Caracterização de polpas celulósicas

Ref. básica para estudo: Capítulos 16: Ek M, Gellerstedt G, Henriksson G. *Pulping Chemistry and Technology* (Volume 2). Berlin, Walter de Gruyter, 2009

NORMAS USADAS INTERNACIONALMENTE

SCAN, Scandinavian Pulp, Paper, and Board Testing committee (Finland, Norway and Sweden)

- TAPPI, Technical Association of the Pulp and Paper Industry, USA
- CPPA-TS, Canadian Pulp and Paper Association, Technical Section
- APPITA, Australian Pulp and Paper Industry Technical Association

\- ISO, envolve normas de ampla aplicação e também são usadas na indústria de celulose e papel

Determinação do comprimento e da espessura de parede das fibras

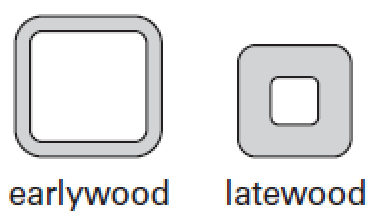
$$L = \frac{\sum_{i}^{n} L_i}{n}$$

Comprimento médio, baseado no número total de fibras medidas: pouco útil, pois pondera igualmente fibras longas e curtas

$$\text{Length weighted length } L_l = \frac{\sum_i^n L_i^2}{\sum_i^n L_i}$$

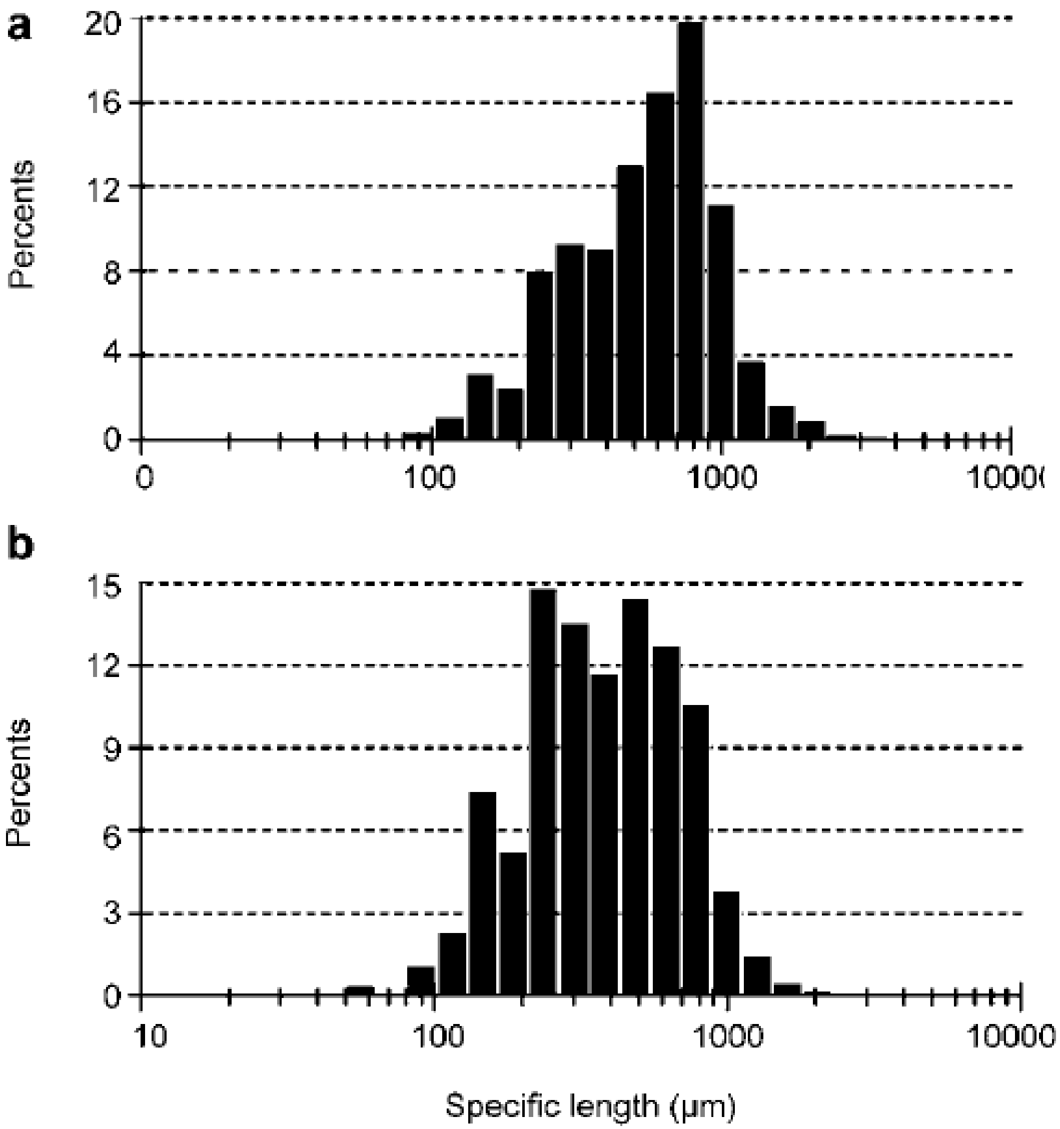
Comprimento médio, ponderado no comprimento: mais utilizado, pois no valor ponderado obtido, as fibras mais longas apresentam maior importância

Espessura da parede celular



Mais flexíveis e colapsam mais facilmente

Distribuição do tamanho das fibras



623 μm (ponderado em **N**)
980 μm (ponderado em **L**)

$$L = \frac{\sum_{i}^{n} L_i}{n}$$

Length weighted length $L_l = \dfrac{\sum_i^n L_i^2}{\sum_i^n L_i}$

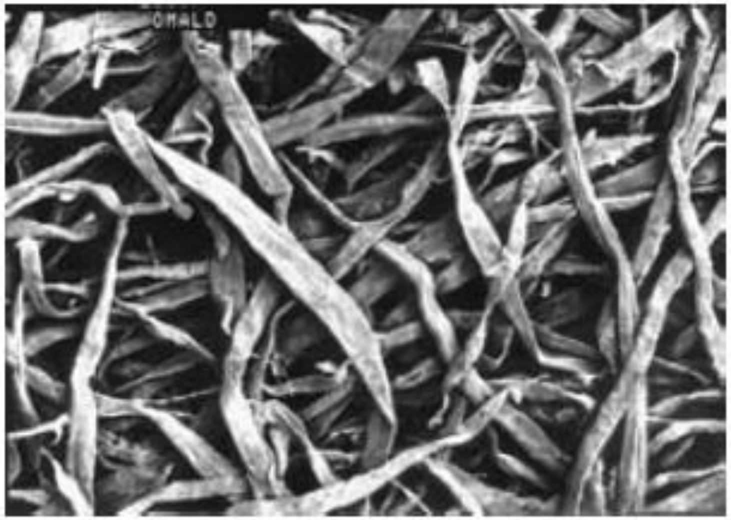
404 μm (ponderado em **N**)
560 μm (ponderado em **L**)

Refino da polpa e evolução das propriedades mecâncias do papel

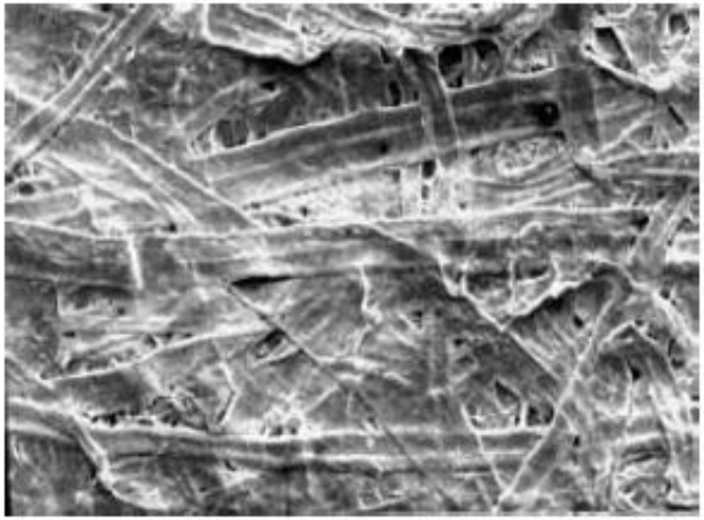
Durante o refino:

- fibras colapsam
- sofrem fibrilação da superfície
- podem gerar fragmentos (finos)

O efeito principal é melhorar a conformação do papel formado, aumentando a resistência aos esforços mecânicos

