MARKET PULP: A FINISHED PRODUCT

Dave Hillman
Market Pulp Consultant
413 Monaca Dr.
Erie, PA 16505
814 452-1136/fax 814 454-4882
e-mail dhillman@erie.net

ABSTRACT:

Over 100 grades of Market Pulp are being produced in 27 countries. The pulp leaves the mill as a finished product in either sheeted bales, rolls, flash-dried bales and, on rare occasions, as wet-lap. Major grades include Bleached Northern & Southern Softwood and Hardwood, Diaper Fluff, Eucalyptus, CTMP, high alpha Specialty Pulps for acetate and viscose applications, as well as mercerized pulps.

With worldwide production approaching 34 million tons annually and Market Pulp considered a worldwide commodity, the industry must take steps to overcome several serious long-standing problems.
1. Most mill's specifications (QALs) are based on tradition and simply being competitive with other major players without regard to satisfying their customers' inherent requirements.
2. Little or no thought has been given to "target marketing": matching a particular pulpmill's "outstanding attribute" with selected customers' "prime requisites" (or essential requirements).
3. Many Market Pulp mills continue to produce a one-size-fits-all commodity grade that is marketed broadly with equal effort and which attempts to be all things to all customers.

In this presentation we will examine Softwood's particular attributes and distinguishing characteristics with emphasis on each species' most appropriate end-use applications and both mixed and single species Hardwood's aesthetic benefits. Selecting exactly the correct grades, blending them together and processing them properly will permit customers to achieve all the required strength, sheet properties and performance objectives.

[EXHIBIT 1]

Market Pulps, especially Softwood, have long been described by means of a Valley Beater Curve or a PFI mill curve which shows the change in TEAR, FOLD, BURST, TENSILE, CALIPER and OPACITY at various levels of beating (fibrillation). In many cases this is the only "technical data" given to a prospective customer. The Purchasing Manager is asked to pass along a carefully packaged 5# sample to their Technical Department with the instructions "take a look at this and see if there's any interest". Nothing is ever said about (a) unique properties, (b) distinguishing characteristics, (cj processing: advice on blending, refining guidelines or relative ease of refining and (most importantly) (dj most appropriate end-use application. In other words, the customers are expected to discover the properties they desire and to make their own decisions as to where and how to use the pulp.

As mentioned, Market Pulp mills tend to match the existing competitors when developing their QALs for their own pulp. Here is a typical example:

SPECIFICATIONS FOR PRIME MARKET PULP

Brightness (ISO) minimum: 88.0
TAPPI Dirt: maximum 3.0ppm
KAPPA Number: 0- 1
Ash content: maximum 0.3%
Species Integrity: minimum 90%
0.5% CED Viscosity
SWD: minimum 16
HWD: minimum 11

One of the most obvious problems to appear to even non-technical people is the use of Minimums and Maximums which tend to tell the customer only what the pulp WILL NOT BE (e.g. brightness not below 88; dirt not above 3ppm) but do nothing to actually describe what the pulp WILL BE. Here is where Product Averages and standard deviations would be very helpful.

I. MARKET PULPS: SOMETHING FOR EVERYONE:

A. SOFTWOODS

1. Northern Bleached Softwood Kraft - NBSK
    a. Douglas Fir, Cedar, Spruces, Pines, Larch, Western and Eastern Hemlocks, Interior Firs
2. Bleached Sulphite Softwood - BSK
    a. Rayonier-Femandina Beach, FL; GP-Bellingham, WA; Weyerhaeuser-Cosmopolis, WA; Fraser-Madawaska, ME
3. Southern Bleached Softwood Kraft - SBSK
    a. High Slash Pine: GP-Brunswick; Rayonier-Jesup; Buckeye-Foley; Champion-Pensacola (principally Florida and Georgia)
    b. Loblolly, Shortleaf, Virginia Pine; all others in the South from Virginia to Texas
4. High Alpha Dissolving Softwoods
    a. Rayonier-Femandina Beach, FL; GP-Bellingham, WA; Buckeye-Foley, FL
5. Diaper Fluff (always in rolls)
    a. Weyco-Columbus, GA, Orglethorpe, GA; New Bern NC; Plymouth NC. GP-Brunswick, GA; Crossett, AR; IP-Georgetown, SC; Texarkana, AR; Natchez, MS; Champion-Pensacola, FL; Alliance Forest Products-Coosa, AL
6. Spruce CTMP: Predominantly BC
7. Mercerized High Porosity Softwoods (steeped in caustic): Rayonier and Buckeye

