

The Use of Short-Fibred Pulp for High Speed Paper Machines

R.S. Sawhney*

"There are fibres, big and short, short and big and the shorts you cannot dispense with."

Increasing Paper/Newsprint consumption and an ever growing per capita in all the countries of the world due to an ever increasing, exploding population, increasing literacy, rapidly progressing civilization and an ever swelling tempo of industrialization is urging us to more and more focus our attention to raw materials supply and to broadening of the raw material front and increasing the yield of the materials. In a report on "Wood Handling" in Canada, Mr. C.W. Heckroth remarks "Not only are wood handling costs getting ridiculous but by 1975, the world is going to be scratching its back side for lack of fibre."

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Conifers have been the traditional raw material sources, having dominated the industry upto 10-20 years ago but cannot meet the demands for all the years and ages to come—the World Wood Pulp demand rising by about 3 million tons a year and be doubling by 1975. The problem has been especially acute and knotty for those countries having no or practically little softwood pulp stands and so come on the scene the Hardwoods, Agricultural Residues (i.e. Bagasse, Cereal, Rice, Straw, Reeds, etc.) Straw, esparto—the only silver lining in the dark clouds. Today the result is that the entire pulp and paper industry is in a process of revolution and radical changes and the traditional relationships between the raw materials, pulping processes, application of pulp produced and the old classification into pulps (groundwood, sulfite, sulfate) which have been holding good for a century are cracking down

and giving place to semi-chemical, chemi-mechanical and other processes which have been possible with the progress in chemical engineering and technology and in the absence of these the present boom in modern pulp making and boost in Paper/Newsprint making which has reached the new horizon would have been unthinkable and rather impossible. These paper pulps occupy an intermediate position combining the High yield of Groundwood and the good paper making qualities of chemical pulp. Today the objection to the use of short fibres in the industry holds no water due to the crystal clear quality improving, upgrading influences in paper making.

In Europe and U.S.A., besides softwoods, more and more hardwood is being used for pulping. The same trend is there in Scandinavia, Australia, Italy, France, Africa, Japan, India, Pakistan. Besides considerable utilization of hardwoods and high yield pulp is being pursued in the Soviet Union where the coniferous stands had been depleted during the First Five Year Plan by dumping of the harvested wood by the big population of forced labour camps into the Western Europe Market. At the same time in South America, Asia, and more recently Africa and some parts of Europe more attention is being paid to the use of Annual Plants—the raw materials so morphologically and chemically different from the traditional spruce wood and demanding New Pulping Techniques.

The woody tissues of softwoods (Conifers) in general contain about 90% Tracheids, 10% ray cells and some parenchyma, whereas hardwoods (Deciduous) contain a lower fibre fraction besides

*Chemical Technologists, The National Newsprint & Paper Mills Ltd., Napanagar (M.P.)

vessels—70% fibres, 15% vessels, 15% ray and parenchyma cells. Softwood pulps (spruce, pine, balsam fir, hemlock) have an average fibre length 2.0 mm. (2.5-50 mm) whereas the hardwood pulps (Beech, Birch, Aspen, Poplar, Mample, Eucalyptus, etc.) have an average fibre length of 1.0 mm (0.6-2.0 mm) or less. The additional fibre length of softwoods results in papers of 30-100% greater strength than papers from hardwood excepting pulps from semi-chemical processes. The diameter of softwoods varies from 0.035 to 0.045 mm as against 0.015-0.025 mm of the hardwoods. This short fibre length and bulky nature of the hardwood is to 100% responsible for their tearing resistance and this seriously limits their use in some papers. These and other differences are cited below:—

No.	Property	Softwoods	Hardwoods.
1.	Cellulose (Cross & Bevan) %	55-61	58-64
2.	Lignon %	25-32	17-26
3.	Pentosan content %	8-13	18-25
4.	Density (Green-wood), lb/ft ³	21-26	22-35
5.	Major type of fibre %	Trachoids 90 Ray cells } Parenchyma } 10	Wood fibre 70 Ray cell } Parenchyma } 15
6.	Length of fibres, mm	2.5-50 varying with areas	0.6-2.0 (Wood fibres vessels shorter and very wide

Hardwoods use in all grades of Paper, Newsprint has gained momentum since 1940 and till today very big, important and spectacular strides have been made and now the pace seems to be getting a new, rapid acceleration. Reasons or the factors

affecting the increasing use of hardwoods throughout the pulping world can be listed as follows:—

- A growing consciousness of the rapid depletion of softwoods with the increasing demand of Paper.
- A disturbing imbalance between the softwoods and hardwoods which cannot be overcome, immediately by softwood replantation because of growth slowness and continued felling.
- The invitation and continued development of the high yield semi-chemical pulping processes.
- Extra, additional impetus for hardwoods usage because of the rising our using of softwood prices.
- Desire to be less dependent on imports.