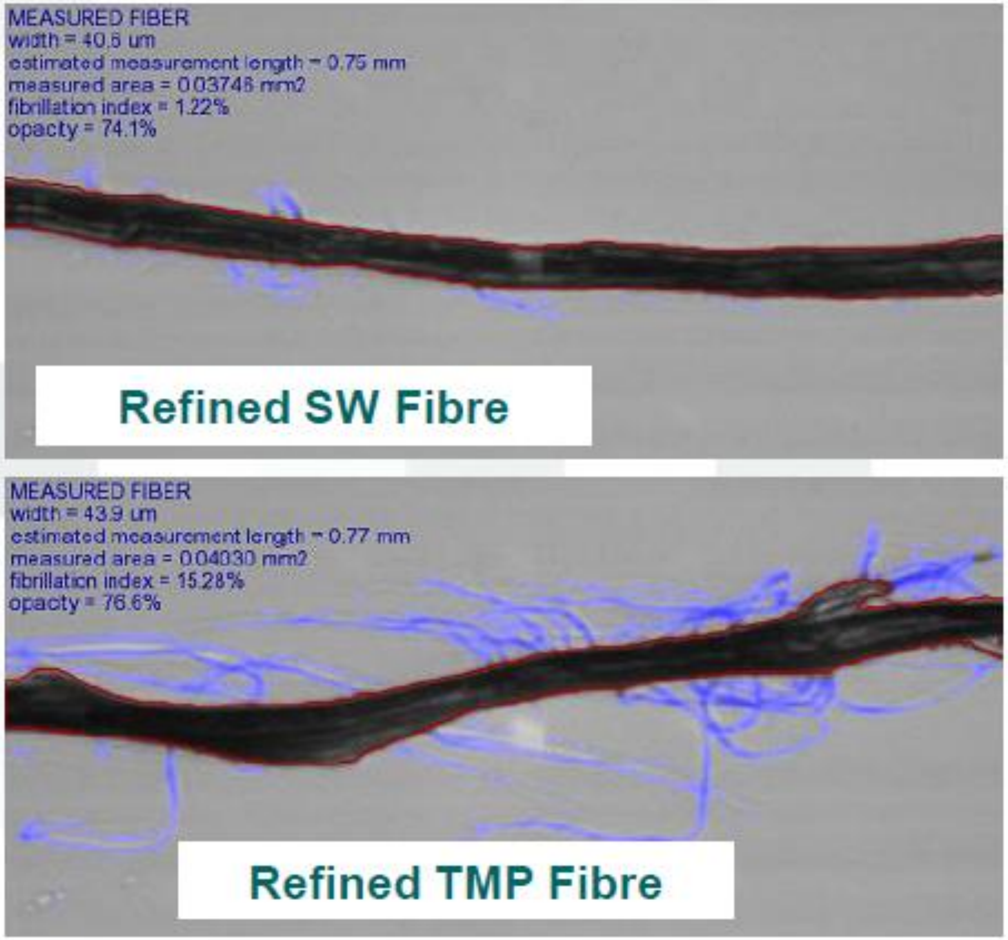


Antes do refino

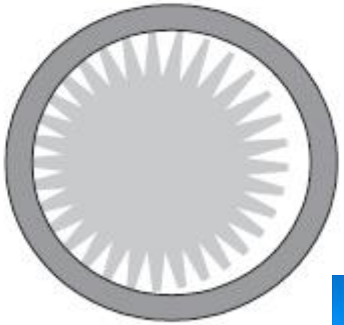


Após o refino

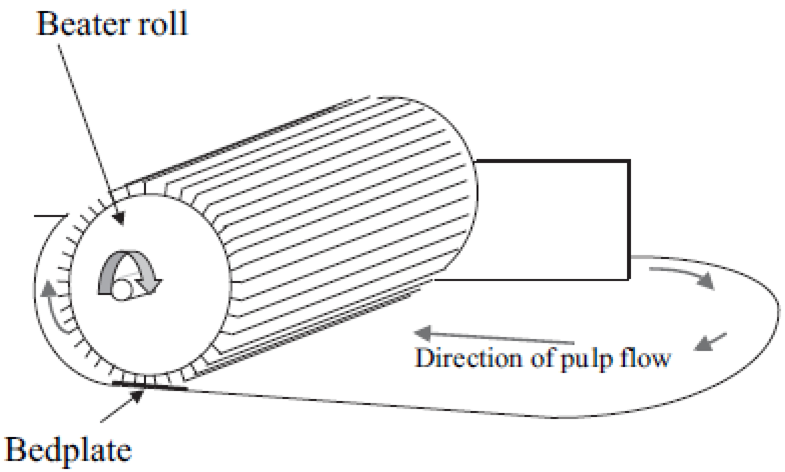
Fibrilação das superfícies externas em função da ação de refino



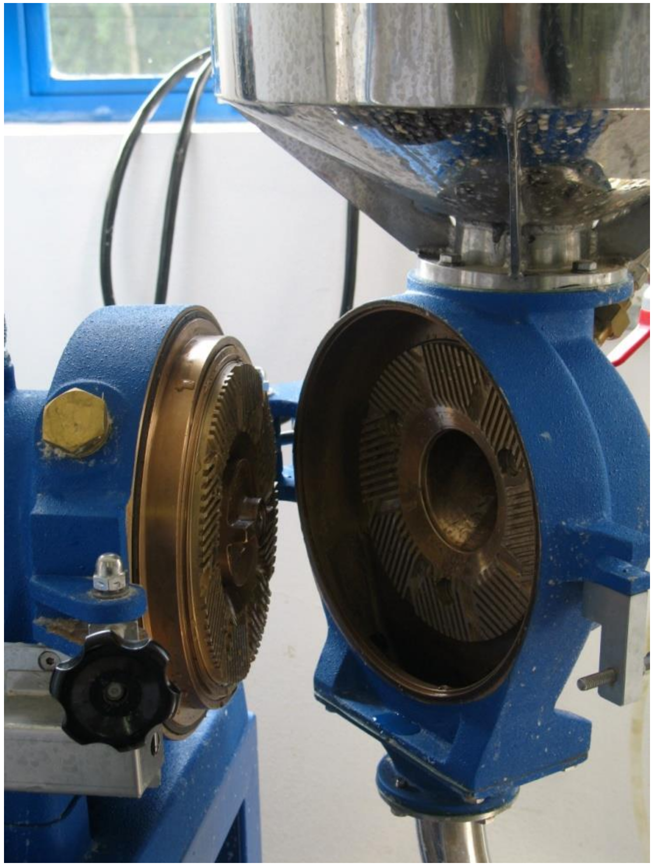
Tipos de refinadores de laboratório



PFI: o mais usado nas normas que envolvem o processamento de polpas químicas



Holandesa



Refinador de discos

Refinadores industriais

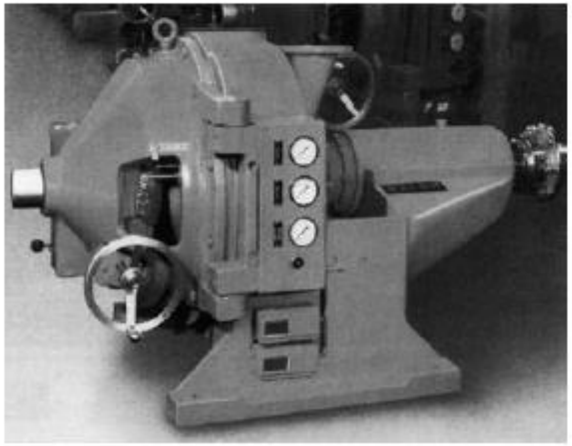


Figure 7.7. Picture of a Beloit double disc refiner. Courtesy of Metso Paper.