B. HARDWOODS

1. Northeastern Mixed Hardwoods: Birch, Beech, Maple, Poplar
2. High Maple Hardwoods (e.g. 80%): Champion-Quinessec, MI; GP-Woodland, ME; Thurso (James MacLaren St. Ann's (P&W)
3. Birch: Irving-New Brunswick; Domtar (E.B.Eddy)-Ontario, Numerous mills in Sweden, Finland, Russia, and Poland.
4. Southern Mixed Hardwoods
    a. High White Oak: Willamette-Hawesville, KY; Westvaco-Wickliffe, KY
    b. High Gum/Red Oak: GP-Leaf River, MS; Alabama River, AL; Bowaters-Calhoun, TN; IP-Natchez, MS; IP-Eastover, SC;

IP-Georgetown, SC; IP-Riegelwood, NC

5. Eucalyptus:
    a. Globulus (temperate variety): Chile, Portugal, Spain, natural growth, harvested in 22-24 years
    b. Grandisflora (tropical variety): Brazil-all tree farmed, harvested in 6 1/2 years.
6. Indonesian Tropical Hardwoods:
    a. Acacia: plantation grown, harvested in 6 years, very high population/high opacity, poor bulk.
    b. Gmelina: used as firebreaks for spongy bark, waterfilled leaves.
    c. Mixed Tropical Hardwoods: will all be cut over by 2003; replaced with Acacia.
7. Aspen CTMP: BC, Alberta and Saskatchewan

II. PROFILING THE MAJOR GRADES:

A. SOFTWOODS [EXHIBITS 2,3]

1. All of these grades, whether made in Chile, Finland, Canada or Alabama, can be divided into three major categories:

a. Species Integrity: Is the pulp composed of all or nearly all of a single species? Most Market Pulp Softwoods are a mixture of as many as 7 or 8 different conifers. Conversely, Chile is producing 100% Radiata Pine and the mills on the West Coast of BC are able to produce 100% Douglas Fir and essentially 100% Cedar.

b. Natural Growth or Plantation Grown, the Age of the Trees and the Growing Conditions: Conifers in the warmer climates can be cut in as little as 11-12 years (Swaziland) and grown on carefully controlled tree farms. In the far north, at the top half of the Boreal Forest, trees grow naturally, in a hostile environment, and take up to 250 years to reach maturity.

[EXHIBITS 4, 5]

c. Wall Thickness/Specific Gravity: This is an important consideration, since it has proven to be an excellent predictor of the ease of refining (reflected in the slope of the curve on the PFI chart). The thinner the wall (e.g. Cedar, White Spruce), the easier the pulp fibrillates and the steeper the curve. Thick walled fibers such as Douglas Fir, Old Growth Hemlock, Slash Pine and (to a slightly lesser degree) Radiata Pine all have a very slow response to refining and have Beater Curves with a more gradual slope. These thick walled fibers are known for their High Tears, which usually survive as the fibers go through stock prep because the fibers respond so slowly.

[EXHIBITS 6,7]

2. AREAS WHERE SUPPLIERS HAVE BEEN DELINQUENT:

a. Emphasizing the importance of refining in commodity printing papers: 90% of a paper's strength (Tensile, Fold and Burst) comes from hydrogen bonding. These bonds are directly linked to the number of exposed OH groups that are available for hydrogen bonding. Pulp suppliers have generally failed to show customers how important it is to properly fibrillate the Softwood fibers without cutting them (high consistency refining is much preferred over the more convenient low consistency refining) to produce a sufficient number of hydrogen bonds to produce the desired Tensile and TEA and to minimize sheet snap-offs and, later, web-breaks.

b. Emphasizing the importance of proper fibrillation and of maintaining maximum fiber length to improve wet-end tensile and minimize wet-end breaks.

c. Failure to recognize that hemi-celluloses hydrate faster than Alpha Cellulose polymers which has led to the Market Pulp mills needlessly raising their Alpha Cellulose because they thought customers preferred this. Actually, a Softwood with an 85/86 Alpha is preferred because it will hydrate faster, improve the response to refining and produce higher strength values. Actually, higher Alpha Cellulose contents are only beneficial to those customers (e.g. chemical companies producing cellulose derivatives such as CMC, MEC and HEC) w-hose process calls for steeping the pulp in caustic.

d. Targeting for higher brightnesses in Softwood at the expense of strength.
Here is another area where Market Pulp mills have failed to properly consider why their customers are buying their Softwood. Being generally acknowledged as a "reinforcing fiber", it should be obvious that strength is Softwood's greatest characteristic and anything that detracts from maintaining it should be avoided. Bleaching has a degrading effect on Softwood's overall strength properties, and yet mills have consistently tried to duplicate Hardwoods' 90 IS0 brightness. In some cases, mills have even tried to impress customers by going beyond 90, even though at great expense to their strength values. When properly fibrillated (as the pulp should be), there will be so many new surfaces exposed that the original brightness will soon be just a memory. Suppliers have been derelict in working exclusively with customers' Purchasing groups simply because it's more convenient and less-threatening. In the future much broader contact with customers' Technical groups will be required.