Hardwoods have been real headaches all along for the Chemists, Technologists, Engineers giving poor quality, short fibred pulps. The use of short fibred chemical pulp of various kinds is well established. Various pulping processes which have contributed to an effective, economical use of hardwoods are:—

- * Chemi-Mechanical
- * Chemi-Groundwood
- * ALB Semi-Cell
- * Cold Soda
- * Grinding in the presence of chemicals.
- * Neutral sulfite semi-chemical (Stora-Brite (Swedish); Blandin and Neucell (U.S., etc.)
- * Refiner Groundwood (groundwood from chips).

All these semi-chemical and chemi-mechanical Pulping processes promise a high yield 80-93%. On the Bone Dry weight of wood as compared to 90-95% in the groundwood, give satisfactory strength pulps thereby replacing quite of good percentage of costly sulfate pulps and a part of softwood groundwood. These hardwood semi-chemical

processes have been truly pronounced as "*Gift of the Gods.*"

Hardwoods on the whole effect great economics and have technical advantages—are easily and abundantly available are cheaper than softwoods—on conversion to high yield, extra high yield pulps the cost advantage becomes still more pronounced and greater as compared to pulp made by any of the chemical processes—are essential to the sustained growth of softwoods—give increased pulp yield per unit of wood because of Higher Density again making an Economic contribution. Besides hardwoods are more flexible than softwood, short fibred, require little or no beating (easier treatment) which is time, power saving, give improved formation, surface, smoothness, bulk, opacity, absorbency, printability, etc., which are all desirables from the printer's point of view.

In U.S.A. much of the semi-chemical and other chemi-mechanical work had been done and the wood residues (waste) and hardwoods form about 42-44% of the total wood pulp demand and greater use has been made of these processes than any other country.

At Great Northern Paper Co., East Millinocket, Maine largest producer of Newsprint in the United States, the short fibred hardwoods (Beech, Birch, Maple) have been utilized very successfully for newsprint production by going in for chemi-groundwood and the furnish consists of 58% spruce groundwood, 12% spruce sulfite, 30% chemi-groundwood running at machines (Paper) with speeds 2000-2500 fpm. The newsprint production is at present about 2000 tons per day as against 240 tpd. in 1900 and 1300 tpd. in 1955. Headboxes are pressurised and the Suction Pickup makes possible the High Speed Transfer of the wet sheet from the fourdrinier into the Press Section.

In Brazil, at Industries Klabin dos Parana de Cellulose S. A; the short fibred Eucalypt in 4' lengths is being treated with 4.0% caustic soda at 80°C for a period of 24 hours in an impregnation

pond before grinding for the production of chemi-mechanical pulp. The newsprint furnish consists of 35% chemi-mechanical pulp, 35% pine groundwood, 20% sulfite and 10% broke and is running at machine speeds 2000-2250 fpm. The Mill is the largest single production of Paper Newsprint in South America.

Japan has too been orbiting ahead with remarkable/spectacular gains of from 10-25% over the last 10 years as compared to gains of from 5 or 10% on paper, newsprint, paper board production of the leading Industrial Nations. It has made especially tremendous strides in the utilization of the short fibred hardwoods to the best possible extent. Here in domestic hardwood pulping Japanese are ahead of the other world Nations. It is their technical Feat of using the short fibred hardwood as a major single ingredient in the furnish for newsprint. Other papers (kraftliner, paper board) and running of the furnish on fast machines which makes one to take of one's hat. The percentage of these short fibred hardwood pulps (i.e. chemi-mechanical, chemi-groundwood, cold soda, neutral sulfite (NS) being 28-40% in the furnish running at Big, High Production Paper Machines at speeds of 2000 fpm and above comparable with the best in Europe and North America.

Even in spite of short fibred hardwoods, forming the major raw material (Being 53%* total requirements) (*of) critical, woeful raw materials shortage, the growth of paper and Newsprint Industry has been meteoric with the result that Japan today is a world leader in % growth—about 10, and ranks number 3 in the world on the Paper Industry and has been very rightly termed as the "Rising Sun of the Paper Industry".

In Hungary more than 35%–40% of short fibred pulp from Paper Euramericana and its various hybrids are used for the production of various papers which is considerably more than in France and Italy, the 2 countries of Europe generally known to use short fibred pulp to the maximum.

In U.K. which is again short of fibrous raw materials especially conifers for paper making, more attention is being given to the maximum and best possible use of short fibred hardwoods. First Hardwood Pulp Mill had been installed by M/s. Wiggins Teape at Sudbrook using Neutral Sulfité process (species used being Beech, Birch, Oak, Alder, Elm, Poplar, Willow, etc.) and the bleached pulp finds passage into the various furnishes to the 46% in dry crpe, 60% in Dartford bank, 15% in vegetable parchment and others as bonds writing paper glassine, gress proof and has good strength characteristics when compared to the Scandanavian sulfité and is better than Sulfité and Sulfate hardwoods. The 2nd Pulp Mill based on Hardwoods had been put up by Bowater for corrugated papers. This utilization of indigenous hardwoods for the production of High yield Paper has been on development of outstanding importance to the British Paper Industry.

In South Africa, short fibred Eucalypt and Wattle Acacia Mollissima have been used for Paper, Newsprint manufacture.