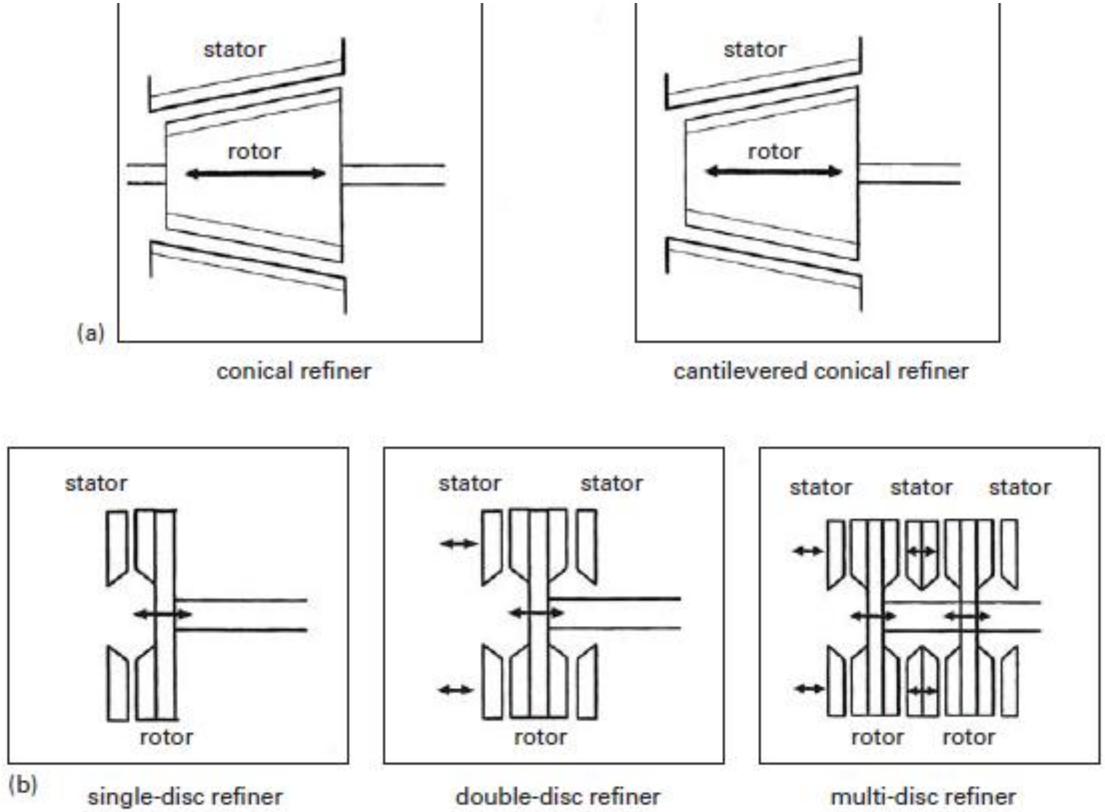
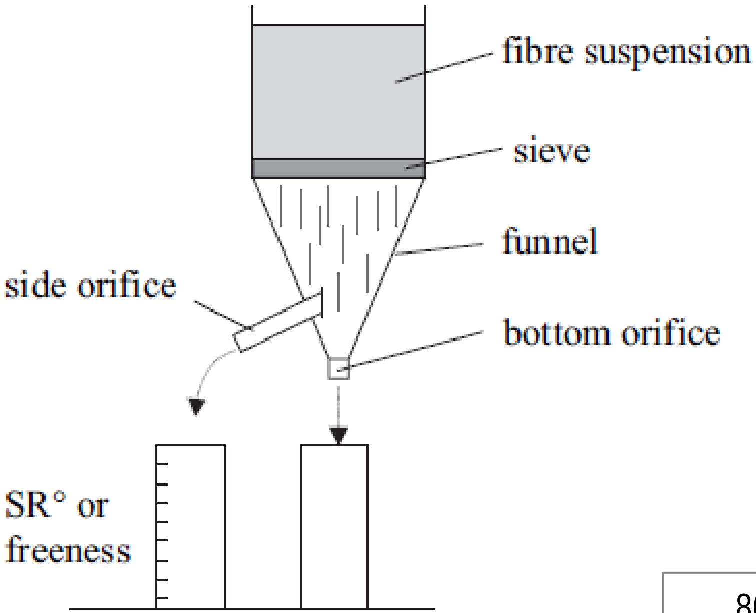
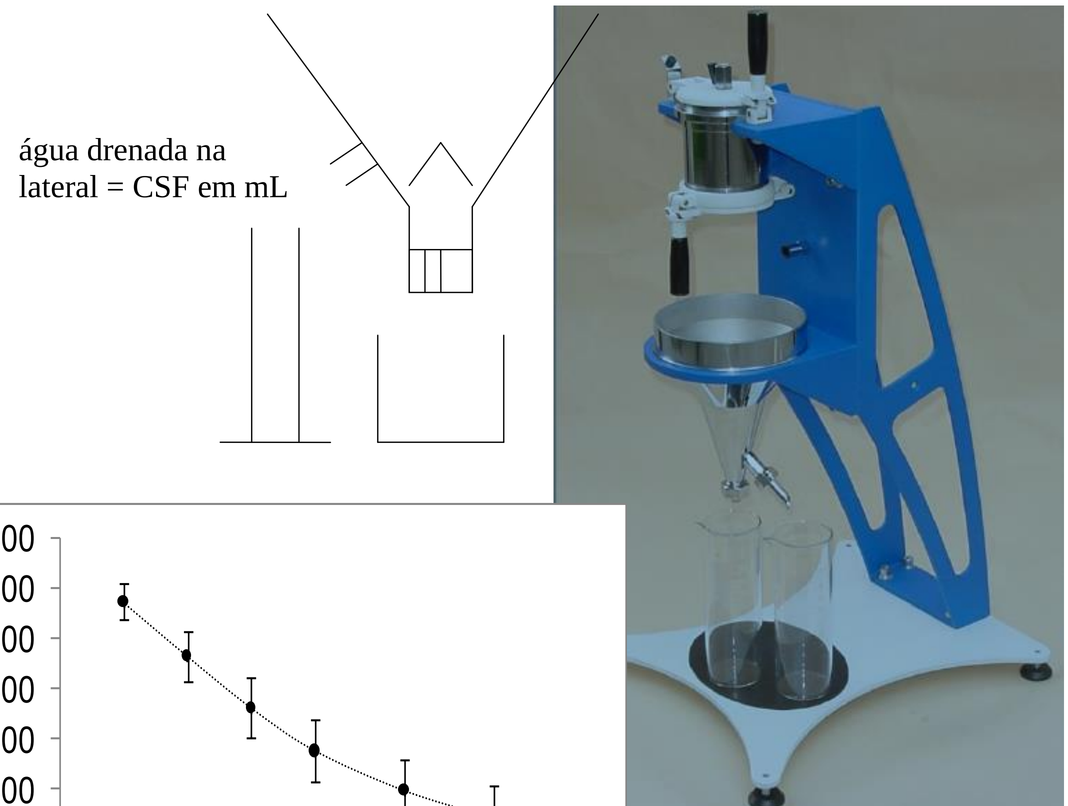


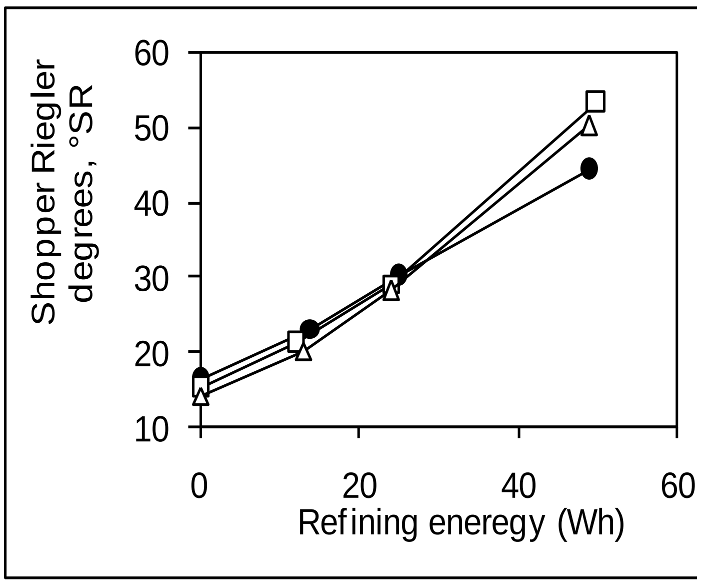
Figure 7.5. Schematic description of conical and disc type refiners. Courtesy of Metso Paper.

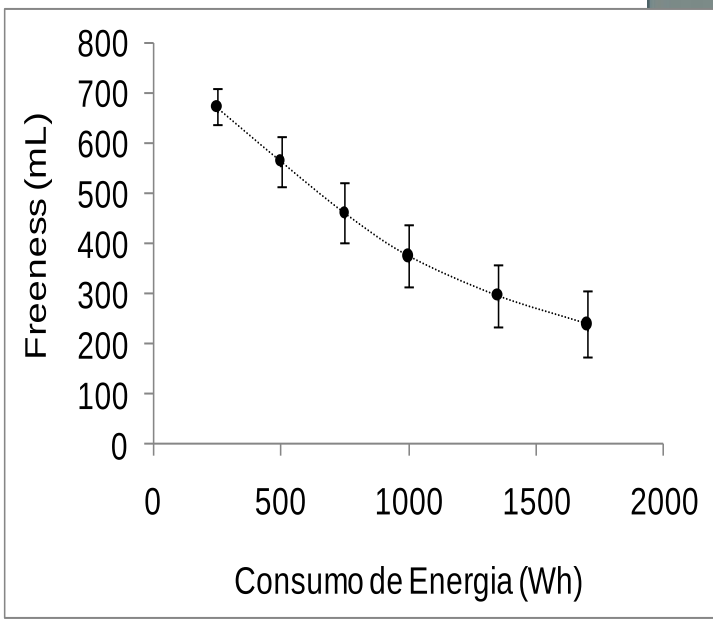
Figure 7.6. Picture of a Metso cantilevered conical refiner. Courtesy of Metso Paper.