3. SUMMARY: Softwood's principal benefit is strength, but this can only be realized with proper refining. Softwood has no aesthetic benefits; it has poor opacity, poor bulk, tends to produce poor formation, is more costly than Hardwood and requires energy to refine. Therefore, a good rule to follow is that it is always adviseable to minimize the amount of Softwood in the furnish.

B. HARDWOODS
1. This component in the furnish is responsible for providing the six aesthetic benefits that many customers regard as "prime requisites": bulk, opacity, formation, density, smoothness and holdout. To varying degrees it has been proven counter-productive to refine Hardwood, since this produces three undesirable results: (a) generates unwanted fines, (b) shortens an already short fiber and (c) collapses the lumens creating a ribbon fiber. Just as the papermaker's goal has been to minimize the percentage of Softwood in the furnish (by realizing the maximum strength potential), his goal with Hardwood is to try and preserve its structural integrity. The side effects of refining are quite serious: bulk and opacity go down brightness goes down as new/unbleached surfaces are exposed, and fines are generated (which leads to retention problems and eventually to two-sidedness in the sheet). Since the refining of Softwood has only positive benefits whereas the refining of Hardwood carries several serious consequences, it would seem logical to do just light or moderate refining on the Hardwood.

[EXHIBIT 8]

2. CLASSIFYING HARDWOODS:
a. Southern Mixed Hardwoods: principally oak, gum ash, poplar along with beech, birch,

maple, sycamore, pecan, magnolia, and hickory. These are considered "coarse" Hardwoods because of the fibers' relatively thick walls and low population (about 4 million fibers/gram after disregarding the particles measuring 0.2mm or less).

b. Northeastern Mixed Hardwoods: maple, birch, beech and poplar. These are finer fibers and number about 8 million fibers/gram. Prior to the early 1990's, a number of mills in New England and the eastern part of Canada produced this kind of NBHK. However, to counter the inroads made by single species pulps such as Eucalyptus, producers began a move to concentrate on the most beneficial fiber...which was felt to be maple.

c. High Maple Hardwood. At first the maple percentage was only 55% but as its popularity grew producers began increasing the percentage to 65%, then 75% and up to the present level of about 80% maple. These high maple Hardwood pulps have gained acceptance and have replaced Eucalyptus in many applications; even premium quality facial tissue. Customers appreciate the uniformity and predictability that comes from a pulp where one species is so prominent.

d. Single Species Hardwoods

1. Aspen - from natural growth forests in Alberta, Saskatchewan, and western Ontario. This, also, is a high population fiber but characterized by significant variation in fiber length and diameter. Wall thicknesses are quite small which means the fiber has a tendency to collapse into a ribbon fiber reducing both its bulk and opacity. These thin walls also mean it is very easy to generate an inordinate number of tines when refining Aspen with Softwood (this is never recommended). The population averages about 15 million fibers/gram but lengths range from 0.7mm to 1.4mm while diameters vary from 14 microns up to 20 microns. The two newer mills in Alberta have installed EMCC systems and state-of-the-art bleaching systems so that brightnesses of 93 IS0 are quite common.

2. Eucalyptus - This major Hardwood can be divided into two distinct categories: Globulus, the temperate variety grown in Spain Portugal and Chile, on privately owned plots of land. Harvesting is done, on average, in 22-24 years, which is longer than is recommended. This Eucalyptus fiber is a bit thicker and longer than the tropical varieties and has thicker walls. Globulus is appreciated by those smaller mills who do not have separate refining but must refine their Hardwood and Softwood together. Globulus' thick wall is able to resist the abuse of refining much better than the thinner walled Grandisflora.

Grandisflora is the tropical Eucalyptus species and is the major species in Brazil. There it is harvested in 6-6 1/2 years from carefully controlled tree farms where many of the seedlings come from cloning. To prevent a wholesale wipe-out by a virus or insect the Brazilian producers have integrated their plantations with E. Seligna, E. Terreticornia and E. Urophylia. This is a high population fiber measuring a consistent 16 million fibers/gram with fiber dimensions of 16 microns by 0.95mm in length. Fines content is quite low, averaging 6.25% (by comparison SBHK runs about 11%).

