and have almost no effect to variation in feed rates. Such system gives scope for infinite turn down ratio. Boiling point rise which is a function of concentration, in conjunction with the temperature limitations imposed by viscosity and scaling characteristics, limits the range where a concentrator can operate to a very narrow span if economical use is to be made of the heating surface. Higher boiling point rise illustrates the need of a concentrator to operate separately from the balance of the evaporator. Therefore, there are practical limits in the use of number of effects in tubular evaporators compared to that of Falling Film.

The distinct advantages of Free Flow Falling Film Evaporator system over the rising film Tubular Evaporator are presented as under:

	Conventional Long Tube Vertical Evaporators.	Falling Film Plate Type Evaporators.
	Less	More than 98%
1. System availability	a) Frequent boilouts. b) Cut out of the bodies to clean the heating surfaces.	System is designed such that it can be washed without outage of the unit.
2. Overall heat transfer coefficient.	Steadily decreases and demands frequent boil-out and mechanical cleaning.	Sustained heat transfer coefficient obtainable due to surfaces maintaining clean—basic design feature.

	Conventional Long Tube Vertical Evaporators	Falling Film Plate Type Evaporators.
3. Final concentration	Possible generally upto 45%. Forced circulation system necessary at higher concentration for more viscous liquor.	Possible even above 65%.
4. Steam economy	4.3 based on Sextuple effect operation in conjunction with Forced circulation system. System is limited to 6 effects as MEE operation.	6.0 based on 7 effects. System can be operated with more than 7 effects.
5. Condensate Quality :		
—Entrainment in combined condensate.	At best not less than 100 ppm as Na ₂ O	As low as 10 ppm as Na ₂ O
—Condensate segregation	—Not possible.	Possible. 96% of the condensate could be odour free.
6. Turndown capability.	75% of design capacity.	25% of design capacity thereby giving higher flexibility in operation.
7. Net savings in terms of Steam & Power	—	Rs. 47 lakhs per annum.

Since the Black liquor can be concentrated to a level that it can be directly fired in the Recovery Boiler, the elimination of direct contact evaporator would greatly reduce the level of emission of malodorous gases. Also, the heat available in the flue gas by elimination of direct contact evaporator can be trapped for the generation of more high pressure steam which could be around 12% in general.

The FFFF Evaporator system being installed at APPM and likely to be commissioned in the first quarter of 1986, is a 7-effect unit designed to concentrate Black liquor from 260 TPD of chemical pulp from 15% to 62% total solids at a steam economy of 6.0. The evaporator would operate on backward feed with the liquor entering in the flash chamber of 5th effect and further flashing in the flash chamber of 6th effect. The thick liquor from first effect is drawn out and flashed before being stored in the thick liquor

tank. The flash vapours from the product liquor would enter in 3rd effect.

The first effect of the system operating as a concentrator has heating surface in three sections. The system is designed in such a way for its piping and instrumentation that any of the section can function as wash. This permits continuous washing of the different sections of the concentration by rotation without any down time or chemical losses. Vapours from the 7th effect are condensed in the surface condenser utilising the same plate type surface as that of the evaporators. In each of the 6th & 7th effects and also in the surface condenser, the condensate is separated by selective condensation as clean and foul condensate. The system is so designed that about 96% of the condensate will be collected as a clean condensate and 4% as foul condensate.