Drenabilidade das polpas – ferramenta de controle do grau de refino

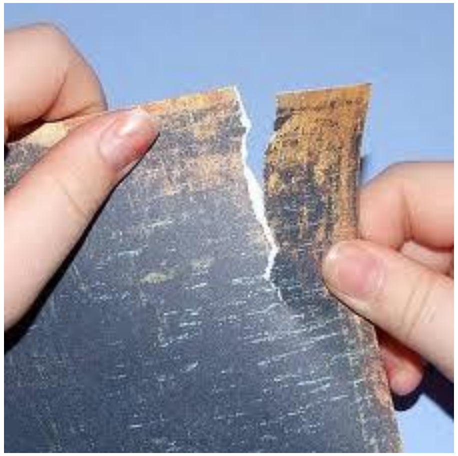




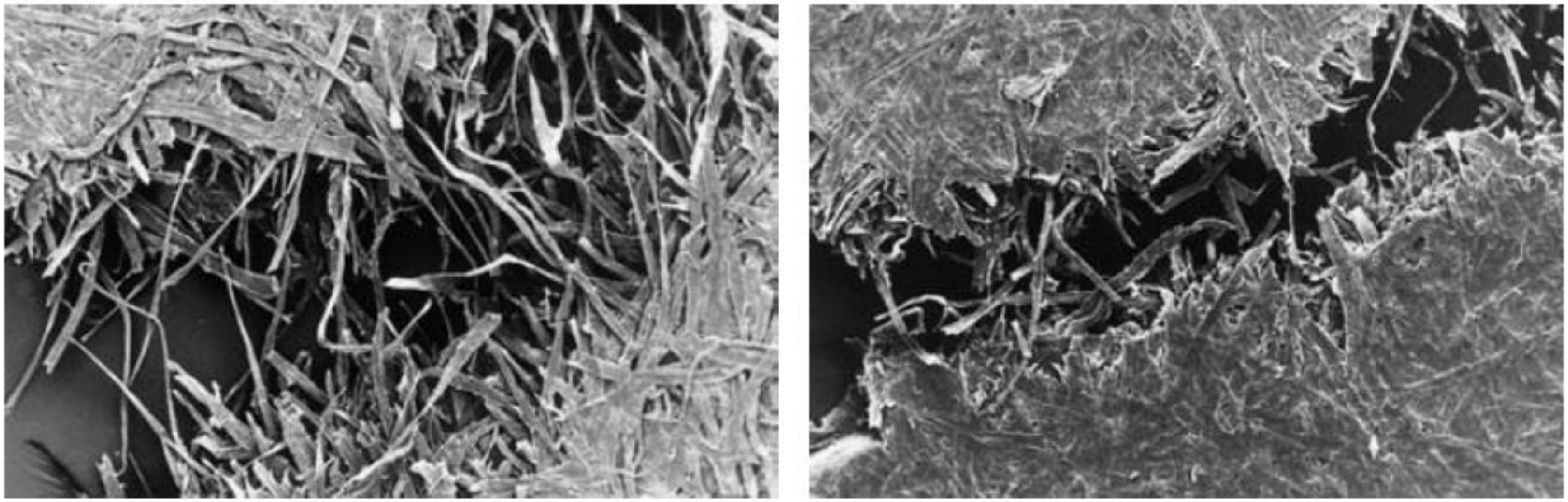




Resistência à tração e ao rasgo versus grau de refino



Resistência à tração



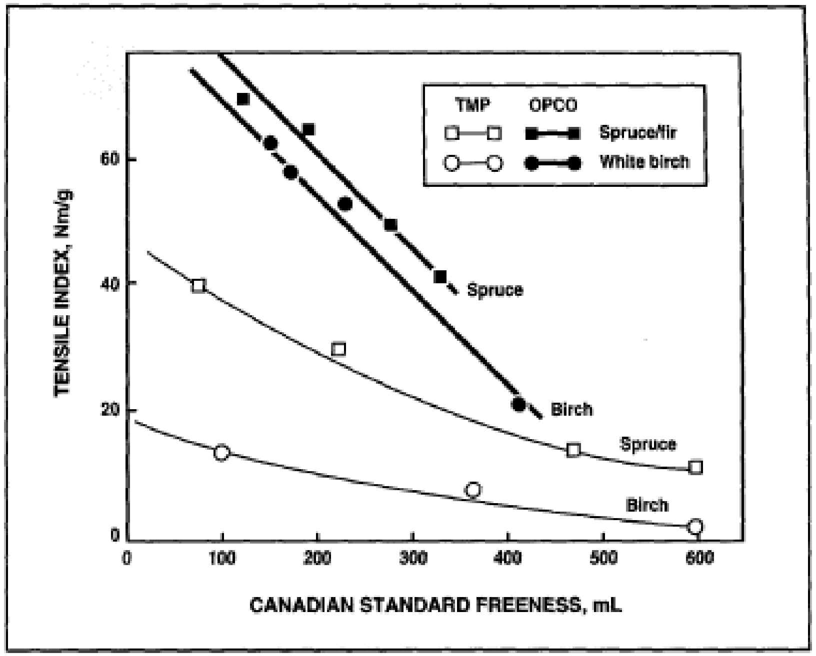
a) low degree of bonding

b) high degree of bonding

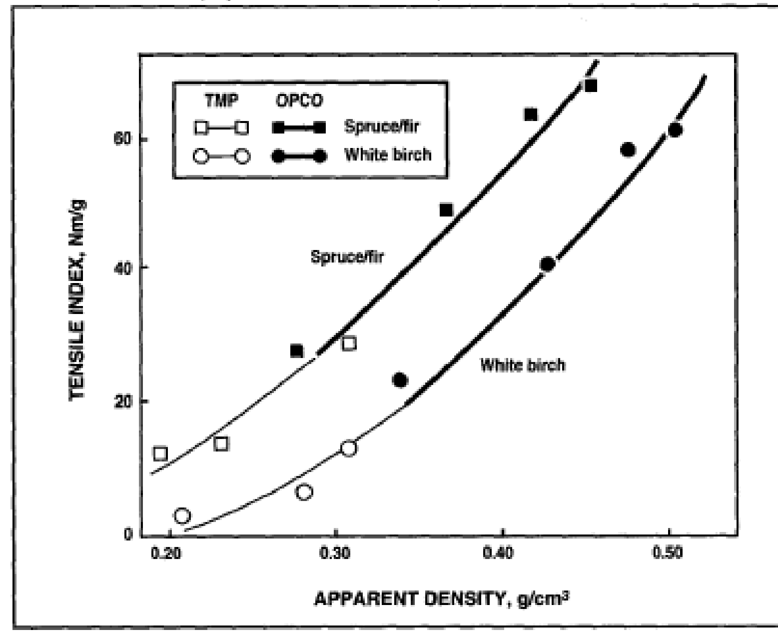
Figure 2.11. The tensile failure in paper is characterized by elongated and broken fibres.

Resistência mecânica versus CSF

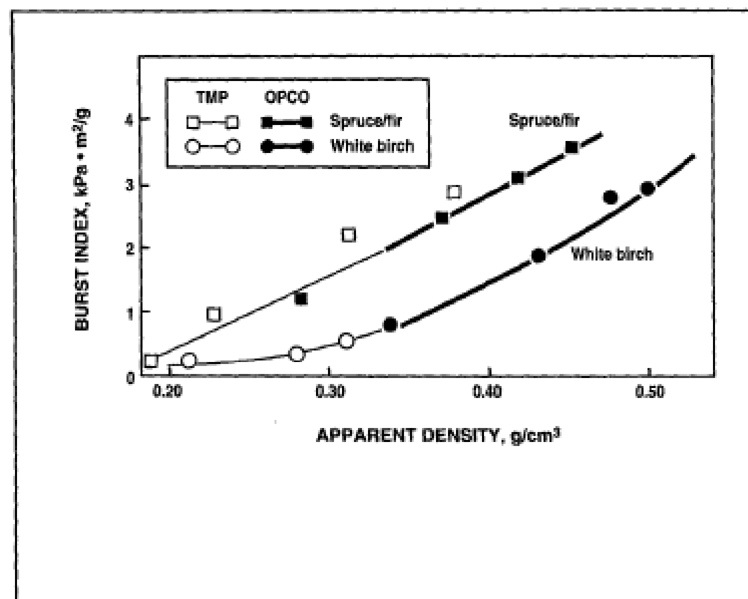
1. Tensile index as a function of CSF for TMP and OPCO pulps of white birch and a spruce/balsam-fir furnish



2. The effect of apparent sheet density on the tensile indices of laboratory handsheets made from TMP and OPCO pulps of white birch and a spruce/fir furnish



3. Burst index vs. apparent sheet density for the same pulps



Resistência mecânica versus ºSR
Comparativo entre fibras curtas e fibras longas

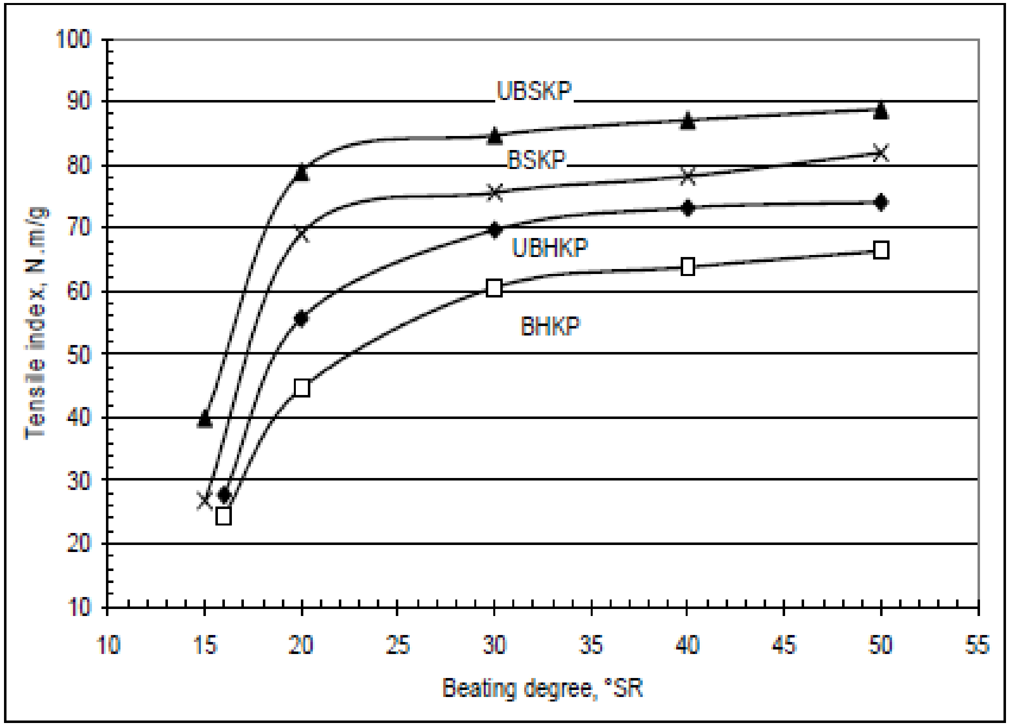
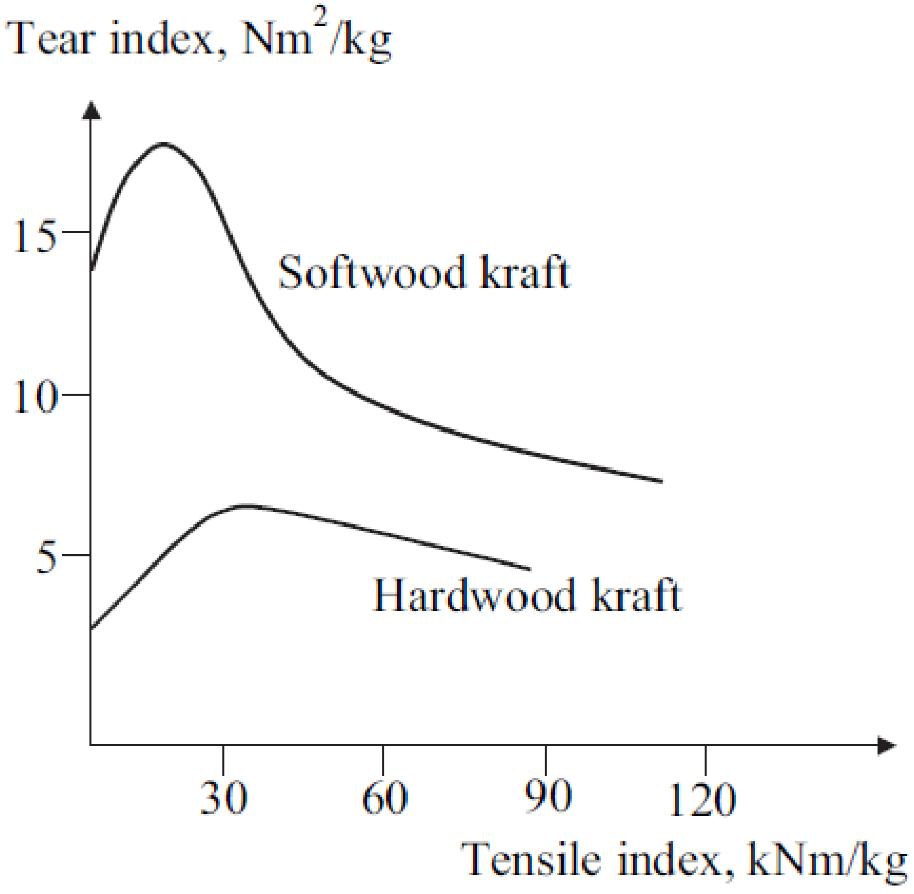