In Australia, more and more attention has been given to short fibred hardwoods (Eucalypt) for use in newsprint, printings wrappings. At Austrailian Newsprint Mills, Tasmania, Boyer, the Eucalypt has been best utilised by going in for Cold Soda Pulping in July 1957. The furnish for newsprint consists of 60% eucalypt groundwood, 23% Eucalypt cold soda pulp and 17% semi-bleached pinus raliata kraft running at machine speeds of 1400-1500 fpm. with an open head-box and open draw at couch. The substitution of 23% cold soda pulp for groundwood has increased the machine speed by 6.5%. Burst factor of mixed stock by 3 points, and tear factor by 5 points with a corresponding increase of 2 points burst factor and 2 points tear factor of the finished newsprint. The freeness of Cold Soda has been found to be in the range of 90-50 Canadian standard for obtaining an optimum combination of wet strength and drainage—the essentials in high speed machine operation. No

particular difficulties have been encountered in the machine run, the only notable change being that the draw between the sections must be reduced to compensate for sheets tendency to shrink more than the normal furnish. The upper limit for Cold Soda Pulp with any mixed furnish appears to lie between 30-40%. But above 30% drainage problem on the machine wire, formation, sheet shrinkage become increasingly important and need extra attention.

Some stocking of pitchy substance at presses has been a problem leading to numerous breaks especially on higher speed machines. This has been tackled by using Sodium Hexa Meta Phosphate at the press roll (rate being 100 gallons/hour) which forms complex with the cations (i.e. Iron and Aluminium).

In Pakistan at Khulna, Newsprint Mills, Khulna, short fibred Gewa (Exccecaria Agallocha) hardwood has been very successfully utilized as early as July 1959 for the manufacture of newsprint, mechanical printings—the furnish being 60% Gewa stone groundwood, 30% Gewa chemi-groundwood and 10% long fibred (Imported Bleached Sulfate) running at machine speeds of 1200-1600 fpm. The speed being one of the fastest where the newsprint containing a high proportion of pulp from a tropical woods is being made. The newsprint machine is equipped with couch vacuum transfer. Daily rated production is 110 tons and on several occasions it has touched 116.0 tons. Expansion programme at 50,000 tons/year from the present 35000 tons/year is already underway.

The newsprint quality matches very well with the American and Scandanavian countries with the average test data as under:—

Basis weight.	Mullen (ps)	Tensile (kg.)	Tear of MD/CD	Smoothness M1/min.	Brightness
51.3	23.4(7.4)	1.5/0.92	23/27	200/250	60.2

In India, the forests are full of hardwoods with conifers concentrated only in the Himalayan region which till now have supposed to be not accessible. A Mill manufacturing 200 ton/day of newsprint utilizing the conifers from the lower Himalayan region is being put up at Nangal (Punjab).

At National Newsprint & Paper Mills, *Boswellia Serrata* (Salai) which is short fibred hardwood is being utilized for mechanical pulping or end use in newsprint. The fibre length values are 0.6-1.2 mm. the average being 0.88 mm. diameter values are 0.0135-0.0385 mm. the average being 0.024 mm; ratio of fibre length diameter or

consumption at Mechanical pulp Grinders so as to circumvent troubles at the paper making stage.

In 1955 during the start up and a few years later newsprint making was all a mess—

“The Burst factor (newsprint) used to be seven And experience has taught us to raise it to eleven, And raise the production to a New Heaven.”

At present the percentage of long fibres (chemical pulp) in the “newsprint furnish” is about 44-45 the highest record figure in the newsprint world. Test, and other data are tabulated below of stone ground-wood (*Boswellia Serrata*); chemical pulp (Bamboo) and newsprint:

Pulp	Freeness C.S.F.	Burst Factor	Break length metres.	Tear	Basis weight of m ²	Cliper Inches/1000	Bright- ness
1. Groundwood	80-120	1.0-3.0	600-900	—			
2. Chemical pulp	360-380	30-34	4500-5000	90-95			
3. Newsprint furnish	250-300	11-12	2000-2250	30-34	52-54	3.7-4.0	63

L/D is 37.1. Hardwoods on the whole give very poor strength mechanical pulps and *Boswellia Serrata* is no exception. At Nepa the situation as far as fibre length and strength of mechanical pulps are concerned has been further aggravated by chronic and all time power shortage at the Mechanical Pulp Grinders and the matters have become still worse because of too frequent sharpening of pulp-stones in order to keep up the mechanical pulp production figure at 50-55 tons/day. These very poor short fibres have not only affected the percent age of long fibred pulp used alongwith in the furnish but at the same time the newsprint quality (A better percentage of mechanical pulp gives better desirable, characteristics to the newsprint, machines run and production and ultimately the Company's profit picture, revenue, short fibred hardwoods have best been tackled and tamed by light burr application and higher power

In order to avoid very many ills resulting from the use of these “Extra-Short” fibres from the hardwood (Salai) at the paper-making stage and making the work continuous, safe and rather break-free on the paper machine at speeds of 800-900 fpm, we had to resort to:

- * Use of all, very fresh wood (Salai).
- * Installation of another screen (centrifugal) for screening of Mechanical Pulp being run in series with the older screen for reducing the shive content of groundwood and in turn of newsprint and giving some relief to the Paper makers as well as production.
- * Refining of longer fibres to a little lesser degree thereby having a higher freeness and a better tear of newsprint furnish in view of brittle, short fibres (groundwood).

