Considerations of Local Availability of Plant & Machinery in planning a Pulp and Paper Mill Project

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There are several factors influencing the choice of equipment and system design while planning a new mill or expanding and modernising an existing unit. Local availability of plant and machinery is one of them. This is very important in our country, because:

(a) The avilability of foreign exchange is very scarce, which restricts the import to the absolute minimum.

(b) The indigenous manufacturers, who have invested considerable amount in developing technical know-how and manufacturing facilities of pulp and paper mill machinery are not getting sufficient orders to utilise their capacities to the fullest extent.

It is quite natural that for certain applications in a mill suitable equipment would not be available indigenously, while in some other cases although the indigenous equipment can be used, they are not the most suitable. and may result in higher investment or operating expenses. The later situation calls for a compromise where the Project Engineer and the entrepreneur will have to use the utmost discretion. It is intended here to discuss and analyse some such applications pertaining to a particular project, for the benefit of both the project implementors and the machinery manufacturers. Considering today's needs a 200 tonnes/day integrated pulp and paper mill making writing printing paper using Bamboo and mixed Hardwoods as raw meterial and the sulphate process would be typical.

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1. Raw material perparation

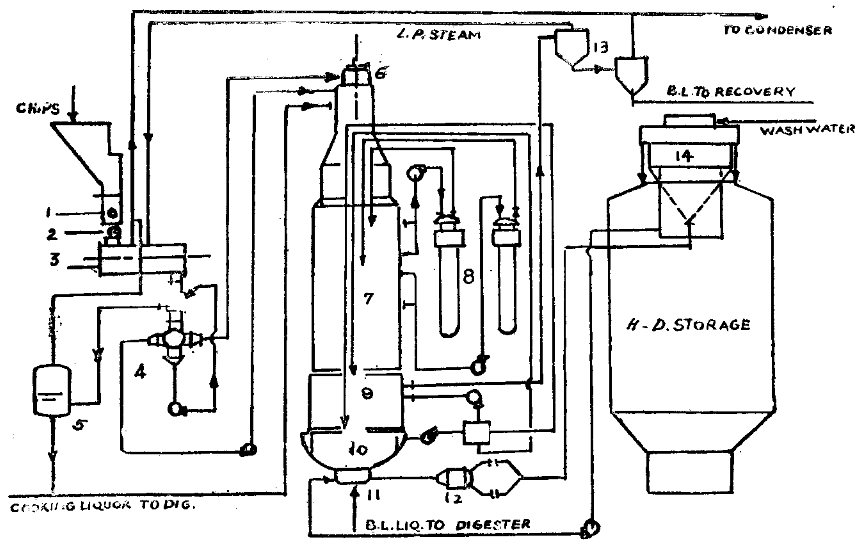
Chippers, Chip Screens, Rechippers and Chip Washers for processing Bamboo are being manufactured indigenously for the last ten years. These are also suitable for Hardwoods, but the Chippers being made in this country at present cannot handle logs larger than about 200 mm dia. Since the hardwoods are received in varying sizes sometimes beyond 600 mm dia, these have to be sawn prior to chipping. One cannot however expect the majority of the Hardwoods received by the mill to pass through the saw mill as this would be a source of additional expenditure, and there is a definite case for either import or the taking up of the indigenous manufacture of a Hard Wood Chipper to handle logs say upto 350 mm dia. so that only the small percentage of logs beyond this size have to be sawn. The type of Hardwoods being used so far were not suitable for mechanical barking. but with the expected availability of plantation logs of regular shape like Eucalyptus there will be an increased requirement of Barking Machines. The extraction equipment for the Chip Storage Silo is not yet made in this country, but this item comes under the purview of the Manufacturers of material handling equipment and pressure should be put on them to study and develop the necessary equipment.

2. Cooking

In choosing the cooking equipment the main decision has to be either for a Continuous Cooking System or the batch digesters.

The main advantage of the Continuous Digester is its capability of producing more uniform quality pulp on a sustained basis and the facility to vary and control the quality of pulp according to requirement. Moreover with the internal Hi-heat Washing and the development of Continuous Diffuser Washing, it provides a very compact cooking and washing system as detailed in Fig. 1. The lower steam consumption and absence of steam peaks, reduces the size of the boiler plant which for this production would be by about 10 tonnes/hr.