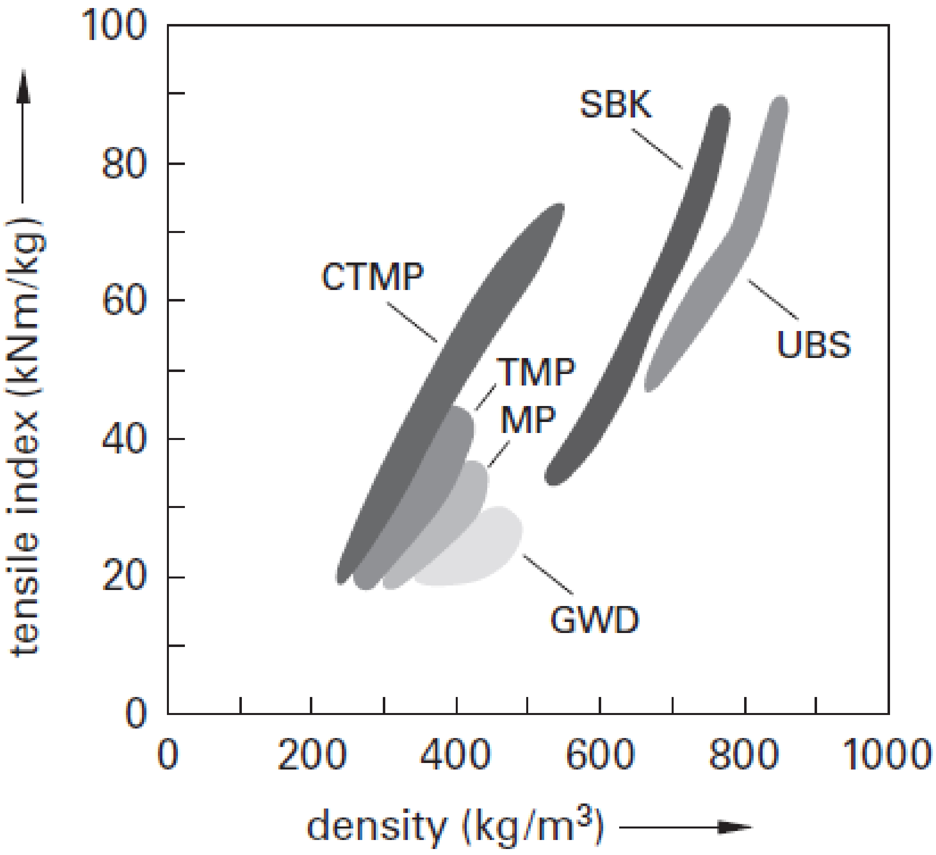
Figure 4: Dependence of tensile index of unbleached and bleached hardwood and softwood kraft pulps on beating degree

Relação tração x rasgo

>> define a aplicação da polpa para a fabricação de muitos tipos de papel



Comparativo de propriedades de fibras de processos comerciais



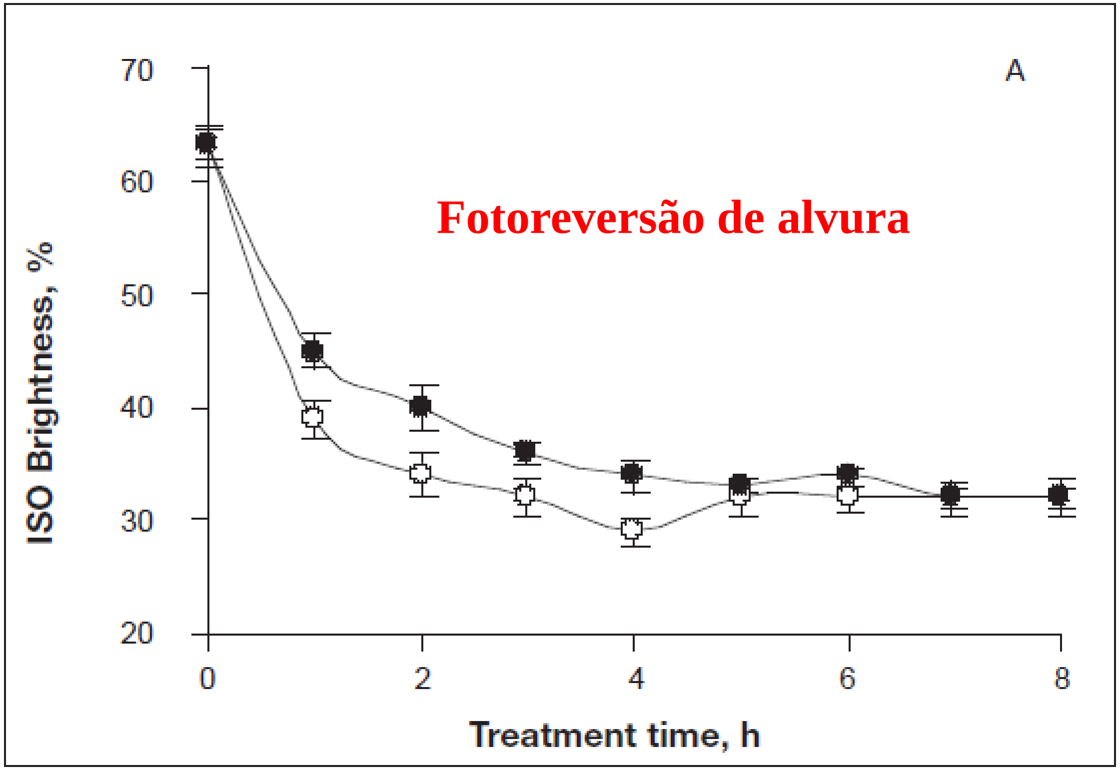
TMP = thermomechanical pulp
RMP = refiner pulp
CTMP = chemimechanical pulp
UBS = unbleached kraft pulp
GWD = groundwood pulp
SBK = semi-bleached kraft pulp

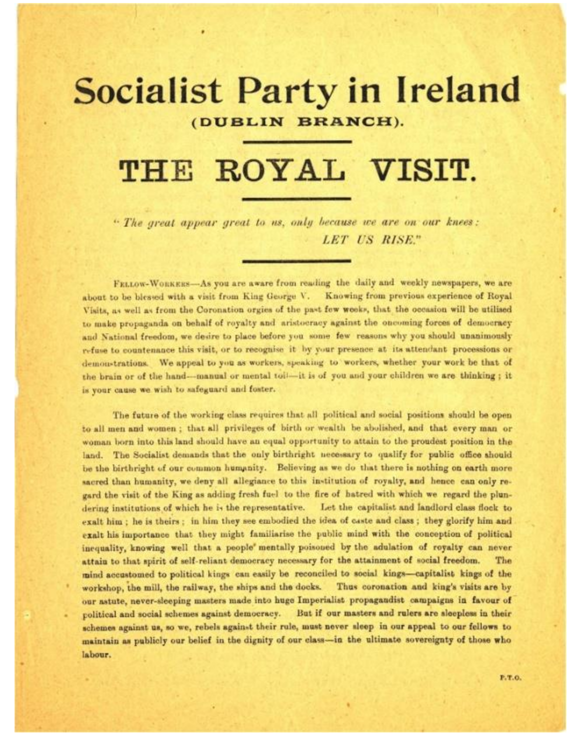
Comparativo de propriedades de fibras de processos comerciais

Table 16.4. Summary of the main characteristics of chemical and mechanical pulp.

	Chemical pulp	**Mechanical pulp**
Pulp yield, %	40–55 %	90–95 %
Lignin content in pulp	0–3 %	20–28 %
Fibre character	Long, strong, collapsed, flexible	Short, weak, uncollapsed, stiff
Sheet density	High	Low
Porosity	Low	High
Fines content in pulp	5–15 %	20–30 %
Pulp strength	High	Low
Light scattering ability	Low	High
Yellowing and ageing	(May be) low	High

Escurecimento de papéis, um grande problema iniciado pela ação da luz





Socialist Party in Ireland

(DUBLIN BRANCH).