- * Installation of another channel after the Bird screens and letting the machine furnish travel some distance before entering the fan pump thereby arresting Head, velocity variations which were giving breaks at the couch because of subsequent substance variation.
- * Finer Mesh Fourdrinier wires (65×52) giving better fines retentions, stronger webs.
- * Certain changes at the Press Sections letting the wet web travel from the first press to the second press with a single handling rather than twice the older practice which was accident causing and time consuming cumbersome.
- * Use of sulphuric acid for a continuous maintenance of pH 5-5.5 at the machine furnish to avoid choking, clogging of fourdrinier wires and sticking at the presses and easy take off of the weaker wet web from the presses.
- * The writer feels that for better/higher paper machine speeds of 1000-1500 fpm either the % of long fibres shall have to increase further (which may not be an economical proposition) or a dramatic change in the short fibres has to be brought in by:
 - Higher more power consumption at the Grinders (mechanical pulp)
 - By lighter burn applications to the Grinding Pulp Stones.
 - By raising the grinding temperatures to 180-185° F from the present practice of 140-150° F.
 - Treating the wood with caustic soda before grinding.
 - Grinding in the presence of caustic soda.

Our Mills is on the threshold of a very large scale/ambitious expansion from the present 30,000 tons/year to 75,000 tons/year which may take 3-4 years and the future furnish of "Nepa Newsprint" would consist of 34% Stone Groundwood, 33% Cold Soda Pulp (Salai) and 33% Chemical Pulp (Bamboo) and not only be resulting in upgraded newsprint

but at the same time even crossing the stipulated production of 250 tpd. The Incorporation of cold soda pulp in the newsprint furnish would be another way of tackling the short fibres, replacing a part of these and at the same a part of the costly chemical pulp permitting higher machine speeds of 1200-1500 fpm. with a safer, break-free run in view of the present trend of newsprint machines speeds 3000-3200 fpm. (For offsetting the rising cost of Men, Materials. Machines) and sky rocketing trend in speeds of 5,000 fpm. and above by 1970. Other innovations, "Pressurized Headbox" and "Suction Pick-up" would enable still a better, safe way of handling the short fibres at couch, presses and further on would go to even enable us to cut down the % of long fibres or increasing the % of short fibres (groundwood) bettering the printing-characteristics of newsprint decreasing the breaks on the machine by 70-75%; toning, taking up the production by 30-35% through higher* speeds making the forestry conservation programmes (*operating) more effective because of the possibility of getting 10-15% more paper with the same amount of pulp-wood due to greater shrinkage in the manufacture of Chemical Pulp than Groundwoods.

Majority of the paper is usually made out of a blend of long and short fibres and these are the short fibres which give to the paper certain desirable characteristics—good sheet formation, opacity, bulk, smoothness, etc., all musts from the printer's point of view.

Treatment of the short fibred pulps is quite different from that of the long fibred pulps—the former do not require much of drastic treatment, very light or no beating would do and this is both time and power saving. Refiner treatment should aim at preserving the fibre, giving the requisite strength with a free, easily draining stock and allowing the use of maximum of dilution—all required for high speed machine operation. In a furnish comprising of 2 or more components, each should be beaten or refined separately when component may undergo an undesirable fibre shortening leading to low tear

before the burst strength of the other component develops. High speed paper machines require the highest possible content of long fibres and a minimum of "Mealy shiff". Tear of the furnish from the short fibred pulp should be given good consideration as it has a great bearing on the running conditions of the machines.

The screening of the short fibred pulps should be a very perfect and tight one before sending the pulps for final stock preparation. Screening, centri-cleaning of the furnish ahead of the Paper Machine would go to help have a break free run at high machine speeds resulting in higher production.

For a good performance of a high speed machine, especially when short fibred pulps are forming the furnish, the preparation of the stock and the arrangements for feeding the fibre suspension to the Paper Machine, require extra care, and attention. The consistency and flow regulation are indispensable for a controlled supply of paper stock for obtaining a uniform paper substance.

A constant consistency can be best maintained by individual consistency regulators for each component of the furnish in the stock preparation unit and a single common control cannot compensate large fluctuations. Besides the layout of stock, water, piping and channels between machine chests and Paper Machine should be so arranged that the shortest path is used avoiding unnecessary recirculation or overflow and intermediate collection in chests.

At the forming (wet) end of the Machine, "Entrained air in the stock is a serious handicap and adversely effects the quality and quantity of production and "Deculator" is the answer and must for short fibred pulp stock and entails the advantages:—

- Vanishing of foam on the stock surface in the head box, leading to saving on "Foam Killers"
- Reduction of slime/flocs.