While the cost of continuous cooking and washing plants combined may be comparable with that of a Batch Digester system in other countries, this is not so in our country due to the incidence of high rate of import duty on the equipment which will be



1. Chip meter.
2. L. P. Feeder.
3. Steaming Vessel
4. H P. Feeder.
5. Level Tank
6. Top Separator.
7. Digester cooking zone.
8. Liquor heaters
9. Digestor Washing Zone.
10. Digester Cooling Zone.
11. Bottom Scraper.
12. Blow Unit.
13. Flash Cyclones.
14. Diffusor Washer.

Fig. 1—Flow Sheet Kamyr Continuous Digester with Diffusor Washer.

imported. A typical batch digester system with 3-stage washing is shown in Fig. 2. In Fig. 3 the B. D. tonnes of pulp produced/day per cubic meter digester volume has been plotted against different cover to cover cycles. With 6.5 hours cycle the pulp production is 0.33 tonnes/m³ per day or for the 200 B. D. tonnes/day the total batch digester volume would be 600 m³. Hence 4 Nos. 150 m³ or 6 Nos. 100 m³ digesters may be chosen depending upon whether one is prepared to undertake site welding or not. Detail break-up of the installed costs of the two systems are given in Annexure I and even allowing for savings in the cost of

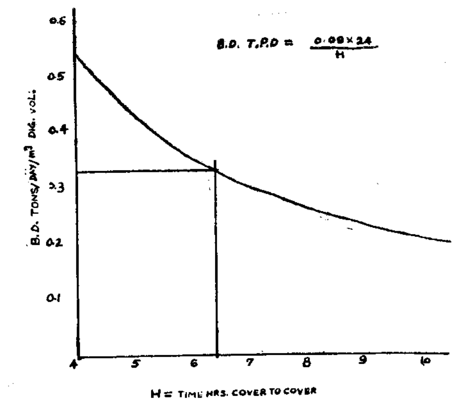


Fig. 3

building and boiler plant, the continuous digester system is costlier by about Rs. 80 lakhs. Considering the operation costs, the continuous digester would definitely require lesser number of operators per shift (in European practice the number of Operators for a continuous digester is 2, whereas for equivalent batch system the number is 3), but this reduction in the number of operating personnel will be offset in this country by the increased number of Supervisors and Maintenance personnel. The major saving with the continuous digester system is in steam consumption which is about 1 tonne less per tonne than the batch system. This saving however, is partially offset by the increased power consumption which is at least 25 KWH more per tonne.

Taking all these above factors into consideration the difference in production cost in both the systems have been worked out in Annexure II, and the cost of production in the continuous digester works out to about Rs. 7/- per tonne higher than in the batch system.

The continuous digester has to be

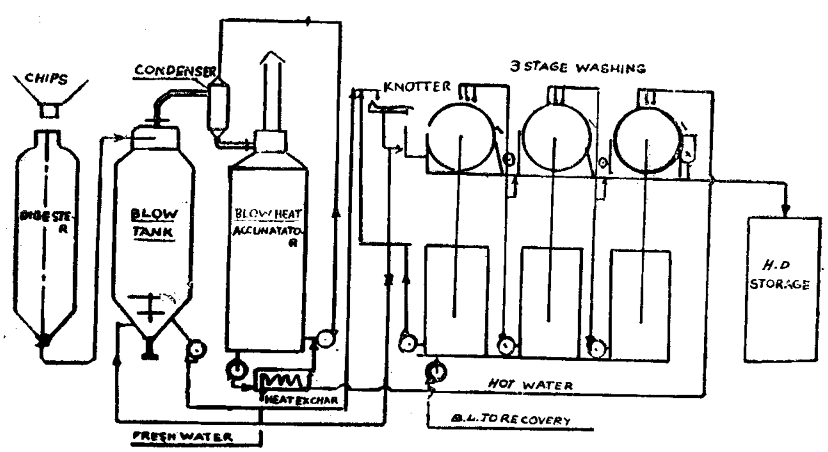


Fig. 2—Flow-Sheet Digester and Washing Plants.

shut down at least once every year for 2/3 weeks for maintenance of the moving parts and cleaning of the screens and pipe lines. It has also to be shut a few times in a year due to breakdowns which would necessitate emptying of the digester, and the total estimated down time in a year is 5/6- weeks. This can be avoided with the batch system as one digester can be shut at a time for necessary maintenance synchronised with the low production days of the Mill. Considering even the mill shut of 2-weeks for the Recovery Boiler's maintenance and annual inspection, it is expected that there will be an additional shut down of 2/3 weeks in a year with the continuous digester system.