THE ROYAL VISIT.

"The great appear great to us, only because we are on our knees:
LET US RISE."

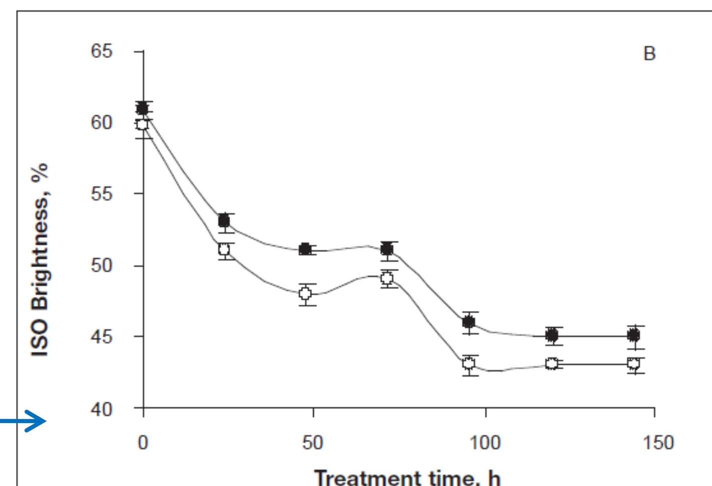
FELLOW-WORKERS—As you are aware from reading the daily and weekly newspapers, we are about to be blessed with a visit from King George V. Knowing from previous experience of Royal Visits, as well as from the Coronation orgies of the past few weeks, that the occasion will be utilised to make propaganda on behalf of royalty and aristocracy against the oncoming forces of democracy and National freedom, we desire to place before you some few reasons why you should unanimously refuse to countenance this visit, or to recognise it by your presence at its attendant processions or demonstrations. We appeal to you as workers, speaking to workers, whether your work be that of the brain or of the hand—manual or mental toil—it is of you and your children we are thinking; it is your cause we wish to safeguard and foster.

The future of the working class requires that all political and social positions should be open to all men and women; that all privileges of birth or wealth be abolished, and that every man or woman born into this land should have an equal opportunity to attain to the proudest position in the land. The Socialist demands that the only birthright necessary to qualify for public office should be the birthright of our common humanity. Believing as we do that there is nothing on earth more sacred than humanity, we deny all allegiance to this institution of royalty, and hence can only regard the visit of the King as adding fresh fuel to the fire of hatred with which we regard the plundering institutions of which he is the representative. Let the capitalist and landlord class flock to exalt him; he is theirs; in him they see embodied the idea of caste and class; they glorify him and exalt his importance that they might familiarise the public mind with the conception of political inequality, knowing well that a people mentally poisoned by the adulation of royalty can never attain to that spirit of self-reliant democracy necessary for the attainment of social freedom. The mind accustomed to political kings can easily be reconciled to social kings—capitalist kings of the workshop, the mill, the railway, the ships and the docks. Thus coronation and king's visits are by our astute, never-sleeping masters made into huge Imperialist propagandist campaigns in favour of political and social schemes against democracy. But if our masters and rulers are sleepless in their schemes against us, so we, rebels against their rule, must never sleep in our appeal to our fellows to maintain as publicly our belief in the dignity of our class—in the ultimate sovereignty of those who labour.

P.T.O.

Exposição à uma lâmpada de 250-W (Mercurio – sem o bulbo de vidro). Distância de 10 cm entre papel e fonte

Termoreversão (110 ºC) de alvura também é comum, mas mais lenta →



Escurecimento de papéis

- A porção do espectro eletromagnético que afeta significativamente os lignocelulósicos está compreendida na região do UV/VISÍVEL

Relação entre energia e freqüência de uma radiação eletromagnética

$$E = h\nu \; ; \; \nu = c / \lambda \; ; \; E = hc / \lambda$$

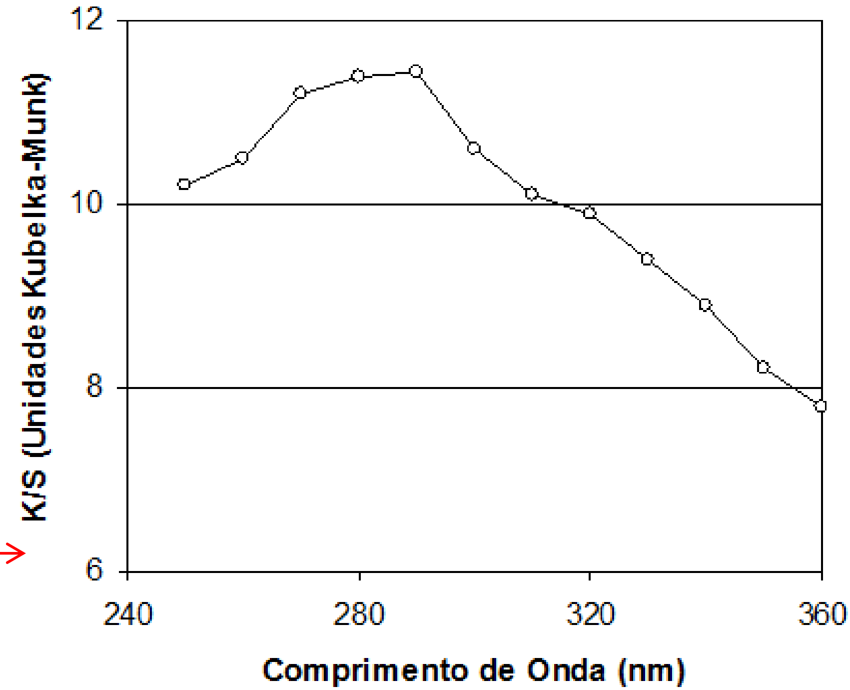
- A radiação infra-vermelho também pode afetar os lignocelulósicos.

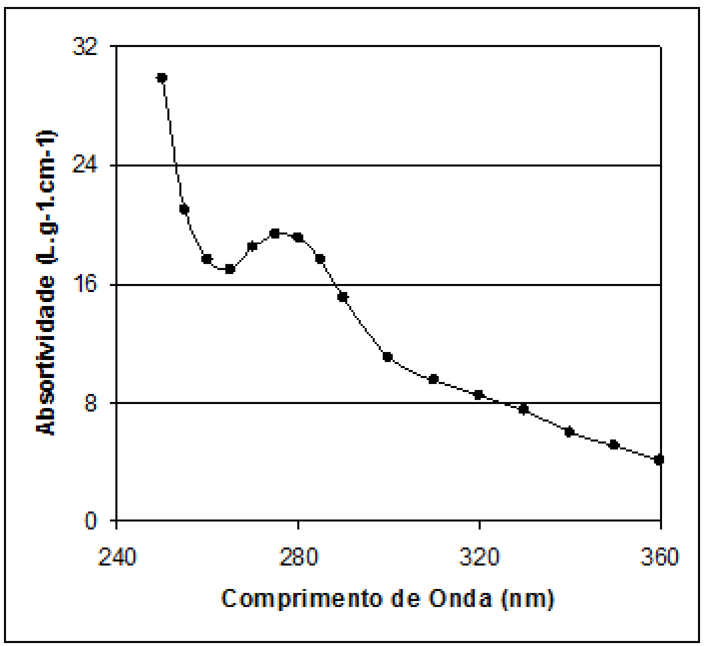
Penetração das radiações nos materiais lignocelulósicos

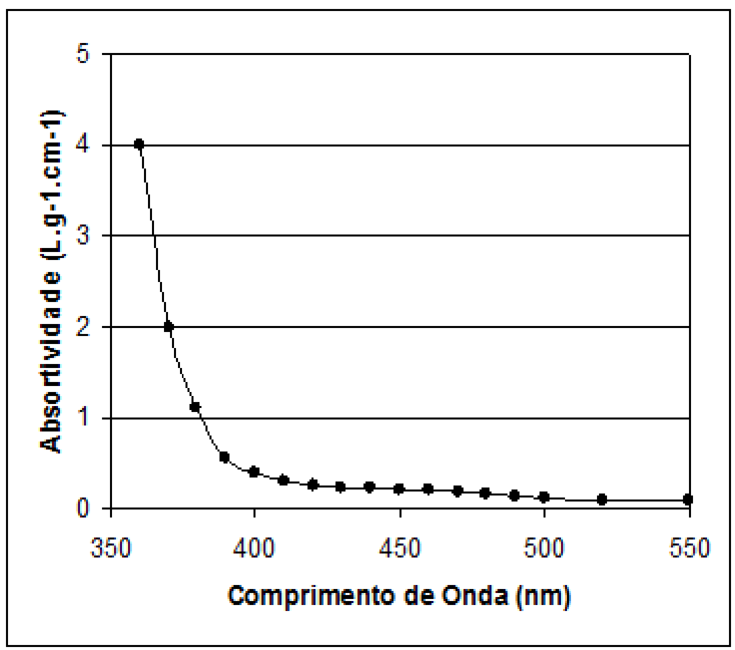
Ultra-violeta: inferior a 75 μm
Luz Visível: até 200 μm
Infravermelho: até 1,5 mm

-A absorção de luz por um lignocelulósico é primariamente determinada pela quantidade de lignina.