3. Acacia - This is currently being plantation grown in Indonesia and mixed with Gmelina which is used as a fire-break. Acacia is a very small fiber with populations ranging from 18 to 22 million fibers/gram. Fiber size is correspondingly small but is not able to be characterized because there exists so much variation (due to the diverse climate, soil and growing conditions of all the widely spread plantations). Acacia has the unique property of being able to maintain its opacity and bulk even after rather severe refining. For instance, it starts out at 83 B&L opacity (quite high compared to other fibers...SBHK measures only 76), and after refining still measures 79 (other fibers lose two and three times as much as Acacia).

4. Birch - It is only recently that this single species Hardwood pulp has been offered by North American producers (in eastern Canada). Previously it was Sweden, Finland,

Poland and Russia that produced this pulp. The birch fiber has an excellent aspect ratio (L/D) and fibrillates easily. Because of its relatively thin walls it has fairly poor opacity and poor bulk. Up until 1980, Birch was widely used in the manufacture of glassine and other translucent papers. Today it is still appreciated by producers of translucent papers, tracing papers, etc. The birch fiber is natural grown and suffers from the same lack of uniformity as does Aspen. Birch averages about 1.4mm in length by 22 microns in diameter. It has relatively thin walls which means it collapses into a ribbon fiber easily.

C. SPECIALTY PULPS

1. Diaper Fluff - This goes to market in roll form with Slash Pine -from the southeastern U.S. being the preferred fiber. Bulk, compression and recovery, pad integrity and TWA (total water absorbency) are the desired properties. Strength and aesthetic properties are of little interest to the diaper producer. Instead, (low) moisture, consistency, reel profile, roll conditionand ease of communution are much more important. The U.S. produces in excess of 3 million mt/year with about half being exported to a great number of countries around the world where their emerging middle class has come to prefer disposable diapers (convenience, but, also as a status symbol).

2. Mercerized Pulps - This is both southern Slash Pine and mixed Hardwood pulps that have been steeped in caustic to cross-link most of the OH groups, to swell the fiber and to render it relatively inert. It's bulk, Frazier porosity and softness far exceed anything that papergrade pulps are capable of producing. It is favored by the filter media producers (especially heavy duty air filters) for its high permeability. There are only two producers of mercerized pulps, both in the southeastern U.S.

3. Cherni-Thermal Mechanical Pulps (CTMP) - These have also been referred to as "High Yield Sulphite Pulps" to try and avoid the "mechanical pulp" connotation. Spruce CTMP is produced from White Spruce, Englemann Spruce and to a lesser extent Black Spruce (all chosen because of their high background brightnesses). This grade has found acceptance by producers of towelling, bleached board and bulk sensitive packaging grades. Outside of towelling, very little is used in the U.S.

The other major CTMP is Aspen: almost a single species pulp (some spruce is added for ease of processing at the pulp mill) which is produced in the western Provinces of Canada. Because Aspen has such a high background brightness, it has been relatively easy for the producers to achieve an 86187 ISO brightness with very little reversion. In the U.S. most Aspen CTMP is used in higher quality towels with a small amount used by papermakers in bulk-sensitive printing & writing grades. CTMP is normally ordered at the desired freeness with the idea that the papermill's own stock prep will do nothing more to it. Refining a high lignin containing fiber is considered counter-productive and something to be avoided.

4. MDIP - the new name for Market De-Inked Pulp from 100% post-consumer-waste recycled fiber. Previously this grade was only available in wet-lap form but it is now readily available in 100% Air Dried, wrapped, sheeted bales. Brightnesses have come up to 86 IS0 with very little reversion; dirt counts have fallen to 3-5ppm and stickies have been greatly reduced to the 5-8 count on a 6 cut scale. The pulp generally contains about 25-30% Softwood but little strength contribution should be expected from it. Also, little or no refining is required and, in fact, only light refining is recommended. The pulp contributes little in the way of strength or bulk but does give fairly good opacity and does close up the sheet to promote sizing and coating holdout. Most papermills are using it today not for its economics (which now are tracking Southern Hardwood