- Less of two sidedness/tougher sheet with reduced porosity.
- Better/Move efficient water removal at the wet end and increased drying rate.
- Reduction in steam consumption because of a drier sheet.
- Increased machine speed. (80-100 fpm.)

Increasing machine speeds increase the attendant troubles, problems and these touch a new horizon especially when short fibred pulps are being used. Two problems out of the very many problems which come to the fore are "Sheet formation" and "Web Transfer".

Above about 1100-1200 fpm, Hydraulic problems crop up at the stric and the sheet forming zone. Increasing speeds mean increasing volume of water and bigger dilution and our aim would be to have uniform distribution of fibres over the entire width of the wire in a steady and smooth flow free of eddies at a speed approximately equal to the wire velocity.

For example, while producing newsprint (52 g/m²) at a speed of about 1650 fpm, 400 gal/ft/minute are brought on the Fourdrinier wire.

The "Head" required at the slice increases as the square of the "velocity" or $h \text{ (in)} = \frac{v^2 \text{ (fpm)}}{f 9200}$

Head (h) at velocity (v) 1000-1150 is—4.5ft (Approx).
 V =1300 ft. h—6.5ft (Approx).
 V =1600 ft. h—11.5ft (Approx).
 V =2600 ft. h—29.5ft (Approx).

Normally an open stock inlet can be employed for speeds upto 1200-1300 fpm—but the head does not remain static, and results in an uncontrolled velocities of stock to the wire giving substance variation and wet end breaks. Heads of more than (2 metres) 6.5 ft. corresponding to machine speeds 1300 fpm make the open stock in-lets very big and clumsy and unmanageable and so come in the picture the "Pressurized Head-boxes", which require less of

materials and space, are more compact, and at the same time provides a short path with lesser stock volume, decreased retention and decreased tendency to flocculation, cross currents, turbulence and shine deposits—all undesirables. The “pressurized head-box” has been a real boon and gone a long way in handling up the short fibred pulps at the high speed machines made possible to obtain practically unlimited heads. Another must for the closed handbox is the constant pressure and delivery of the fan pump as any variations would result in variations in the sheet weight, causing change in draw and consequently breaks at the couch.

The critical zone for a good, efficient fibre distribution for a good sheet are the first 3 feet of the fourdrinier wire immediately behind the slice. Especially at higher operating speeds we need a careful design of machine components which would ensure a turbulence free flow at the point of impact on the wire and adjusting and controlling drainage for a good sheet formation.

Short fibred pulps are mostly less free and High Speed Paper Machine operation demands more free furnish for an efficient and successful run. The short fibred pulps because of their more wetness result in slow water removal on the wire and press section, slow drying and even limit the machine speed and affect the runability. In the assessing of drainage on wire it is the type of pulp and the method of beating which play a vital/dominating role. In actual practice the drainage properties of the stock can be improved, upgraded by the addition of a lightly beaten long-fibred pulp. In some cases there are factors mostly economic which go to limit the extent of improvement which can be achieved this way. It becomes imperative therefore to have Fourdrinier wires of bigger, better lengths than those normally employed for long-fibred furnishes. This point has got to be taken good care of while designing machines for high speed, especially supposed to run on furnishes containing short-fibred pulps. Besides these even we may have to join for more presses and more dryers.

Mr. K.R. Suttie in his Paper “A Relationship of Fourdrinier Wire Length and Machine Output” (Paper Technology, Vol. 2, No. 4; 367-369, 377; 1961) gives the following formula for calculating the wire length quickly:—

$$\text{Wire length (L)} = C/P$$

$$L = \text{Wire length (ft)}$$

$$P = \text{Output in Lb/Hr. in width}$$

$$C = \text{Constant depending on the class of paper.}$$

$$\text{Value of C for newsprint and wall paper is } 9.5-10.0$$

Short-fibred pulps even because of their inadequate drainage on the wire result in a wet web of high water content which would lead to poor couching, wet and breaks and crushing at the presses. Because of the lower size or smaller dimensions short fibres would necessitate in the use of Finer Mesh Fourdrinier wires, which would give better/more retention of fines (and less corrosion of wire because of lower white water consistency and resultant conductivity) leading to stronger wet web—a desirable for high speed machine operation.

Recently Black Clawson has put in the market an unusual machine “Chemifiner” which gives high freeness to low freeness pulps because of “Negative Refining”. Besides raising the freeness this “Wonder Machine” which I would dare say, increases tear also which is a big desirable at high speed of Paper Machine. This machine has been put to use for Deinked fibres which have low freeness and needs much virgin stock to raise the freeness. It can handle 100-tons and runs at high density somewhere between 20% to 50% consistency and pumps directly to paper machine, has been installed at a number of Mills and till recently at Great Northern Paper Co. This chemifiner would certainly find more and more application and would especially help short-fibred pulp stock to run at higher paper machine speeds and be a boon and more than welcome.

