

# Future Needs in Research and Development in Indian Paper Industry

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## Introduction

The present stage of civilization is the sum total of all the discoveries based on R & D and utilisation thereof spread over a long period. The economy of any nation is closely linked with its Research & Development activities and more so on its proper utilisation.

India is well placed in terms of technical manpower resources, occupying third place in the world behind USA and USSR. As on April, 1974 total strength of Research & Development personnel in the country was estimated to be 15 lakhs. The country has accepted the philosophy of Research and Development, which is reflected in the formation of Science & Technology (NCST) as an integrated part of the fifth five year plan.

Expenditure for R & D covers a wide range of activities from the search of new knowledge and its utilisation for the development of new processes and products. In

*The paper lists the various areas in the paper industry, where R & D effort will help to reduce costs and improve the profitability of the industry. Some of these areas are : 1) Forest operation 2) High yield pulping 3) Chemical pulping 4) Bleaching 5) Stock Preparation 6) Paper making 7) Process control and automation 8) Conservation of materials and energy 9) Pollution control 10) Process improvement 11) New products and 12 Machinery development.*

1975-76, estimated expenses on R & D are of the order of Rs. 116 crores. The latest budget for 1976-77 has made a provision for Rs. 156 crores, a big jump indeed 34% over the previous year. R & D in private industry accounts for about ten percent of the over all R & D expenditure in the country.

The present thinking of the government is to earmark one percent of GNP for Research & Development expenses. Also, it has been stated that rules for R & D cess will be formulated soon. To promote genuine R & D activity, the funds collected by R & D cess should be utilised in encouraging result oriented schemes in the industry.

## Paper Industry

Most of the research and development activity in the paper industry all over the world is oriented towards applied research. Fundamental or basic research is taken up at the universities while

research institute supported jointly by the industry and the government divide their work between applied research and basic research, the former, usually accounting for over 60% of the total research effort.

Some of the areas in the Indian Paper Industry where R & D effort is to be focussed are given below:

(1) Forest Operations (2) High yield pulps (3) Chemical pulps (4) Bleaching (5) Stock Preparation (6) Papermaking (7) Process control and automation (8) Conservation (9) Pollution control (10) Process improvement (11) New products and (12) Machinery development. Each of these areas is discussed briefly in the paper.

It will be useful to summarise the developments in the pulp and paper industry throughout the world in the last few decades, so as to determine their profitable

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application to the Indian scene. A brief summary of these developments is given in Table 1.

#### Forest Operations

The yield of bamboo per hectare on the average is just around 1.0 ton. Through better silvicultural practices, it may be possible to increase the yield threefold.

Also, a good look needs to be taken on whole tree chipping of woods, since the Indian paper industry is turning increasingly towards the use of hardwoods.

Another important factor will be to raise fast growing plantations. Australian experience in raising tropical pines and Eucalyptus is encouraging and, maybe, the Indian paper industry could review the available information in this area and determine the effect of Indian environment on the various fastgrowing wood species, from an overall economic angle.

Kenaf seems to be the fiber of future. It is worthwhile studying systematically the effect of soil, climate, fertiliser application, etc on the yield of this annual crop. Since this is a bulky material, it will help to cut down transport cost, if it could be brought to the paper mill in packed form. Kenaf fiber will be especially useful to small and medium paper mills manufacturing packing papers. If bark, constituting around 25% of the total kenaf stick, could be economically removed and rendered

**TABLE 1—Some Important Developments in the World Pulp and Paper Industry for the Last Fifty Years (1926-1976)**

#### Wood Preparation

- 1) Hydraulic and mechanical barkers
- 2) Multi knife and special chippers.
- 3) Whole tree chipping
- 4) Outside chip storage

#### Pulping

- 1) Tomlinson Recovery furnace
- 2) Byproduct recovery
- 3) Pre hydrolysis kraft process
- 4) Kraft odour control
- 5) Continuous digesters
- 6) Sawdust pulping
- 7) Semi chemical processes, Mg Na, NH<sub>3</sub> base sulphite processes, including recovery.
- 8) Chemical recovery for NSSC process.
- 9) Improved pulpwood grinders including synthetic stones
- 10) Refiner mechanical pulping
- 11) Thermo mechanical pulping.