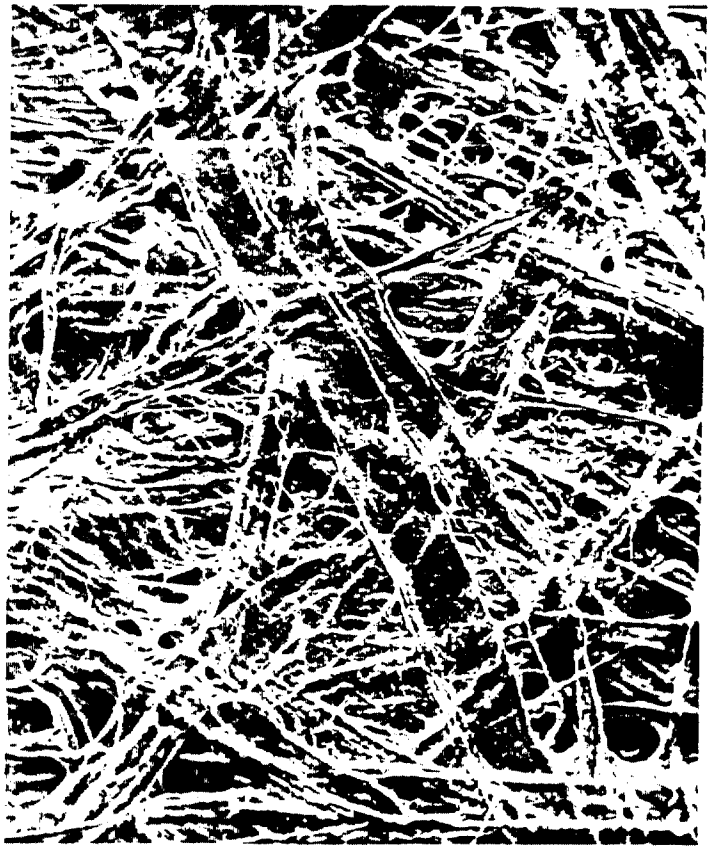
quite closely) or for its technical benefits, but rather, simply to satisfy the Government's requirement that all paper bought with taxpayer's money must contain 30% PCW recycled fiber. This bill was signed into Law by President Clinton in 1998, but has not always been closely obeyed by all Federal, State and local Governments. Today this is a greater emphasis and more companies and Government agencies are requiring their paper suppliers to use MDIP.

HARDWOOD

UNREFINED SOFTWOOD

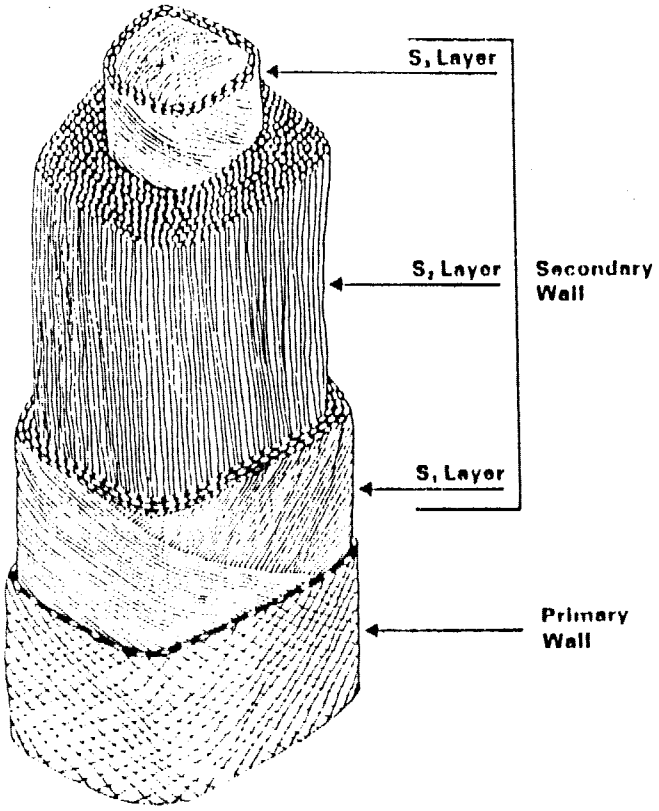
41. An Unrefined (Unbeaten) Kraft, Softwood Pulp. SEM. 110X

