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**RESEARCH AND DEVELOPMENT TRENDS
IN PULP AND PAPER INDUSTRY**

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Abstract

There is a dire need for a well organised research and development programme for pulp and paper industry as the industry is capital heavy and energy intensive resulting in low profit margin. The industry for its survival has to adopt many innovative changes to bring about higher productivity and cost effectiveness. Research and development has to be geared up to meet these challenges by encompassing multi-disciplinary approach. Basic as well as applied researches have to be carried out to fulfill the aim of finding the suitable means of fibrizing the raw materials available on the sustained yield basis and felting the fibrized material into a sheet of paper of required specification at an economic level with maximum productivity and minimum pollution. The various research problems are highlighted. It is also pointed out that the studies not only require a strong team of dedicated qualified researchers, sound financial support in the shape of good library and laboratories but also collaboration between the university, industry, and institute of research. These will go a long way in solving the problem of the industry.

The trends of research and development in pulp & paper industry are pointing to the fact that useful results as applicable to the industry could only be achieved by a strong team of dedicated qualified researchers encompassing multidisciplinary approach. The main aim of research in this field is to find out suitable means of fiberizing the fibrous raw material available on sustained yield basis and felting the fiberized material into a sheet of paper of required specifications at an economic level with maximum productivity and minimum pollution. The economics of these two operations will depend on the costs of fibrous raw materials, power, water, chemicals, equipments and their maintenance, labour, overheads and pollution abatement.

To achieve above mentioned goals basic and applied researches have to be carried out in the following fields :-

1. Silviculture, management and storage of the fibrous materials so that they are available at economic price on a sustained yield basis.
2. Chemistry, Physics and anatomy of the fibres, including cell wall structure. Work on these aspects will lead to development of suitable process and effects of the process variables on the yield, quality of the fibres and its conversion into a suitable quality of the sheet.
3. Chemical Engineering for deciding the various process parameters, besides chemical recovery and economy in steam and chemicals consumption and quality control, corrosion and testing equipments for fatigue.
4. Mechanical, electrical and electronic engineering for the development of suitable equipments and their maintenance, power saving etc.
5. Civil Engineering and Engineering and Environmental Engineering for working out processes for controlling air, water and solid waste discharges and bringing them to the required specifications before discharge by developing suitable methodology.

So far in the country the main thrust of research has been on the utilization of the available raw materials for the production of various grades of pulps & papers by finding the effect of process variables like type and concentration of chemicals, temperature and time on the rate of deliquification during pulping and bleaching. Very little work has been done on the morphology of the fibres and its relationship to the paper making quality including pulping, cell wall structure and chemistry of its various constituents like cellulose, hemicellulose, lignin and extraneous matter, utilization of effluent for irrigation of the agriculture as well as forest produce.

Large scale plantations and reforestation programmes are afoot to meet the demands of various forest-based industries in the industrial catchment areas listed in Annexure (1). For pulp and paper the main qualities required in raw materials are:

- (i) medium specific gravity around 0.5
- (ii) straight grain
- (iii) minimum branches and knots
- (iv) light colour
- (v) easily debarkable.

The growth and management practices have to be worked out to meet the required standards on a sustained high yield/hectare/annum at an economic level of working. Effect of mono culture on the soil characteristics and other ecological and environmental conditions needs a through study in various catchment areas. Our forests are generally mixed hardwoods and growth characteristics of suitable multi culture forests have also to be worked out in various catchment areas. Genetical stains have to be developed for obtaining the above characteristics in high yields at economic level.

The main chemical constituents of the cell wall are cellulose, lignin, hemicellulose and extraneous matter. Studies had been initiated in the chemistry of bamboo lignin and Eucalyptus lignin and its reactions like oxidation, nitration, halogenation, hydrolysis etc. Kinetics and thermodynamics study of these reactions needs further investigations for deciding the pulping and bleaching techniques. The work has to be further extended to find-out the physico-chemical characteristics of these lignins like the molecular weight, glass transition temperatures, solubilities, etc. and changes in them during various reactions at various temperatures. Studies have been carried out on the chemistry of hemicellulose of various raw materials and their impact on paper making quality of the fibres, especially on the strength properties have been studied. Methods of economically extracting these hemicelluloses and their further modifications have to be studied so that these can be used as water additives for improving the runability and strength properties of papers. Chemistry of various gums growing in the country has to be studied so that they can be used as water additives as such or with modification.