Espectro UV de reflexão de uma placa de madeira (*Pinus radiata*)

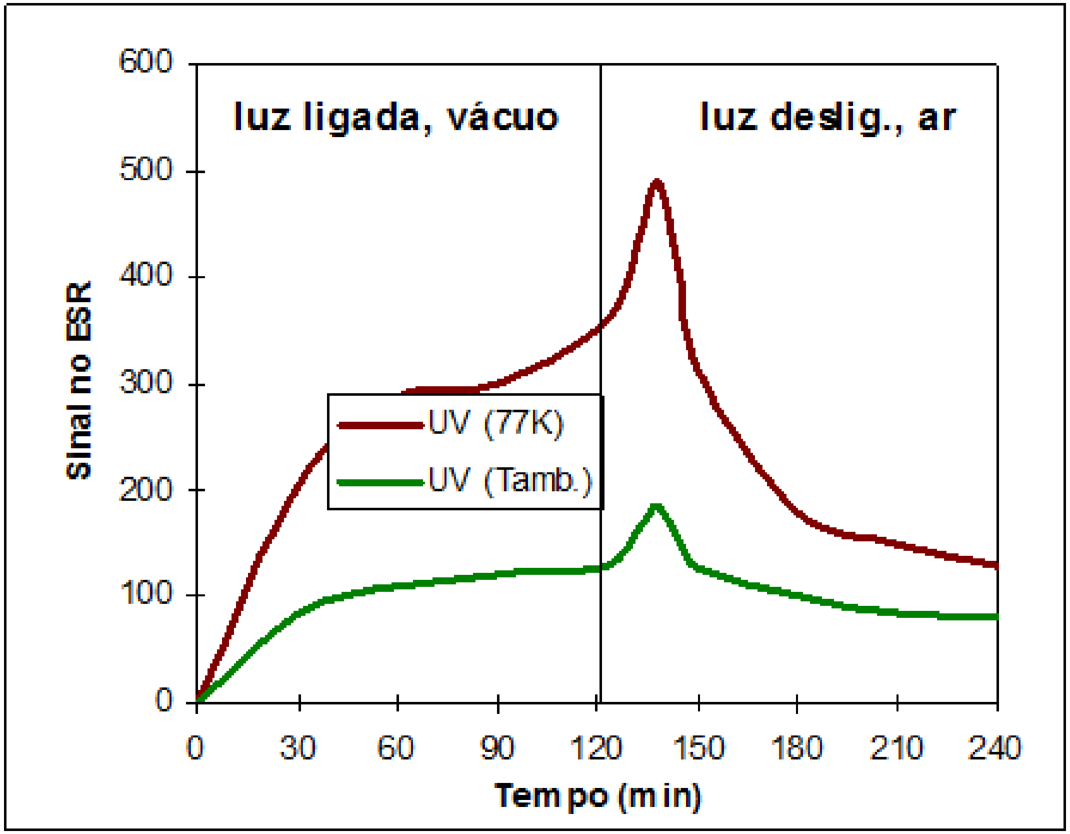






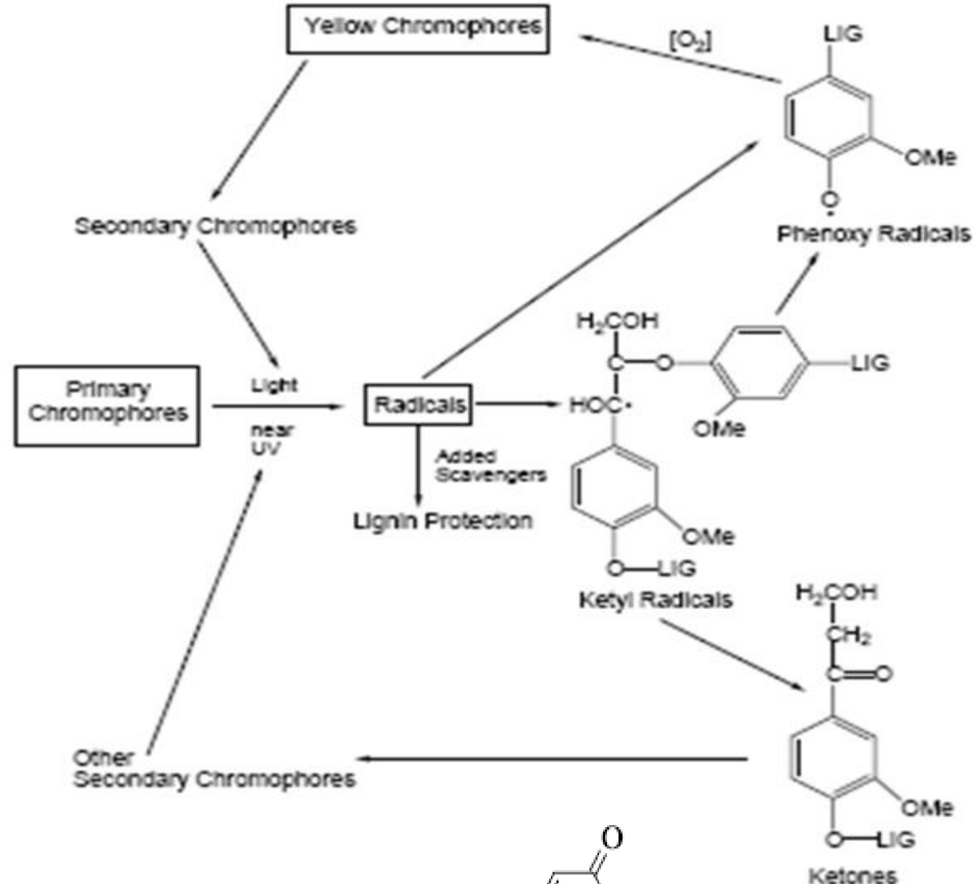
Espectros UV/visível lignina (MWL) de *Pinus radiata*

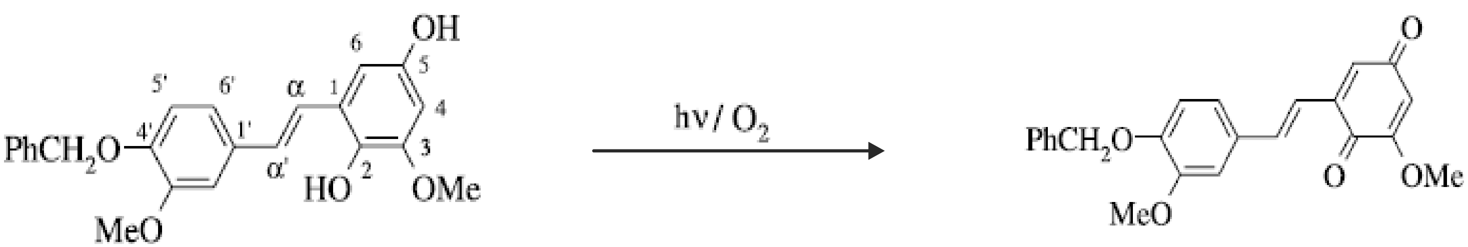
- Está demonstrado que a degradação dos lignocelulósicos por radiação UV/Visível é iniciada pela formação de radicais livres.



Sinal de ESR durante a irradiação de *Pinus taeda* na presença e ausência de oxigênio

Algumas subestruturas do lignocelulósico (principalmente da lignina) absorvem luz e reagem formando outros compostos que absorvem luz na região do visível.





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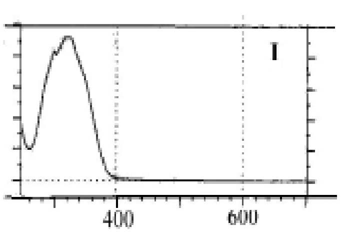
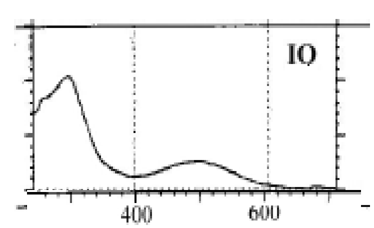
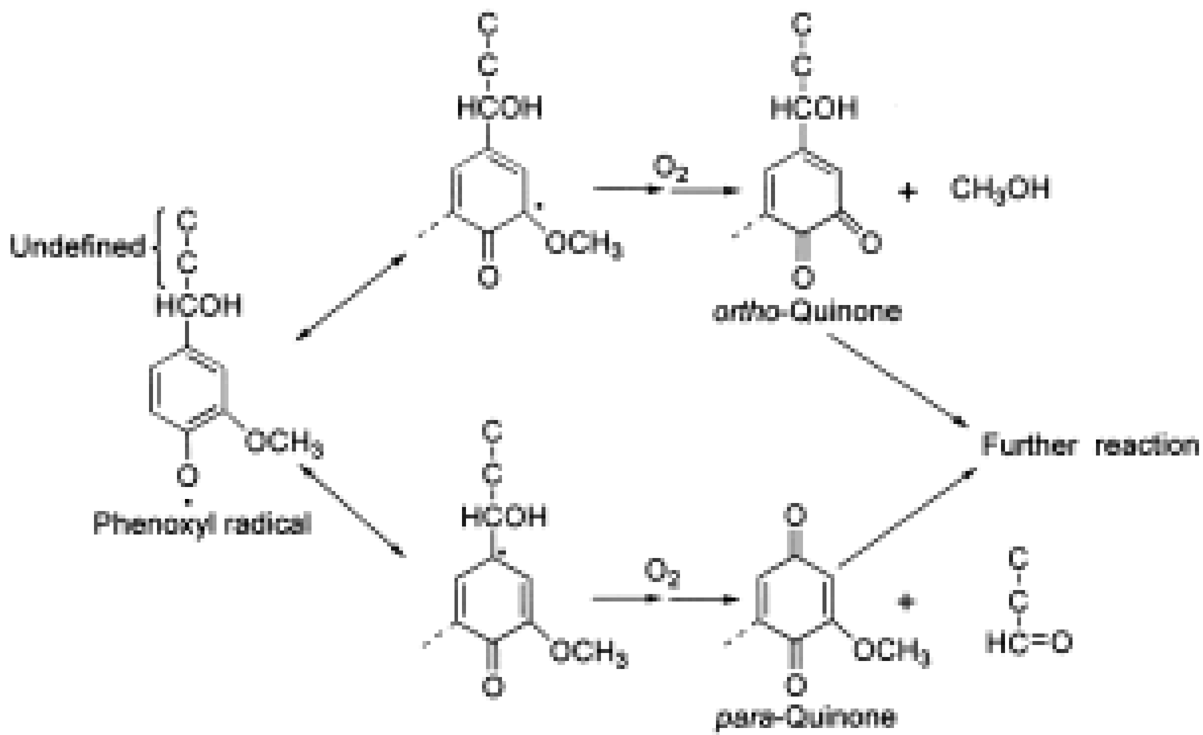