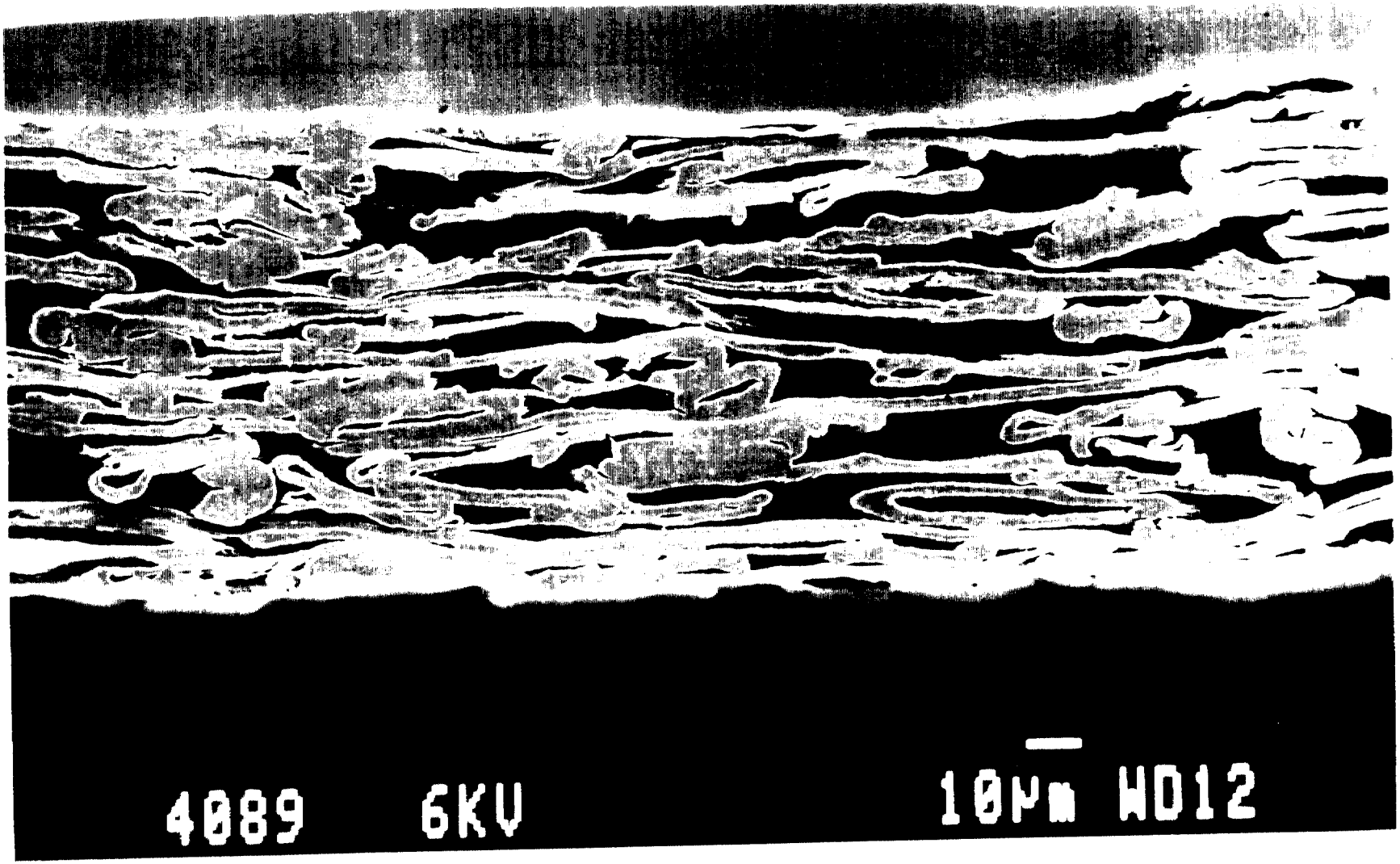
PROPERLY FIBRILLATED SOFTWOOD



42. Same Pulp as in Fig. 41 After 50 Min of Beating. SEM. 110X