From the above considerations and the analysis in Annexures I & II, it is clear that inspite of the technical advantages with the Continuous Digester, choice of a batch system would not place the mill at a financial disadvantageous position. On the other hand, there will be benefits of lower down time and independence from imported spares.

3. **Screening & Cleaning :**

The screening system is very flexible and there is always controversial opinions on the most suitable ones. for any particular application. Fig. 4 represents a typical system. This consists of Primary, Secondary and tertiary screens, 3-stage centricleaner battery, a vacuum filter thickener and a H. D. Storage Tower. Centrifugal Screens have been used both in the primary and secondary stages. The accepts of the primary screens should correspond to about 200 A. D. tonnes/day pulp and the accepts of the Secondary screen should correspond to about 40–50 tonnes/day A. D. Pulp. To avoid multiplicity of units, one would choose two or at the most three units in the Primary Screening Stage, and since centrifugal screen of this size is not made in this country, there is a very good case for either the import or taking up the manufacture of centrifugal screens with a capacity of 75–100 tonnes/day at 0.6–0.8% inlet consistency to match the optimum operating condition of the centricleaners. All the other equipment of the screening system are already being manufactured indigenously.

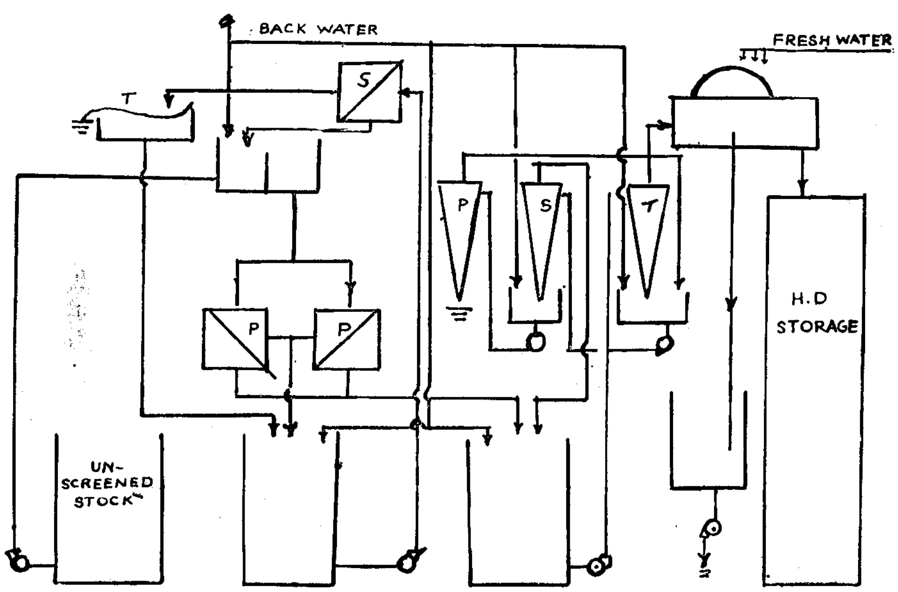


Fig. 4—Flow Sheet Screening Plants

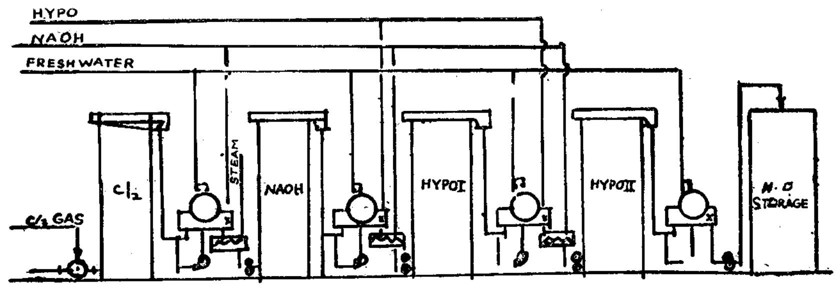
4. **Bleaching**

Fig. 5 represents two bleaching plants, typical of many modern mills outside this country. These require very little building space, and consequently can be built at a lower cost. However, the High density pumps and equipment for the High density upflow towers are not made in this country. Fig. 5 shows a bleaching plant, which can be built with indigenous equipment and is equally effective. Hence the system shown in Fig. 6 would be chosen inspite of the high intial costs, mainly to conserve foreign exchange both for the original equipment and spares.