#### Bleaching

- 1) Multi stage bleaching including ClO<sub>2</sub> (and generation), peroxides, etc.
- 2) Oxygen bleaching
- 3) Displacement bleaching
- 4) Gas phase bleaching
- 5) Sequential bleaching
- 6) Brightening of high yield pulps with peroxide, hydrosulphites, etc.

#### Fiberizing, Washing, Screening and Cleaning.

- 1) Vacuum cylinders and diffusion washes.
- 2) Disk fiberisers and refiners
- 3) Centrifugal screens and cleaners, knotters
- 4) Dewatering screens
- 5) High density pulp storage

#### Market Pulp

- 1) Flakt drying
- 2) Flash drying

#### Paper Machine :

- 1) Twin wire formers
- 2) Plastic wires/synthetic felts
- 3) Fabric/ Venta nip and other wet pressing developments
- 4) Infra red drying

#### General

- 1) Computers and electronic instruments for process control
- 2) Process water recycling.

available its chemical pulp in admixture with the high yield pulp of the stick could form a furnish for newsprint manufac-

ture on a small scale. Also, bark fiber chemical pulp will be good for making tissue and paper grades.

Even from the national angle, it is essential to have higher yields from forest land to obtain release of the forest land for plantations of cellulosic raw materials. At present, as against the agricultural sector which contributes.

In addition to identifying and raising fast growing species, possibly the concept of plant tissue culture could be utilised in improving the per acre yield in the forests. With this new method, plantlets can be raised without conventional sexual reproductions. Somatic hybridisation of the same species or between different species opens up possibilities for the development of new types of plants. Also, it is possible to obtain virus free plants by the tissue culture techniques. This is proved in raising virus free sugarcane plants, which was normally difficult by other methods

#### **High yield pulps :**

Due to dwindling fiber resources and to cut raw material costs, it is imperative to go in for high yield pulps.

Significant research is needed in studying the characteristics of high yield pulps versus end use requirements. For example, there has been a gradual lowering down of the basis weight of newsprint and magazine papers to save on postal rates. In this context, is it possible to use a higher proportion of high yield pulp substituting chemical pulp partially or wholly and yet run the printing

presses satisfactorily without sacrificing opacity, printability, printfidelity, etc ?

In the last two years, thermo mechanical pulping has proved its usefulness to substitute chemical pulp partially or wholly in newsprint. Modifications of thermo mechanical pulp, especially prior chemical treatment, seems, to open up possibilities for using this pulp in magazine papers. This pulping process deserves study as a furnish for making newsprint or cheap grade printing papers in India in medium sized paper mills (50 TPD).

Much work still remains to be done in optimising the thermo mechanical pulping (TMP) process, especially in selecting the right type of power input between the various stages of refining.

It is gratifying that proven technology is now available for NSSC chemical recovery. Copland fluidized bed recovery process is used in a mill in South Africa & sonoco NSSC recovery process in a mill in Australia. It is worth studying the economics of these processes in Indian scene, especially in mills where the product mix is essentially oriented towards packaging papers.

Green liquor pulping is also a promising process, as it dispenses totally with causticization. Abroad successful machine trials of both linerboard corrugating medium have been taken from green liquor pulps of soft woods

and hardwoods. In a few cases, it was necessary to use a wetting agent on the paper machine to improve drainage. This pulping technique could be tried on Indian raw materials for both unbleached and bleached pulps. Maybe, selective bleaching will help in producing medium and high brightness pulps.

#### **Chemical Pulping**

Kraft pulping is used in all Indian mills, except one mill which employs bisulphite cooking. R & D work in kraft pulping will be worthwhile in respect to the advantages of hot stock refining, the level of polysulphide sulfur that could be used to affect yield increases without the need for additional recovery for polysulphide sulfur, etc. In hardwood pulping especially, there is a great need for more efficient pulp washing.

Alkali oxygen pulping could be studied in detail for pulp yields, pulp properties, spent liquor properties and for over all economics. This work will be useful for new mill installations.

Laboratory research will often be useful in predicting the efficiency of black liquor evaporation. The scale forming tendency, viscosity, heat transfer coefficients and swelling characteristics of black liquor from a particular raw material will help in the efficient design and operation of evaporators and recovery boilers. When the Indian paper industry's raw material source is mixed hard-

woods and bamboo, a study of the individual and mixed black liquor characteristics is a must, especially when using dense hardwoods. For example, it will be very difficult to eliminate direct contact evaporator while handling a high percentage of dense hardwoods, because of the very high viscosity of black liquor from the latter. How to decrease the viscosity of these black liquors is another important area for research.

