Increased Use Of Mixed Tropical Hardwoods For Paper-Grade Pulps—Behaviour Of Spent Liquor In Evaporator Operation

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SUMMARY

Seshasayee Paper and Boards Limited commenced production of printing and writing papers in 1962 with an installed capacity of 20,000 tonnes per annum, on a furnish mix of 70% bamboo and 30% bagasse. Since then, the mill has expanded in two stages to its present capacity of 55,000 tonnes per annum. Faced with the limited forest resources of Tamilnadu, the Mill had to perforce alter its raw material mix to 40% bamboo and 60% mixed tropical hardwoods in order to keep pace with the growth of the mill. Hardwoods utilisation was at first restricted to Eucalyptus hybrid and later relaxed to include other selected locally available hardwoods. The extreme heterogeneity of raw material mix, resulting in complex spent liquor characteristics, makes the classical evaporator operation extremely unstable. Tube scaling, high viscosity, granulating tendency and a very high content of fibre fines of the spent liquor dictates certain limitations to the conventional indirect contact evaporation. The mill's experience would suggest that the spent liquor be concentrated upto 30—35% in conventional LTV evaporators and further upto a final liquor concentration of 40—45% in a finisher effect with forced circulation.

INTRODUCTION

In 1962 Seshasayee Paper and Boards Limited, with an installed capacity of 20,000 tonnes per annum, commenced production of quality printing and writing papers with a furnish comprising 70% bamboo pulp and 30% bagasse pulp. The raw material bagasse was then being procured, in exchange for furnace oil, from a sugar mill in the neighbourhood. During the period 1962-1969, the price of furnace oil steadily escalated from Rs. 150 per tonne to more than Rs. 800 per tonne, making it highly uneconomical to continue using bagasse pulp from bagasse procured on a fuel-exchange basis. As the bamboo availability in Tamilnadu was limited, the mill had to select alternate raw material to replace bagasse. The obvious choice was tropical hardwoods. Eucalyptus hybrid (comprising of E. botryoides, E. cameloulensis, E. tereticornis, E. Robusta and E. iransversa) was taken up for pulping in admixture with bamboo. When the use of bagasse was discontinued, Eucalyptus hybrid was used to the extent of about 10% of the total raw material furnish. Over the years, the use of Eucalyptus had to be steadily stepped upto around 25% of the total furnish. Apart from Eucalyptus, the mill had to identify and select definite species of other hardwoods for pulping. Extensive laboratory pulping trials were carried out on a wide spectrum of locally available hardwoods. These trials were used to establish parameters for pulping as also to determine the characteristics of the spent liquor. About 35 varieties of hardwoods were subjected to

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such pulping trials. On the basis of the pulping trials as well as the procurement capacity, five individual species were identified and selected for procurement and pulping in addition to bamboo and Eucalyptus hybrid.

In 1968, about the time when pulping of bagasse was gradually discontinued, the mill embarked on a Expansion Programme raising the capacity of the mill from 20,000 tonnes per annum to 35,000 tonnes per annum. To achieve capacity production, the mill had to operate on a raw material furnish comprising 70% bamboo and 30% mixed tropical hardwoods. At that time the mixed tropical hardwoods used by the mill, comprised substantially of Eucalyptus hybrid to the extent of 70% and the balance being other selected varieties of tropical hardwoods.

The Second Stage Expansion of the mill was planned in 1976, to increase the capacity from 35,000 tonnes per annum to 55,000 tonnes per annum. Based on the raw material availability, the planned furnish after the Second Stage Expansion was 60% bamboo and 40% hardwoods. By the time this expansion was completed, the bamboo in the Tamilnadu Forests experienced gregarious flowering and the bamboo supply to the mill started dwindling. The mill had to perforce revise its raw material composition to 40% bamboo and 60% mixed tropical hardwoods. Here again, the availability of Eucalyptus hybrid being limited only 50% of the tropical hardwoods requirment could bemet by Eucalyptus hybrid and the balance requirement of hardwoods had to be met by a variety of tropical hardwood species in addition to the five selected species.

At present the mill uses about 15 different varieties of hardwoods in admixture with bamboo. Consequent to the increased use of hardwoods, further accentuated by increased number of species, the mill has faced numerous operating problems.

This paper briefly submarises one of the major problems faced by the mill, namely in evaporation of the spent liquor from pulping.

2 MISCELLANEOUS HARDWOOD SUITABLE FOR PULPING

The suitability of Eucalyptus hybrid as a pulping raw material has long since been widely established and needs no particular mention. The laboratory scale pulping trials of 35 different locally available hardwoods identified & the following additional species as being most suitable for manufacture of paper grade pulps :

1. Dadup (Erythrina suberosa)
2. Tanuku (Gyrocarpus jaquina)
3. Vadanarayan (Poinciana elota)
4. Kiluvai (Portium candatum)
5. Dollia (Trama orientalis)

Apart from the aforementioned species of tropical hardwoods, one more species the mill had also been using, is Acacia arabica (Babul), locally known as Karuvelan.