5. **Paper Machine and auxilliaries**

Modern Paper Machines making writing printing papers are already operating in this country between 400-600 m/min and for this consideration an operating speed of 500 m/min will be quite reasonable In Fig. 7 the daily production of 50 g.s.m. paper has been plotted against trimmed width of the Paper Machine at this speed, and for 200 tonnes/day the required trimmed width is 6.3 metres.

A Paper Machine of this size may not be available from indigenous manufacture. For making a paper machine of this width, considerable investment would be needed in wider machine tools, and increased foundry facilities. This investment can only be justified if there is an assurance



FLOW SHEET, MULTISTAGE BLEACH PLANT WITH FILTERS.

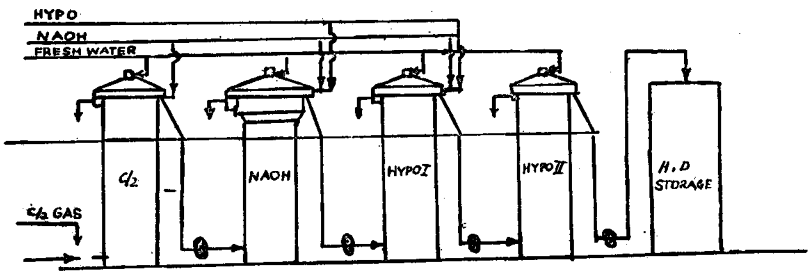


Fig. 5—Flow sheet, Multistage Bleach plant With Diffusor Washing.

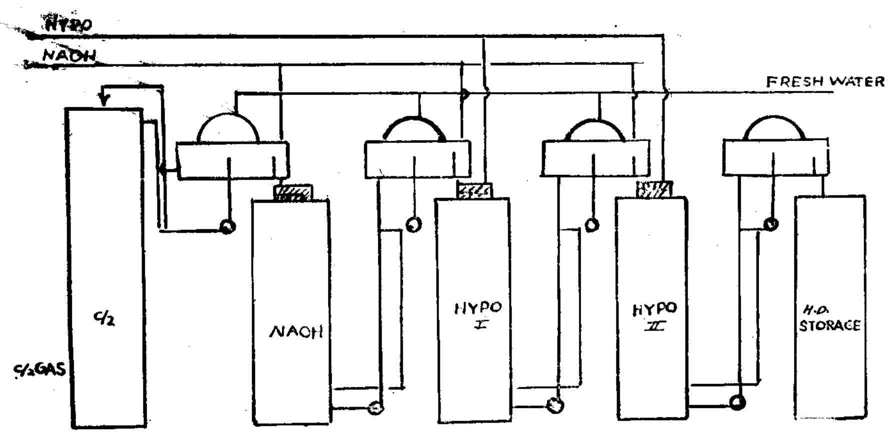


Fig. 6—Flow Sheet, Multistage Bleaching Without H.D. Pumps.

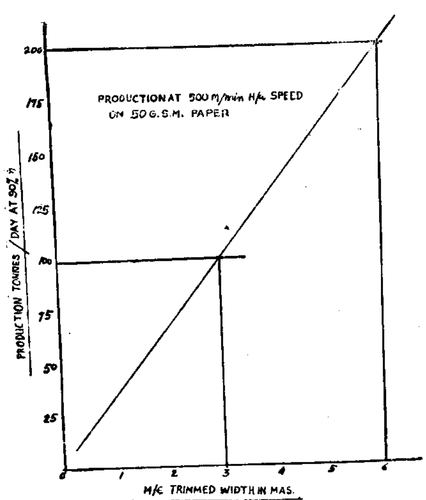


Fig. 7

of several orders for large Paper machines in the next few years.

Facilities for manufacture of paper mill equipment have been set up in this country since 1960/61, in collaboration with some of the internationally famous organisations. Looking back into the history of the past ten years, apart from a few small size machines (Upto 10 tonnes/day) and rebuilds, only one Yankee Machine with substantial imported components has been delivered from indigenous manufacture. Orders for a light weight paper machine and a multi-ply board machine are under execution with the manufacturers. All these machines are below 4 metres in trimmed width. Hence it is not at all expected that the manufacturers would invest in further facilities when their existing facilities have not been utilised.

Although from the cost point of view a single Paper Machine would be advantageous, considering the local availability two Paper Machines each about 3.2 metres trimmed width should be chosen for this Project and there will be resultant benefits like :

(a) Ready availability of Machine furnishing from local manufacture.

(b) Ready availability of spare parts from local manufacture.