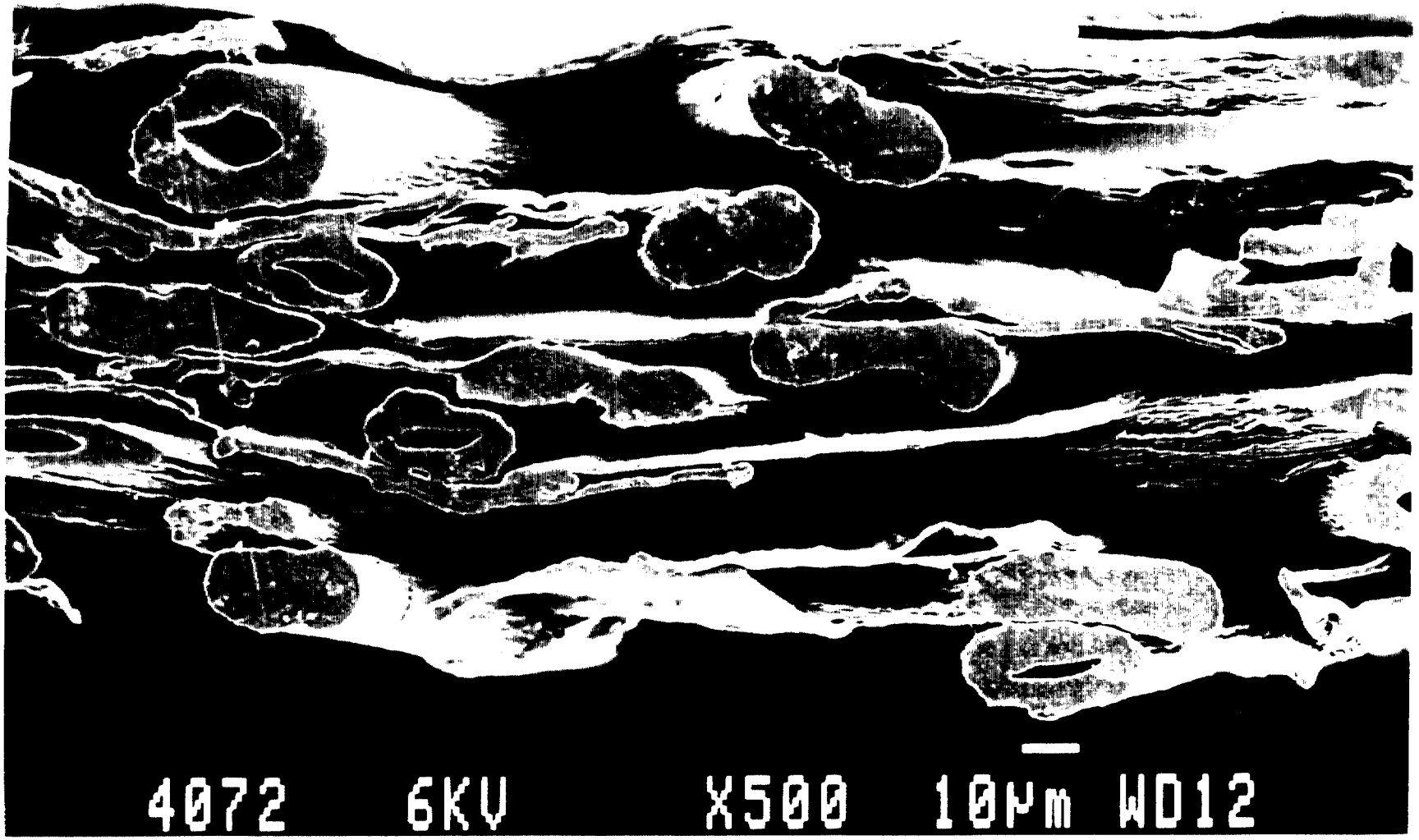
TYPICAL CELLULOSE FIBER STRUCTURE





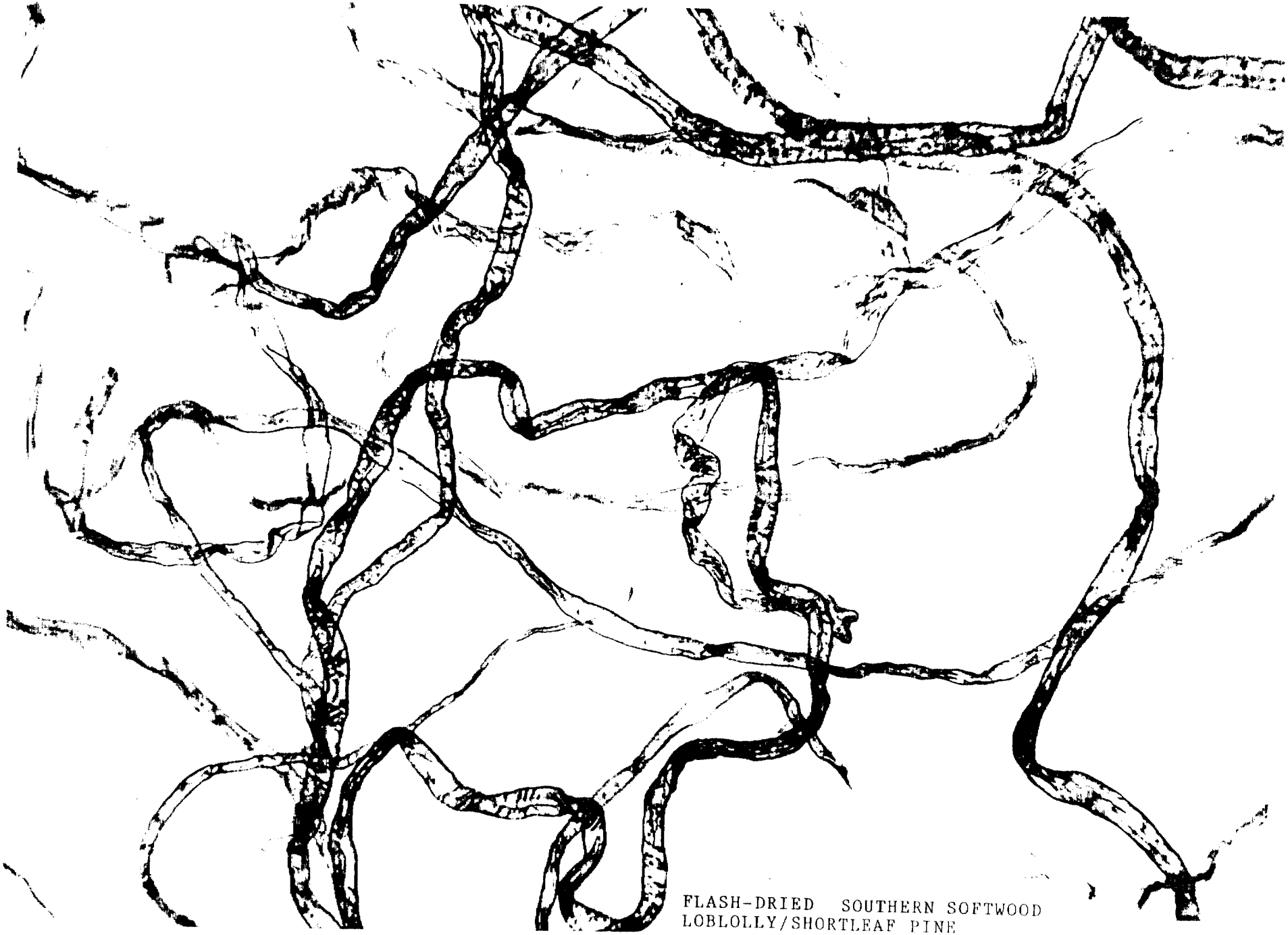
THIN WALLED FIBERS SHOWING EXTREME LUMEN COLLAPSE