Besides the operational problems in pulping and paper making, the increased use of mixed tropical hardwoods had a definite and adverse impact on the various operations in the recovery of spent cooking liquor.

3 EVAPORATOR OPERATION-MILL EXPERIENCE

As installed in 1962, the evaporator section of the mill consisted of one street of six body quintuple effect LTV evaporators, with the following general specifications :

Type	6 body quintuple effect LTV evaporators
Length of tubes	24 ft
Diameter	2"
Heating area	2200 sq.ft/effect
Water evaporation capacity	70,000 lbs/h
Feed	1,00,000 lbs/h
Inlet concentration	13—15%
Outlet concentration	40—45
Steam economy	4.2 t of water per tonne of steam
Feed sequence	IV–V–III–II–I/IA

Integral preheaters are provided for V, IV, III and II effects. The I effect and its spare (IA) do not have a preheater but the evaporation is done in two passes as against the single pass evaporation in the other effects. The I effect and its spare are provided with stainless steel tubes while the other effects. are provided with carbon steel tubes. Demister pads are provided in V, IV, III and II effects Vacuum operation is achieved by a two stage ejector system with barometric type of primary and secondary condensers.

In the initial years after the commencement of of production in 1962, the mill was operating with a furnish composition of 70% bamboo and 30% bagasse pulps. No particular problem was experienced in black liquor evaporation during that time excepting for the scale formation in the higher concentration eff cts. The scaling was the direct consequence of the high silica content of the raw

materials. The scaling could be removed by mechanical cleaning on a pre-planned schedule. The scaling was mainly internal scaling of the tubes and no appreciable fouling of calendria was observed.

Towards 1968, when the mill started to gradually discontinue the use of bagasse, the bamboo pulp content in the raw material mix was increased and Eucalyptus hybrid was included, to replace bagasse. In the first few years after the discon inuance of bagasse, Eucalyptus hybrid was used to the extent of 10% of the total raw material mix. At this stage the change in raw material mix did not produce any appreciable change in the behaviour of the spent liquor during evaporation. However, over the years since 1968, the percentage of Eucalyptus hybrid in the raw material mix was gradually stepped upto 25%. At this stage there was a distinct and appreciable increase in the viscosity of the spent liquor. The increase in viscosity had its impact on evaporation as well as burning of the liquor in furnace. The viscosity phenomina is attributable to the polyphenols content in the extractives of Eucalyptus hybrid. These polyphenols are present in a polymarised form and provide a nucleus for condensation of lignin thereby increasing the viscosity of black liquor. The polyphenols constituents like ellagic acid, gallic acid, ellagi tannins and their polymers are highly chromegenic under alkaline conditions and cause deposition of complexes formed between metals and the acids on to the evaporator tubes.

During this period the mill had completed the pulping trials on 35 different varieties of tropical hardwoods and had identified the five different species mentioned earlier in this paper. These selected hardwoods were subsequently procured and used for pulping on a regular basis. It was observed that the use of one particular species namely Dadup *Erythrina suberosa* improved certain characteristics in the spent cooking liquor. Laboratory examination revealed that the black liquor from Dadup does not indicate any solid separation (granulation) even at 55% concentration. The spent cooking liquor from the pulping of Dadup seemed to act as a thinner to reduce the viscosity of the spent cooking liquor. Further more, it was observed that the use of Dadup also improved the burning characteristics of the spent liquor in the furnace. A similar effect was later observed when *Acacia arabica* was used in the raw material mix.

Subsequent to the Second Stage Expansion of the mill and the raw material crisis created by the gregarious flowering of bamboo in Tamilnadu Forest, the mill had to perforce revise its raw material mix to 40% bamboo and 60% mixed tropical hardwoods. As earlier stated the limited availability of Eucalyptus, Dadup and *Acacia arabica*, the mill has been forced to include about 15 different species of tropical hardwoods in the raw material mix. This has had tremendous impact upon the spent liquor characteristics. The spent liquor characteristics apart from being unfavourable, are also very inconsistant and erratic. The high viscosity and the granulation effect results in very frequent and severe tube fouling resulting in very poor evaporator efficiency. The use of the different miscellaneous hardwood species also results in the production of a pulp with a very high content of fines. Substantial amounts of these pulp fines find their way into the spent cooking liquor during the brown stock washing operation. These fines in the black liquor provide the necleus for scaling of evaporator tubes. These scales are soft and less tenacious unlike the conventional silica based evaporator tube scales. Nevertheless the soft scales cause sufficient fouling of the tubes requiring boiling-out. Besides the thermal conductivity and specific heat, the boiling point elevation also shows an increase. This results in lower temperature difference and calls for increased steam pressures. Increased steam pressure (and hence the temperature) accelerates tube scaling. The unfavourable heat transfer characteristics on account of high viscosity also adds to the problems created by the scaling and tube fouling tendencies of the spent cooking liquor.