The profit margin in the paper industry is very low as it is capital heavy and energy intensive so far survival industry has to adopt many innovative changes to bring higher productivity and cost effectiveness. Specific chemicals are used (1) for yield improvement in digesters, (2) chemicals for decreasing degradation, viscosity control and brightness improvement in bleaching, (3) addition of strength improvers, retention aids, specific

property improvers in stock preparation, use of deformers, alimicides, surface sizing chemicals, binders, plasticizers and lubricants in paper making, (4) chemicals for flocculation, clarification, disilication, viscosity reduction, clogging elimination in black lignin handling and treatment.

These chemicals are propriety chemicals and are very costly and recommended in low dosages. No authentic information is available in many cases on optimum dosages, preparation, methodologies, rent of addition in handling and storage besides adverse side effects and their impact on environment. It is essential to generate the data if not available and publish them for the benefit of the industry. It is also necessary to study the rate of penetration of various liquids like water, caustic soda etc. in the cell walls of various temperatures for evolving better pulping techniques. Changes in the morphological and swelling characteristics of fibres during beating have to be studied and relationship of these changes with fibre bonding, strength development have to be worked out. Begining has been made in these fields in our country. Swelling and hygroscopicity of the fibres and changes in the elastic limits of these have to be worked out. Mechanics of sheet formation has to be studied in detail based on indiginous fibres encompassing (i) flocculation and deflocculation of the fibres in dilute suspensions, (ii) Hydrodynamic properties and drainage characteristics of the fibres in dilute suspension, (iii) Felting & compacting of the fibre net work nd its geometry in different stages of sheet formation and the effect of the various variables like suction, pressing, drying temperature on strength development at various speeds, (iv) effect of beater additives, filers, sizing materials n the felting properties of the fibres nd the sheet properties, (v) loss of the intrinsic strength of the fibre at various stages of sheet formation. These studies will lead to the proper design of beaters and paper machine suiting our fibres and also decide the various parameters like control in, drainage, suction in couch & presses, pressure on the press rolls and the drying temperature and rate of drying. All these studies in Chemistry, Physics and Anatomy of the fibres will go a long way in optimising process technology, process variables and in developing suitable desings of equipments of our raw materials.

The balances of water, chemicals, heat and power in different sections of pulp an paper mills have to be worked out so that the mill runs economically. Design changes and recycling processes have to be worked out so that there is maximum productivity with minimum of discharges. Suitable methods have to be evolved for corrossion controls as the nature of the corrosion will be dependent on the chemistry of the fibres & chemicals used in the process nd the material of construction of the equipment. Processes for non-destructive testing of various equipment

have to be evolved for determining the life span of these equipments after regular intervals to avoid major accidents. For developing economical chemical and heat balance it is necessary to make studies on the nature of black liquor obtained after pulping.

The nature of the discharges through the chimney have to be studied to recommend suitable equipments to meet the required standards for discharge into the atmosphere. The liquid discharge is composed of soluble and suspended lignin and its comounds like alkali lignin, chlorolignin etc. and wastes water from the paper machine containing sizing and loading materials and other chemicals like colour, defoaming agents, slimisides etc. and fibres. For treatment of these effluents suitable chemical, anacrobic and aerobic treatments have to be evolved, microbidlogy of these discharges have to be studies so that suitable microbes or fungicides can be developed to improve the quality of discharge into the river or Economical methods of treatment of the solid waste from different sections of the mill have to be developed so that it can either be roused in the process or another suitable by-product can be made.

From the foregoing it is amply clear that we have to go a long way in solving not only the day to day problems but also future developments. These studies will not only require strong team of dedicated qualified resarchors encompassing multidisciplinary approach but wil require a sound financial support in the shape of good laboratories and libraries and collaboration of various research institutes, Universities and the Industry.

List of Industrial Catchments

1. Jhalum
2. Chinab
3. Jamuna (H.P.)
4. Jamuna (U.P.)
5. Kulu Valley
6. Y. P. eucalyptus
7. Bastor (M.P.)
8. Bilaspur (M.P.)
9. Chandrapur and Bhandara (Maharashtra)
10. Nepa Mills (M.P. and Maharashtra)
11. East Godavari and Khammam District (A.P.)
12. Krishna (A. P.)
13. Mahboobnagar (A. P.)
14. North Karnataka (West Coast Paper Mills)
15. Central Karnataka (Mysore Paper Mills)
16. South Karnataka (Mandya Paper Mills)
17. South West Tamil Nadu (Sheshashayee Paper Mills and South India Viscose)
18. North Kerala (Gwalior Rayon)
19. Central and South Kerala
20. News Print Project and Punalur Paper Mills (Kerala)
21. South Bihar
22. Koraput District (Orissa)
23. North Bengal
24. Nowgong (Assam)
25. Cachar (Assam)
26. Norch Cachar (Assam)
27. Tripura
28. Manipur
29. Mizoram
30. Nagaland
31. Arunachal Pradesh.