Black liquor oxidation will soon be a regular feature of most pulp mills to stabilise sodium sulphide in black liquor sodium thiosulphate and prevent the escape of hydrogen sulphide, mercaptans, etc which add to the air pollution problem. This is an area needing immediate attention both from the conservation and pollution viewpoint.

For medium sized mills pulping principally agricultural residues, the wet air oxidation process could be useful from the chemical and heat recovery viewpoint. The process does not need use of evaporators and circumvent the silica problem.

Pilot plant experiments on black liquors of agricultural residues will generate beneficial information for the small/medium scale paper mills.

#### **Bleaching**

In India, CEHH bleaching sequence is commonly used for kraft pulps for 78-80% brightness pulps.

The Indian market does not call for very high brightness pulps using  $\text{ClO}_2$  or  $\text{H}_2\text{O}_2$  in more than four stages. Chlorination stage, however, accounts for about 40% of the total effluent in the pulp mill. This effluent is not being recycled because of the corrosion and lignin reprecipitation problems experienced in recycling this effluent. In view of the imperative need to cut down effluent volume to minimise effluent treatment costs, research is necessary to find suitable materials of construction to handle this effluent and determine the process parameters for its use in unbleached stock dilution, as is done abroad.

Oxygen bleaching, found useful for reducing effluent colour, BOD and COD, might be useful as well from the Indian context, since it can easily replace or substitute 'C' stage in CEHH.

Another area worth investigation is bleaching of thermo-mechanical pulps from the viewpoint of brightness stability, as this could offer an outlet for cheap grade printing papers. Ozone,  $\text{H}_2\text{O}_2$ , hydrosulphites could be used as bleaching chemicals.

Displacement bleaching enabling the incorporation of many bleaching stages in one tower will substantially cut down investment costs. This bleaching method could be considered for new bleach plant installations.

It will be good to develop information on Indian pulps using this method.

#### **Stock Preparation :**

Refining of pulps is an important area in papermaking, especially when using dense hardwood pulps. Bar width, tackle, specific energy load are some of the important parameters to be studied to obtain the optimum pulp properties. These parameters could be studied for individual and mixed pulp furnishes for different end use requirements. Also, since refiners contribute significantly towards noise pollution in a paper mill, appropriate systems could be developed to minimise this problem. Besides, correct design and operation of refiners goes a long way in the mill's energy conservation programme.

#### **Papermaking**

After laboratory research, it is essential to have pilot plant runs to have adequate information on the potential of pulps from various raw materials (by different processes) for papermaking. It is necessary to develop as much initial information as possible in laboratory scale before taking up pilot plant trials as these are ten times as expensive or more. Drainage behaviour of various furnishes could be predicted by their WRV, specific surface and specific volume results in addition to freeness. The wet web strength often gives an idea of the runnability of the paper from a particular furnish on the machine.

Twin wire formers are increasingly replacing the conventional fourdrinier, giving a well formed sheet with minimum two sidedness. A study of the flexibility of these formers for Indian raw materials for different paper grades will be a useful exercise. Similarly, developments in paper machine clothing elsewhere for application in the Indian paper industry calls for some preliminary research and development work in the suppliers' research laboratory. This will help in slashing trial costs and soon have the way for more efficient utilisation of the new products in felts and wires.

In view of the tendency today to close the white water systems, to conserve water and reduce pollution, it often helps to study the causes of pitch and slime deposits and study their characteristics to determine the optimum dosages of dispersants and biocides without impairing sizing or other important properties in final paper.

Wet pressing and drying areas provide ample scope for research on energy conservation, which will go a long way in cutting down production costs.

#### **Process Control and Automation :**

The paper industry in developed countries has been successfully using computers for process control to give uniform quality products. The computer print out will generate data during operation and when a break

occurs, it is possible to pinpoint the reason for it from a good look at the data.

In labour intensive Indian situation, it will neither be possible nor advisable to go to the same degree of automation, as is practised abroad. However, it helps to have automatic control on important paper properties like basis weight, caliper, moisture, etc so as to ensure minimum machine down time and minimum rejection of finished paper.