(c) Utilisation of indigenous equipment in the stock preparation systems. The largest refiner being made in this country has a throughput of about 50 tonnes/day. These are quite suitable for a 100 tonnes/day Paper machine as the stock can be treated in two parallel flows, but for the 200 tonnes/day Machine the multiplicity of flows would present operational and regulation problems, as well as substantial additional expenditure in piping, valves and regulating equipment. The position is also similar in the case of other stock preparation equipment.

(d) Lower cost of the machine due to utilisation of the already available patterns and moulds, e. g.

for the drying cylinders which have already been made in this size.

(e) Quicker delivery due to utilisation of existing facilities and minimum rejections.

(f) Flexibility in operation with two Paper Machines as smaller lot orders can be taken and two different varieties can be made at a time. This has particular advantages for a mill entirely dependent on the domestic market in a developing country.

For the Refining equipment the choice has to be made between the Conical and Disc Refiners. In other countries for many grades of Papers, Disc Refiners are now being chosen in favour of the conical ones. The main advantages are saving in power consumption and better strength properties of the paper. This is however only possible by correct choice of the configuration of the fillings suitable for a particular type of stock. Disc refiners are available only in larger sizes, and would definitely be more expensive in initial costs. Considering the lack of experience in the use of Disc Refiners in the stock from local raw meterials and their non-availability from indigenous manufacture, the choice in this particular case would be on the conical refiners with suitable fillings for the Refining and Jordaning applications.

Fig. 8 is the flow-sheet of a typical stock preparation system using conical refiners. The equipment that are not yet made in this country are :

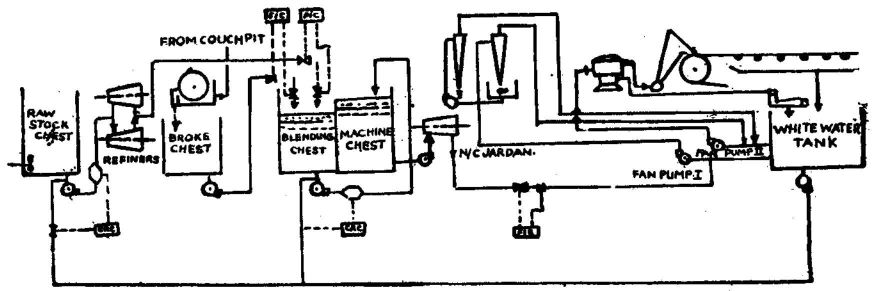


Fig. 8—Flow sheet stock praparation

(a) Suitable pressure screens-capacity 50 or 100 tonnes/day.

(b) Save-all-Flotation or Filter type.

The main parts of the Paper Machine that have not yet been taken up for manufacture are the pressurised head box, suction rolls for different applications, stonite/granite rolls, Dandy rolls and certain control equipment

6. Finishing :

The requirement in this particular case would be Rewinders and Cutters suitable for 3.2 metres trimmed width. Unfortunately, these have not yet been manufactured in the country, and there is the necessity of some reputable manufacturer to take up these sophisticated and precision equipment to avoid their continued import.

7. Chemical Recovery :

Evaporators, Recovery Boilers and Causticizing Plants of more or less the required capacity, corresponding to 200 tonnes/day pulp production have either been made in this country or are in the process of manufacture. These equipment are being made in collaboration with firms of international repute and technically suitable plants can be procured from indigenous sources.

8. Control and Regulating equipment:

A number of firms both in the private and public sector have taken up the manufacture of Process Control Instruments. However, two most required equipment in the Pulp and Paper making process e. g. Consistency Regulators and Magnetic Flowmeters are not made indigenously and have to be imported.

The above discussion has been elaborated to point out particularly the equipment which need to be imported. inspite of the best efforts of the project implementors to utilise indigenous equipment, even at the cost of the economy and efficiency of the Project and to indicate the possibility of avoiding import of equipment by suitable choice of design parameters and system. It is hoped that it will make some contribution in this field.