At High Paper Machine speeds, the processes of “drainage” and “sheet formation” occur in an

extremely short period—that is the twinkling of an eye. For example in a Newsprint Machine running at 1600-1650 fpm with a wire length of 100 ft. the period of drainage on the wire is only about 1.5 seconds. Fibre Dwell Time (Time a fibre remains in the forming area between Breast roll's centreline and first suction box's leading edge) is still lesser and is about 0.8-0.9 seconds and it is this time when the fibre becomes oriented on the fibre mat and then becomes fixed in the general sheet characteristic. The observation of details of discharge and drainage especially at high speeds becomes rather difficult. So "high speed Photography" and "Flash light stroboscopy" have been employed for getting/gaining an insight into the observation of flow conditions at the point of stock discharge to the wire and of the sheet forming and drainage zones down the wire which has led to the design/development and perfection of suitable construction means for the control of drainage rate and sheet formation in high speed machines of today especially fed with short-fibred pulps which aggregate the problems/troubles a step further.

The way in which the stock makes contact with the wire and what happens on the subsequent 6-7 ft. of the wire determines the sheet formation quality and is also very important for a steady, undisturbed sheet transfer at the couch.

Further down the wire the water removal takes place only at table rolls. Here a considerable amount of water is thrown off by centrifugal force—a good quantity of water clings to the wire underside, is carried to the next roll and forced back there into the web and leads to irregularities on the web surface, substance, variations and poor look through. At high speeds the table rolls have been found to be unsuitable and have been replaced by "Multi-Foils" or "Hydrofoils" which have allowed positive, gentle and much better control of drainage by decreasing the angle which the hydrofoils form with the wire, eliminated pressure ridges, wire sag, snap back and resulted in better sheet formation, improved sheet quality and still higher speeds. Hydrofoils

because of their gentle removal of water mean better fines/filler retention and consequent improvement of formation leading to stronger wet web a must especially when short-fibred are there in stock and speeds of machine are high. Hydrofoils also permit wire length to be shortened and especially go to nullify and meet the demand of short fibred pulp which dictate longer fordrinier wires at higher machine speeds because of their low freeness.

At Suction Boxes, the drainage takes place mainly immediately after passing the leading edge of the box, and the water is drawn back into the sheet by capillary forces, an interruption of the vacuum and for avoiding which the effective surface of the suction boxes should be sufficiently large so as to increase the time of action especially when short fibred pulps are forming the furnish. A good control and graduation of vacuum from Box to Box (Vacuum to be successively increasing) is very essential. Any undue increase of vacuum would result in excessive wire wear, wire making and excessive power consumption. Covers for suction boxes of end of grain maple wood have proved to be very suitable but recently very many others have come up in the market and their use has gained lot of prominence/publicity and have given another count of boosting of Paper Machine speeds to new horizon. These are Robalit (Leader-r-Riemen-Austriam); Rokide (Norton International); K.T. Silicon Carbide (Carborundum Co.); Tungstun Carbide (Union Carbide Corp); Teflon (Joseph T. Ryerson); SPK Oxide Ceramics (Feldmühle), (Urethare Rubbers), (Rubber Plastics Ltd.), LFT-4 (Polyurethane), Pulp/Paper Mill Accessories; Hypalox (Ceramic); American (Feldmühle) Hylife (Hpyck), Gatke (U.S.A.), Aluminium Oxide (Wilbanks Inc) (Ceramic); Stainless Steel and give very many advantages: Higher wear/abrasion/corrosion resistance: Less of maintenance and rare resurfacing;—No. Imbedding of Girt/Dist. because of smoother surface. No Plugging: No rewetting—Appreciable increase in wire life—lesser consumption of power at couch-1

Improved/Better Drainage. Higher vacuum without Power consumption Increase—No slime/Pitch Development—Less Frequent wire/change and lesser down time. Better, higher machine speeds. Increase in Production/profits. Reduced cost of newsprint/ton.

At most of high speed paper machines there is a draw (Stretch) between the couch and the Press Felt (First) of from about 2% to 5% and further between each subsequent press there is a draw of about 1% thereby making a total of 4-7% stretch between the couch and the first Dryer and this especially at the juncture when the Paper is in its weakest state and again when short fibred pulps are forming the stock constituents. This stretch is proportional to the adhesion of the sheet to the wire or top roll and with well hydrated papers (i.e. greaseproof) the stretch may well be doubted. The earnest machine designed by Fourdrinier had no stretch on the paper from wire to press and deserves mention here.

It is accepted that once the stock has been prepared and the sheet projected into the wire nothing can be done to upgrade/improve its inherent characteristics and subsequent operations (Pressing, Drying and Calendering) cannot injure the originally formed sheet.

Another Area/critical point where the short fibred pulp stock at High Machine Speeds gives the greatest trouble, is the Transfer of the wet sheet or the web from the couch to the first Press when the web is in its weaker condition and the Dry content between 17.20% and when it is supposed to carry its own weight during the transfer. If the web is weaker then it breaks and so as to increase its strength, we have to add long fibred pulps, even when the need for these in the Finished product may be lacking.