Apart from the tube-side scaling, it has been observed that the pulp fines in the black liquor are carried over in the vapour stream and results in the fouling of the calendria side of the effects operating under vacuum.

During the Second Stage Expansion of the mill the evaporator section was strengthed by the addition of one more street of evaporators identical to the existing one, but manufactured and installed as a mirror image. Excepting for minor changes in design and construction the newly installed street is identical to the earlier existing street.

After the successful completion of the Second Stage Expansion, the raw material availability dictated a mix of 40% bamboo, 30–40% Eucalptus hybrid and 20—30% miscellaneous mixed tropical hardwoods. With this raw material mix, the spent cooking liquor has all the unfavourable characteristics that can possibly be encountered. Tube scaling, calendria fouling and an erratically high viscosity profile have all contributed to a very critical condition in evaporator operation. The above factors have very often crippled the evaporator operation to a near standstill. The evaporator bodies had to be very often pulled

out of service for thorough cleaning of the tubes. Frequent mechanical cleaning, which very often has to be severe, has a definite impact in reducing the life of the tubes. The tubes of the evaporator bodies of the older street very soon came up for renewal. All the tubes in all the effects of this street were replaced by stainless steel tubes. This resulted in a easier cleaning operation of the tubes. Nevertheless, the evaporators required frequent water boiling to remove the soft scales caused primarily by the presence of pulp fines in the black liquor. It must be mentioned here that efforts to remove the pulp fines by the different screening methods didnot show any appreciable improvement. A frequent boiling out pattern reduces the evaporator availability besides imposing a financial burden arising out of chemical loss during water-boiling.

4 OPERATING SCHEDULE OF EVAPORATOR BODIES

Both the streets of six-body quintuple effect Evaporators are generally run as quadruple effect Evaporators since almost at all times, two evaporators bodies of each street are out of service for descaling and cleaning.

The runnability of the various evaporator effects are as under :

I and IA	30 days
II and III	45 to 60 days
IV and V	90 days

Caustic cleaning of calendria of IV and V effects is only once a year during the annual mill shutdown. The availability factor of the various evapoator effects is as under :

I and IA	50%
II and III	60%

As earlier stated, frequent water-boilings has to be carried out in order to achieve capacity operation of the chemical recovery unit. On the average, each street is subjected to water-boiling about 9 times a month. Each water-boiling operation last for about 4 hrs and imposes a chemical loss of about 150 kgs as Na_2O.

The two streets of six body quintuple effect evaporators have, under normal operation, yielded a steam economy as much as 4.3. Under the presently prevailing conditions, both the streets generally operate only as six-body quadruple effect evaporators since two bodies are usually out of service for cleaning. The steam economy is therefore down to about 3.2.

5 DEVELOPMENT EFFORTS

In parallel with the actual efforts made to ensure day-to-day operation of the evaporators, studies were carried out to correlate the scaling and fouling tendencies of the spent liquor with the concentration level. It was concluded that the conventional LTV evaporators would run reasonably trouble free, if the outlet concentration was restricted to about 36%.

The above conclusion prompted a trial run of one evaporator streets by spliting the six bodies into two separate units. The V, IV, III, II and IA effects were used to form to a five body quatruple effect evaporator unit where the IA and II effect were alternatively used as the first effect. The original I effect was separately used as an improvised finisher effect. The five body quatruple effect unit was used to deliver black liquor at an intermediate concentration of 36% which was then supplied to the "finisher effect". The first effect which was used as an improvised finisher effect was modified to provide forced circulation. Live steam was supplied to the improvised finisher effect as well as IA or II effect. Since the operation was on a trial basis the existing flexibility of the vapour line circuit was used without any major modifications. Consequently the vapour from improvised finisher effect was vented to atmosphere. With this arrangement an ultimate concentration of 40-42% could be maintained with a considerably lesser number of water-boilings and an overall increase in availability of this street of evaporators. This temporary arrangement is, no doubt, uneconomical and unconventional, but is enabling the mill to maintain capacity operation. Furthermore, this trial operation has established beyond reasonable doubts that the evaporator problem on account of increased use of hardwoods can be overcome by concentrating the spent cooking liquor to about 30—32% in conventional LTV evaporators and processing it upto a final concentration of 42% in a separate finisher.

The mill is presently fabricating a finisher effect of its own design, which is expected to be put into operation by mid March 1980. This finisher is being fabricated within the mill and will use stainless steel tubes salvaged from the tube renewal of the old street which was recently carried out. Since the proposed finisher uses salvaged tubes, the tube length has been fixed at 18 ft. and the design for heating surface, number of passes, etc. has been accordingly worked out. A circulation velocity of about 9 ft/second has been attempted. A horizontal split casing centrifugal pump is proposed for the finisher effect.