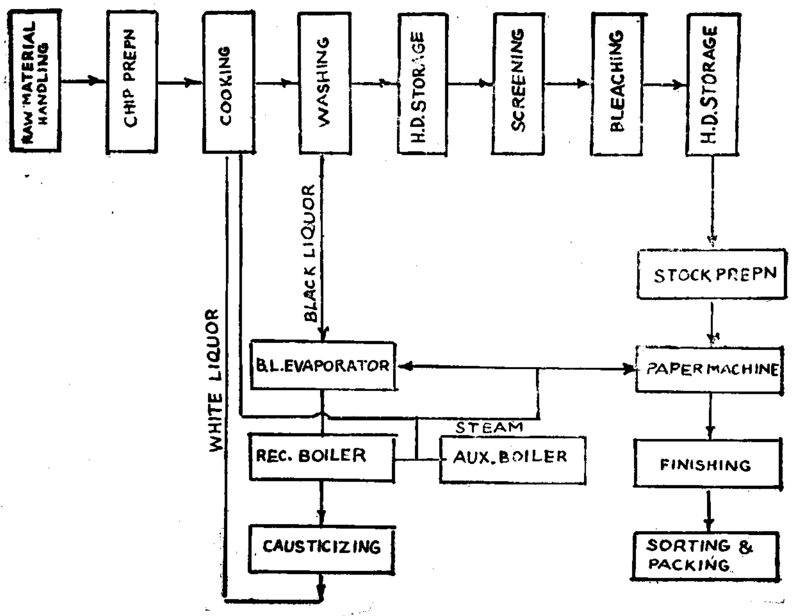


Fig. 9—Block Diagram, Integrated Pulp & Paper Mill

Fig. 9 is a block diagram of the Mill, where Sections (Chip prepn. Stock prepn, Paper Machines, Finishing) for which equipment is not available indigenously.

Reference:

1. Crocker, J.W., : 'Digesting-Economic comparisons of Batch and continuous Systems.' *Paper Trade Journal* Oct. 29, 1962.
2. Blundell, K.D.,: Underlying Principles of designing a modern refining system.
3. Schonemann, K. F., : Comments on the Choice of Paper Machine width. *Tappi.* October 1958.

ANNEXURE I

ALT I (Estimated installed cost of Continuous digester system with Diffusor Washing).

C. I. F. Cost of 200 Tonnes/day Continuous digester with Diffusor Washing estimated cost U.S.$.19,40,000/- F.O.B):	Rs. 1,55,32,000
Customs Duty & local transport cost at 35% of the C. I. F. costs.	Rs. 54,36,000
Indigenous equipment like tanks, Motors & Electricals etc.	Rs. 30,00,000
Total equipment cost:	Rs. 2,39,68.000
Buildings costs inclusive of H D. storage tower.	Rs. 10,00,000
Erection costs inclusive of Material and Engineering, at 20% of equipment costs (less Customs Duty).	Rs. 38,00,000
Total estimated installed costs:	Rs 2,87,68,000

ALT II (Estimated installed cost of batch digester system with 3-stage washing).

4 Batch Digesters each 153 m^3 Vol. with heating and circulation system, pipes, valves, fittings and Instruments.	Rs. 80,00,000
Blow tank 350 m^3 vol. with agitator, pump, fittings and Blow-heat recovery system.	Rs. 15,00,000
White and black liquor tanks, pump and piping.	Rs. 5,00,000
3-stage Brown Stock Washing with 3 Nos. 60 m^2 area Filters, repulpers, tanks, pumps. piping, valves and Instruments.	Rs 35,00,000
Total equipment cost:	Rs. 1,35 00.000
Local Transport, insurance and taxes at 5%	Rs. 7,00,000
Building Costs inclusive of Digester House, Washer building and H. D. Tower	Rs 20,00,000
Erection costs inclusive of Material & Engineering at 20% of equipment cost.	Rs. 27,00,000
Total estimated installed cost.	Rs. 1,89,00,000

ANNEXURE II

Total installed cost of Pulping Plant with Continuous Digester System.	Rs.	2,87,68,000
Total installed costs of Pulping Plant with Batch Digester System.	Rs.	1,89,00,000
Additional Cost with the Continuous System	Rs.	98,68,000
Less : Reduced investment in boiler plant 10 tonnes at Rs. 1,00,000/tonne per hr. capacity.	Rs.	10,00,000
Net : Additional investment	Rs.	88,68,000

Operational Costs

Interest, depreciation and insurance on additional investment at 16% of average diminishing value/year = Rs. 7,00,000 with 66,000 tonnes/year production, Addl. cost/tonne	Rs. 10.30
Savings in steam at Rs. 10/-per tonne.	—Rs. 10.00
	00.30
Increased power costs, 25 Kwh/tonnes at 0.12P/Kwh.	3.00
Additional spare parts costs/tonne (at 2.5% of the addl. equipment cost/year divided on 6,000 tonnes)	3.70
Net increased production cost/tonne with the Continuous Digester System.	Rs. 7.00