WESTERN RED CEDAR

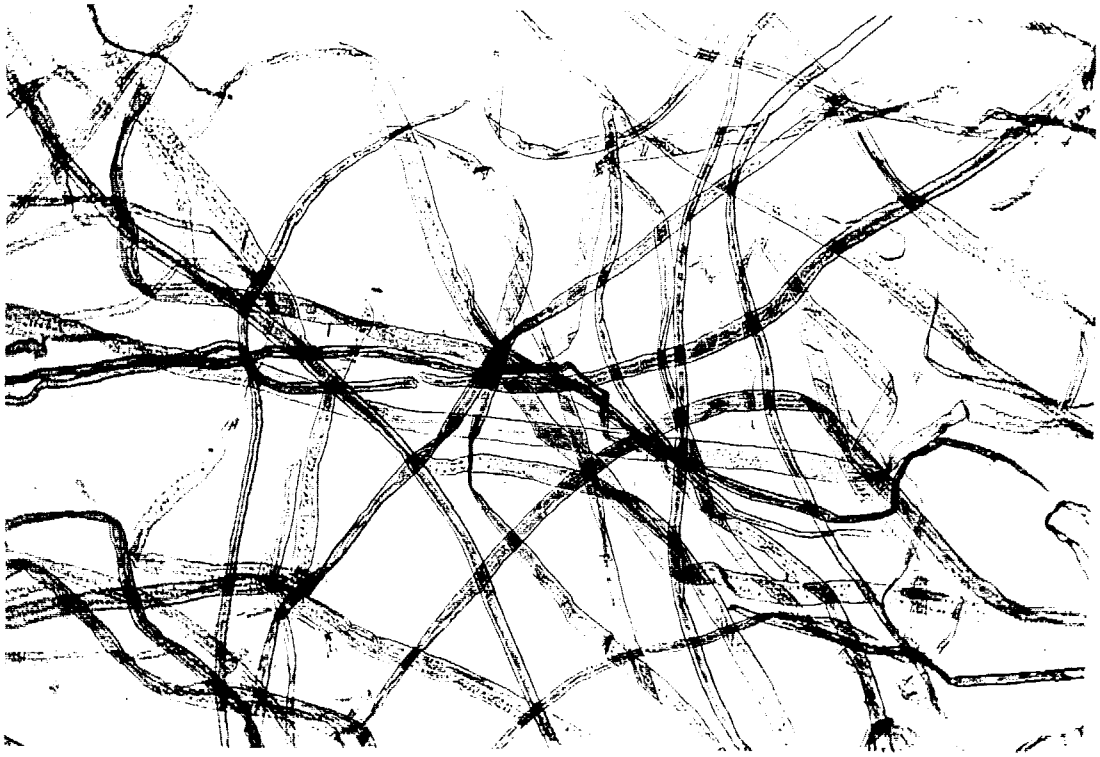


THICK WALLED FIBERS, HIGH SPECIFIC GRAVITY, SLOW RESPONSE TO REFINING

COASTAL DOUGLAS-FIR



FLASH-DRIED SOUTHERN SOFTWOOD
LOBLOLLY/SHORTLEAF PINE



1. Isolated Longitudinal Tracheids from a Coniferous wood. SOFTWOOD RIBBONS
Light micrograph. 60X

TYPICAL BEATER CURVE
SOUTHERN SOFTWOOD KRAFT