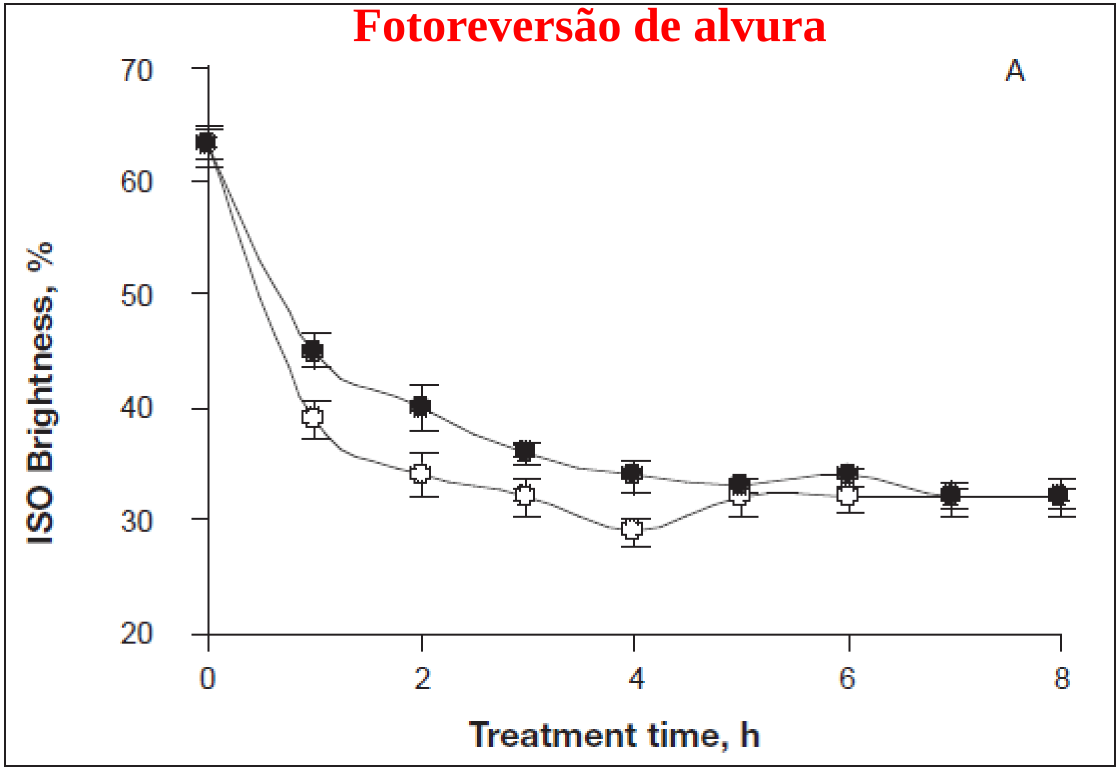
B Ruffin e A Castellan. Can. J. Chem. 78: 73–83 (2000)

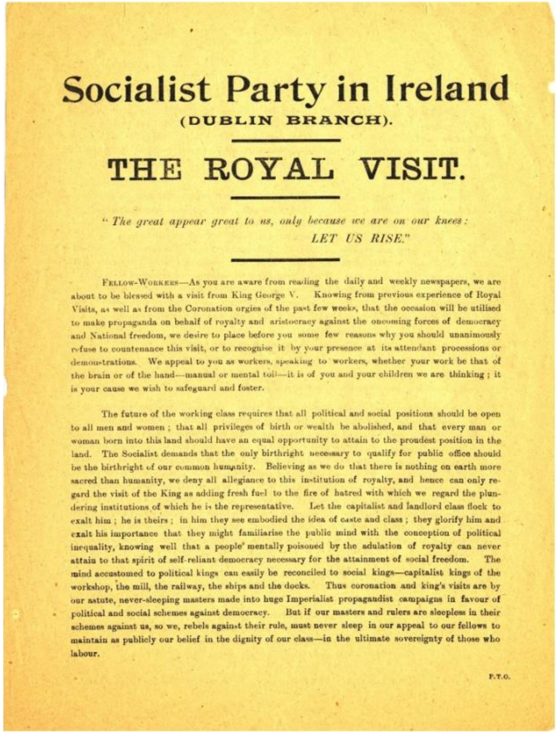
Formação de cromóforos a partir de uma fenoxila



Escurecimento de papéis

Única solução eficiente >> Remover toda a lignina no processo de branqueamento





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Exposição à uma lâmpada de 250-W (Mercurio – sem o bulbo de vidro). Distância de 10 cm entre papel e fonte

Da fibra ao papel

Tissue paper: papéis higiênicos, toalhas de papel, lenços de papel e correlatos – gramatura típica 15-25 g/m2 (2 a 4 folhas)

Fibras usadas: TMP, papel reciclado, kraft branqueada

Table 16.5. Properties of Tissue.

Important property	Why it is important
Softness	For the end-use the paper should be velvet-like and easily yield when crumbled
Smoothness	A rough surface, with fibres sticking up giving the surface an uneven appearance would feel rough against the human skin. Smoothness, the inverse of roughness, is therefore important.
Ability to absorb water	The most common use of tissue paper is for wiping up liquid media of some sort, usually water, and the ability to absorb relatively large volumes is probably the most important property. Oil, grease etc are also commonly wiped by tissue.
Wet strength	The tensile strength of wet tissue paper is important since in its end-use tissue will always be wetted. The tissue has to have sufficient wet strength not to fall apart at once when getting moist or soaked.
Dry strength	In the converting process, a certain dry strength is necessary.

Da fibra ao papel

Papel de impressão para jornais e revistas

– gramatura típica 40-45 g/m2

Fibras usadas: TMP, papel reciclado, raramente se emprega kraft branqueada como reforço

Table 16.6. Properties of Printing paper.

Important property	Why it is important
Surface strength	Low surface strength will result in fibres torn off the web surface. This may lead to dusting, if the fibres are ripped off the web and end up in the air. Linting can occur if the fibres ripped off will stick to the printing press surface. Linting will reduce the runnability of the printing machine as it would have to be shut down and cleaned.
Fracture strength	Fracture strength is another property important for the runnability of the printing press. It gives the ability of the paper web to resist against fracture from a crack in the web. Low fracture strength can result in web breakage.
Opacity	It is not desirable to read the printing on the opposite side of the paper. Opacity is a measure of „the see-throughness" of a paper. High opacity means the print on the opposite side is well hidden.
Smoothness	A smooth surface is a prerequisite of good printing. A rough surface has fibres sticking up from the surface and may both lead to linting and dusting, as discussed earlier, and to uneven print quality.

Da fibra ao papel

Papéis finos ou de reprografia: tipicamente A4 para cópias e impressoras – gramatura 50-100 g/m2

Fibras usadas: kraft branqueada de coníferas ou folhosas e aditivos (fillers)

Table 16.7. Properties of Fine paper.

Important property	Why it is important
Surface strength	Low surface strength will result in fibres torn off the web surface. The fibres ripped off will stick to surfaces within the copying machine, causing machine failure.
Dimensional stability	For example, when toner is applied onto the paper in a copying machine the paper should not curl.
Bending stiffness	The paper has to stay flat when held, not be like a piece of cloth, velvet-like and bendingn.
Smoothness	A smooth surface is a prerequisite of good printing. A rough surface has fibres sticking up from the surface and may lead to uneven print quality.

Da fibra ao papel

Papéis de embalagem e cartões: sacos de papel, revestimentos de caixas de papelão

Fibras usadas para embalagem (sackpaper): kraft não branqueada com kappas entre 35-55; gramatura típica 60 – 150 g/m2

Table 16.8. Properties of Sackpaper.

Important property	Why it is important
Toughness	Sackpaper needs to endure applied forces of large magnitude by having a good stretching ability. Curled fibres with microcompressions are more stretchable
Porosity	Good porosity is important so air can escape from within the sack as it is filled.

Fibras usadas para papéis de revestimento de caixas (kraft liner): kraft não branqueada com kappas entre 80-110; – gramatura típica 100-400 g/m2

Table 16.9. Properties of Kraftliner.

Important property	**Why it is important**
Toughness	Tough paper with good resistance against fractures is important for papers used for packages.
Compression strength	Boxes and cartons made of kraft liner are often piled on each other and thereby experience compressional forces.
Bending stiffness	The packages made from linerboard need to be rigid and not crumble when stresses are applied.

Fibras usadas para cartões (paperborad): kraft não branqueada, polpa mecânica, fibras recicladas, raramente kraft branqueada – 3 a 5 camadas e gramatura final de 250 g/m2 ou maior

Table 16.10. Properties of Paperboard.

Important property	Why it is important
Bending stiffness	Packages need to be rigid and not crumble when stresses are applied.
Compression strength	Boxes and cartons are often piled on each other and thereby experience compressional forces.
Smoothness	A smooth surface is a prerequisite of good printing. The top layers of paper-board boxes are often used to print messages of the box contents etc.