In order to avoid, mitigate these difficulties, simplify.

Make easy and advance Paper Making, recent Technological research, development has brought

to the fore "Suction or vacuum Pick-up", eliminating the draw from the couch and Presses (First and Second) and is especially a must with low substances (30-50 gm 2) and enables the Margin of operational safety to be extended, has special significance in "Newsprint Manufacture where it has permitted a speeds of 3000-3200 tpm from the unital initial 1800 spm. Herein the end suction pick-up by means of the suction roll in the pick-up Felt the wet web is transferred from the wire to the first press Felt, assisted by a further suction roll. In the further travel of the Paper web through the Machine the web is carried by compressed Air and rope conveyors without effort on the operators part. The vacuum pick-up a big innovation has a host of benefits/advantages :

- Reduced Paper stretching at the wet end (even in spite of 2.5% draw between the couch and press) and consequently higher tensile strength.
- Lesser Breaks (About 75% reduction) and less of broke brooke even at higher speeds.
- Higher machine speeds with production increase of about 35% and improved efficiency.
- Reduction of long speed (chemical) pulp content from 20% to about 10% a tremendous rupee or dollar saving.
- Decreased % of long fibres meaning an increased % of short fibred stock or Groundwood resulting in better Paper Newsprint with improved/better printing characteristics.
- Reduction in substance (or Basis weight) of the Paper especially, Newsprint as the printer is interested to get for his money a maximum of area for printing and is not willing to pay the same price for heavy basis weight (i.e. 58-60 gm²)
- More effective conservation of Mill Forestry Programmes—because of the possibility of getting 10-15% More paper with the same amount of pulpwood due to greater shrinkage in chemical pulp manufacture than groundwood.

—Lesser cost of paper/newsprint ton and upgraded profits.

—Smaller Amount of extra power-vacuum (6-8 inches) needed by vacuum pick-up not much and this extra cost is offset by the increase in speed/production (Due to wet and breaks reduction).

At presses then short fibred pulps are forming the stock and the speeds are high, we may have 'stocking' at the Presses, which may result in numerous press breaks and serious loss of production. The sheet take off may also become difficult at presses. The only remedy for this is the addition of agents forming complexes with cations such as Aluminium and Iron i.e. the application of complexing agent "Sodium Hexameta Phosphate" to the Press roll.

Pressing at higher speeds with shorter fibres may necessitate even having 3 presses instead of 2 for attending the requisite amount of Dryness of the web ensuring a safer travel on its further journey. The presses take out 10-15% more of moisture and an effective water removal out of the web in the chief future making possible the present day high speeds of machines.

Keeping in view of the following statements:—

—It is 91 times as expensive to remove water at the press section as at the Fourdrinier and 503 times more costly at the dryer section (Mr. Foster P. Doane).

—It is more economical to squeeze out water on the wet presses than to evaporate it on the dryers as on the latter case the cost of drying is 10-15 times as high (Mr. Karl Schmidt).

—Removal of water at the Dryers costs 4.5-5 times as much as removing mechanically the water at Presses (Mr. F.W. Laemmermann). and the desirability of improving the water removal efficiency in the press Section and the Dryness of the web at Higher speeds has led to the development of New Spectacular Techniques such as:—Mead Fabric Press, Appleton Sleeve development, the venta—Nip and the Hi l presses and the Divided Press.

The small sized material in the short fibred pulps not only restrict drainage on the Fourdrinier wire but also decreases the rate of "Drying of the Paper and ultimately affects the speed and capacity of the Machine or may dictate the addition of more dryers. If the fibre wall is thin then the fibre collapses during drying and forms a ribbons, whereas when the wall is thick—influences the Mechanical Properties of Paper-Strength, bulk and opacity. In certain plants—broadleaf Trees, grasses containing varying percentage of very thin walled fibres such as vessels, which on drying form thin almost transparent Filmy flakes. If so happens that these cells do not stick well to the paper structure, giving fuzz, which is picked up by Tacky Printing Inks and result in Printing troubles. For the Tacky Printing Inks the curb rests with the Ink-maker rather than the Paper-making. The short fibred pulps—sheet also has tendency to develop cockle and curl during Drying and for avoiding these machine conditions have to be suitably adjusted. Some recent developments—various types of "Blowing rolls" (e.g. Madeleine roll). Heimback and Pocket ventilating (PV) eliminating need for Felt Dryer cylinders and helping making the Dryer Section short less expensive improving Moisture profile and especially more valuable for short fibred pulp stocks, open weave Dryers felts (i.e. needled and Plastic fabrics) which give increased % of Drying (10-15%) and fewer fabric changes or more life, lesser down time and reduced costs are a big welcome: C-Dryer (C for complact), B-Dryer are also attracting considerable attention/interest. Experiments are being conducted with "Through Drying, Dielectric Drying, Fluidized Bed Drying in anticipation of Higher Machine Speeds, when Drying may possible be a bottleneck.

A New chrome coat has appeared on the scene with an 'Easy' release surface called chrome. Release and is especially valuable in short fibred pulps when being used on High Speed Machines as it reduces the tendency for picking in the dryer section and particularly in the after dryer section.