#### **Conservation :**

Conservation of raw material, chemicals, water and energy is important from the production cost and ecology viewpoints. The mill will do well to have an energy cell and institute a Btu accounting system to plug heat and power losses. Also, a study of different alternatives of by-product power generation from a non-condensing turbine, condensing turbine and purchased power will often help in minimising the energy bill. Process improvements in pulping, recovery, bleaching, refining and papermaking account for substantial conservation of material and energy. For instance, bamboo dust could be used in mill's multi fuel boilers or made into a fertiliser.

Recycling of waste paper is a very important area in fiber conservation. Research in this area should be directed towards removing asphalt, bitumen, plastics, etc from paper with minimum

loss in papermaking potentials of the recycled paper.

#### **Pollution Control :**

Water pollution act was already enacted in 1974. Air pollution act is in the offing.

The best and cheapest way is to have minimum effluent load to the sewers, through efficient in-plant control. Then the choice often comes to aerated lagoon or activated sludge system for biological treatments, since most mills do not have enough land for using effluent for irrigation. Where the effluent is used for irrigation, the effect of using the effluent on land should be known earlier, so that there will not be a significant build up in salinity of the land.

Most of the design data for biological treatment (to reduce BOD) are based on information available with municipal sewage. Besides, the design data for treatment systems for particular industries abroad will not be applicable to the Indian conditions because of the climatic factors. The systems rate constant varies widely. This is perhaps the reason why many effluent treatment plants in process industries are not functioning properly. Laboratory and pilot plant data should be generated for each case, depending on the raw materials used and the final products made. The emphasis should be to evolve low cost effluent treatment plants.

### New Products :

Paper industry will have to compete with plastics for packaging, although cellulosic fibers are superior and cheaper for packaging, when stiffness per unit volume is considered as basis of calculation. Also, to penetrate into new markets cellulose-plastic combinations, cellulose-textile combinations, cellulose-glass fiber combinations will be useful. For instance, cellulose-plastic combinations will be useful for better reproduction papers, packaging papers requiring barrier properties.

### Machinery Developments

To cut down investment costs, new technology and new machinery will be very much required.

Displacement bleaching is a step in that direction.

A case can be made for new type of recovery processes. One of the disadvantages of the present recovery process is that when the black liquor is burnt it still contains 40% water. A considerable part of the energy available is consumed for the evaporation of this water. To maintain the process a very high temperature is also required causing the chemicals to melt.

Also, the chipper knife life will be less than 3 hours when chipping dense hardwoods. Close cooperation and collaboration between the paper mill, machinery manufacturer and metallurgist is necessary to develop a suitable

chipper knife for dense hardwoods.

### Additional Comments

It pays to have a good in-house R & D department in a mill. The effectiveness of the R & D department depends on how far the top management has succeeded in setting up clear objectives, arranging the necessary resources and making arrangements

to utilise them effectively and efficiently. To be effective, the in-house R & D facility must be well staffed and have representation from marketing, sales, production, engineering and research departments and have the clear support of the topmost management. The development of a particular grade of paper requires the inter-action of the various departments, as shown in Table 2. Similarly, the development

TABLE 2—  
Printing Paper Product Development—Sequence of Events

Function	Responsible Department
Recognition opportunity	Sales, User
Preliminary economic evaluation	Sales
Technical evaluation	R & D, Operations
Economic evaluation	R & D, Finance
Project plan	R & D
Decision	Management or Policy
Preliminary specifications	
Product	R & D, Sales
Process	R & D, Operation, Supplier
Laboratory & pilot plant trials	
Product	R & D, Supplier
Equipment	R & D Engineering, Operations, Supplier
Mill trials	
Trial organization	R & D, Operations
Trial notices	R & D, Scheduling
Manufacture	Operations
Technical aid	R & D, Supplier
Testing	Quality Control, R & D
Documentation	R & D
Print tests	
Purchased commercial presses	R & D
Customer equipment	Sales, R & D
Repeat mill trial	R & D, Operations
Economic check	Accounting
Final product and process specifications	R & D, Sales Operations, Quality Control
Transfer to regular production	Operations, Sales, Quality Control.

of a particular process has to pass through (a) laboratory work (b) semiplant stage in glass vessels (c) pilot plant design and operation and (d) design of a commercial plant and operation. The R & D director, who coordinates the efforts of the various groups, would be a thinker, discoverer, designer, hunter and psychologist. In such a situation, the contribution of R & D cell to the profitability and growth of the organisation is indeed immense.