Totally enclosed Hoods in the Dryer Section have gone a long way in reducing the exhaust and supply volumes—steam consumption/pressure/increasing Drying efficiency improving moisture profits at reel Machine efficiency and working conditions and overall production.

The Paper Machine (Mechanical or Sectional) Drives especially or High Speed operation running on short fibred pulp stock require even more attention than the Machine itself. The overall speed should be steady and the individual speeds between sections especially at the wet end should be capable of fine adjustment and be controlled within very close limits. Otherwise which may either limit the speed or may lead to serious production losses because of weaken web.

Electric Multi Motor Section Drives have been used exclusively for High Speed Paper Machines requiring close Draw control. A further development of the Electric Drive is the introduction of "Electronic speed regulation" with Amplifying Machines allowing a more positive sensitive control than the methods employed hitherto, as well as the application of the Multi-generator Principle. The Multi-generator system is more flexible than a single generator and more suitable for "High Speeds" especially, when short fibred pulps are being used and where paper making considerations are more critical due to the greater Tensions in the weaken sheets, adhesion of sheet to the wire and rolls etc. because of more rapid "speed of Response". "Besides even the start up is smoother reducing any unnecessary load on wires and Felts.

Drainage Aid, Drying Improvers

The present state of Automation and Instrumentation covering almost the whole range of operation besides other Innovations Low consistency Regulators (Fibretol etc.) Automatic Freeness Recorders, Slimicides, Foamkillers, Wire Life extenders, plastic chromeplated and stainless Steel Fourdrinier wires, wire Tension controllers clothing guides Needled

wet felts, Hydrofoils, Rotabelt, Flo-vace, special suction Box covers, Fabric Press, continuous Felt cleaning units, High velocity Hoods, Dryer Temperature indicators, Dryer Felts (Needled/Plastic), Fuzz/Fluff/Dust removers/extractors, Break Alarms, Automatic Paper web Feed through, Hole/void Detectors, calender crown control (i.e. Accra Nip Control (Black Clawson) variable crown king Roll (KMW) controlled crown Rolls (Baloit) etc. Swimming Rolls (Farrel Corp.); Breaker stacks, Basis weight and Moisture controllers and Recorders Formation Testers computer controls have all added another dimension in the High speed Machine Operation resulting in improved production/Quantity, Cost/ton reduction and reduction from Art to Science of overhall process of Paper production.

Much of the Attendant problems of short fibred pulps have been made soluble and overcome increasing realisation is being of their unlimited potentialities and are to day not only considered a Diluent for the long fibred pulps but form indispensable fibre constituent and valuable paper-making Raw Materials. Still another field which is cloudy, needs further probe/investigation is the Drainage Rate/Strength especially Tear-relationship. It is very possible that 'High Consistency Refining' (HCR)—30% which aims at preserving the original Fibre length or no fibre shortening gives gentle peeling of the external wall of Fibre and delicate fibrillation better interweaving and interfibre bonding with absence of fibre debris and fines and "Negative Refining" (Aims at increasing the freeness and Tear) may provide the long sought answer.

Recently M/s. KMW Karlstad, Sweden have put in the Market, KMW inlet Box Drainage Tester, Uniformer, Fabric Press and specially, recommended these for the production of Paper newsprint from short fibred pulps particularly Bagasse.

It is further anticipated that future research and Development in the Laboratories of Machinery Manufactures and Rand D Centres of the Paper Mills would bring in still more/better ways and

means of taming and tacking and extending the Horizon/Avenues of the use of short fibred pulps at still Higher and Higher Machine Speeds and thereby be a big boon to those countries especially lacking conifers and at the same time giving a big relief to the conifers which have been very highly taxed during all these years of pulp and paper industry Development and where the Development trend knows no bounds.

The present development and boom on the use and increasing percentages without fear and flaw and of short fibred Pulps at Higher/Better Paper Machine Speeds has been possible due to the first class. Machinery of Modern and ultra Modern Design due to the very close collaboration, cooperation ingenuity and inventiveness of the Researchers/ Machine builders and users.

Recent years have witnessed a dramatic increase skyrocketing trends in the Machine Speeds with over increasing output per unit and the Machine

itself has undergone radical/revolutionary refinement since its development towards the 18th century end. Newsprint Machine speeds have reached 300%-3200 fpm. Insure Machines are already running successfully over 4000 fpm. one running at 4000 fpm. at Georgia Pacific Corp. (U.S.A) Another Machine (Tissue) designed for Top speed 5280 fpm. Just went into production at crow zellerbach's Mill at Wauna-Oregon (U.S.A) 1965-end still another Tissue Machine with speed of 4000 fpm. strated up late summer 1965 at G.A. Serlachius Oy. Mantta-Finland, Speeds of above 5000 fpm are foreseeable and not unrealistic, is low speed for paper machine 1970 would be 3000 fpm. and by that time many machines would be making paper at 45000 fpm. or Higher 6000 fpm.

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