Effect of eucalyptus wood chips pretreatment with sodium xylenesulphonate (SXS) in the kraft cellulosic pulp quality

Efeito do pré-tratamento dos cavacos da madeira de eucalipto com xilenosulfonato de sódio (SXS) na qualidade da polpa celulósica kraft

Magnos Alan Vivian¹ and Francides Gomes da Siva Júnior²

Resumo

O presente estudo teve por objetivo avaliar o efeito da aplicação do xilenosulfonato de sódio (SXS) como pré-tratamento em cavacos da madeira de *Eucalyptus grandis* x *Eucalyptus urophylla* na qualidade da polpa celulósica kraft. Primeiramente procedeu-se a caracterização química da madeira, na sequência os cavacos foram submetidos ao pré-tratamento nas condições: 12 horas, concentração de 30 % de SXS e temperatura de 130 °C. Após o pré-tratamento determinaram-se os parâmetros de rendimento e teor de lignina remanescente nos cavacos. Os cavacos pré-tratados e normais (testemunha) foram submetidos ao processo de polpação kraft para obtenção de polpa com número kappa $15 \pm 0,5$; para análise do efeito do pré-tratamento na qualidade da celulose. A partir dos resultados obtidos foi possível observar que o pré-tratamento com SXS possibilitou a extração de 39,12 % da lignina dos cavacos, em comparação com a madeira normal. Em relação ao processo de polpação, os valores de rendimento da polpa obtida a partir dos cavacos pré-tratados com SXS foram muito inferiores aos cavacos normais, porém em contrapartida apresentaram alto grau de deslignificação, sendo possível obter polpa de mesmo número kappa ($15 \pm 0,5$) com cargas de álcali ativo 34,8 e 37,6 % menores, sem e com antraquinona, respectivamente, quando comparado com os cavacos normais. A adição da antraquinona aumentou o rendimento depurado e intensificou a taxa de deslignificação da polpa para os cavacos normais, não apresentando efeito notório para os cavacos pré-tratados. O pré-tratamento com SXS reduziu consideravelmente o teor de ácidos hexenurônicos, e aumentou a viscosidade da polpa celulósica. Analisando os resultados obtidos a partir dos materiais pré-tratados com xilenosulfonato de sódio infere-se que o composto em questão é uma alternativa para o setor celulósico, pois alia características benéficas deste (biodegradável, inodoro, não incrustante, não corrosivo, baixa volatilidade, baixa inflamabilidade, fácil recuperação e alta seletividade), à redução do consumo de reagentes no processo de polpação, com melhoria da qualidade da polpa celulósica.

Palavras-chave: Extração de lignina; Consumo de reagentes; Qualidade da celulose.

Abstract

This study aimed to evaluate the effect of sodium xylenesulphonate (SXS) application as a pretreatment in wood chips of *Eucalyptus grandis* x *Eucalyptus urophylla* in the kraft cellulosic pulp quality. First the wood chemical characterization was made; subsequently the chips underwent a pretreatment in the following conditions: 12 hours, 30% concentration of SXS and temperature of 130°C. After the pretreatment the yield parameters and lignin content remaining in the chips were determined. The pretreated and normal chips (control) were subjected to the kraft pulping process for obtaining a pulp with kappa number 15 ± 0.5 ; for analyzing the pretreatment effect on the pulp quality. From the results obtained, it was possible to observe that the pretreatment with SXS allowed the extraction of 39.12% of lignin from wood chips, compared with the normal wood. Regarding the pulping process, the pulp yield values obtained from the wood chips pretreated with SXS were lower than the normal chips, but on the other hand showed a high degree of delignification, allowing to obtain pulp with the same kappa number (15 ± 0.5) with active alkali loads 34.8 and 37.6% lower, without and with anthraquinone, respectively, when compared with the normal chips. The addition of anthraquinone increased the screened yield and intensified the pulp delignification rate for the normal chips, not featuring notorious effect for the pretreated chips. The pretreatment with SXS considerably reduced the hexenuronic acids content, and increased the cellulosic pulp viscosity. By analyzing the results obtained from the materials pretreated with sodium xylenesulphonate, it is inferred that the concerned compound is an alternative to the cellulosic industry, because it combines its beneficial characteristics (biodegradable, odorless, non-incrustant, non-corrosive, low volatility, low flammability, easy recovery and high selectivity), to a reduction of reagents consumption in the pulping process, with an improvement in the cellulosic pulp quality.

Keywords: Lignin extraction; Reagents consumption; Pulp quality.

¹PhD Professor at Agriculture, biodiversity and Forests Department. UFSC - Universidade Federal de Santa Catarina, Curitibanos Campus. Ulysses Gaboardi - km 3 - 89520000 - Curitibanos, SC, Brazil. E-mail: magnosalan@gmail.com.

²Associate Professor at Forestry Department. USP - Universidade de São Paulo / ESALQ - Escola Superior de Agricultura Luiz de Queiroz. Padua Dias Avenue, 11 - Postal Code: 9 - 13418-900 - Piracicaba, SP, Brasil. E-mail: fjr@usp.br.

INTRODUCTION

The Brazilian cellulosic industry has been growing significantly in recent years, which is directly related to the increased demand, competitiveness and investments in research, and new technologies, especially for the eucalyptus.

Currently, Brazil is the second largest world producer of pulp, with emphasis on the short-fiber segment, from eucalyptus wood. In 2016 the country produced 18.8 million tons of pulp, and 86.2% is from short fiber, which stands out the *Eucalyptus* genus, with an increase of 8.0% compared to 2015 for short-fiber pulp (IBÁ, 2017).

In this growth context of the sector, it is of paramount importance to conduct studies that aim to add quality to the process, as well as the quality improvement of the produced cellulosic pulp. One of the possibilities is the use of wood pretreatments, through which it is possible to extract compounds that make the wood chips transformation into cellulosic pulp difficult, especially lignin, in order to increase its efficiency, making the process easier and reducing the load of reagents required for that.

According to Mosier et al. (2005) several pretreatment alternatives of wood chips intended for the pulp production have been developed, but additional research is required, in order to obtain low-cost procedures, combined with economic, technical and environmental sustainability. For obtaining such sustainability there comes a possibility of using solutions called hydrotropic, which are biodegradable, non-incrustating, non-corrosive, and do not exude unpleasant odors.

Therefore, such hydrotropic solutions, defined as saline compounds that increase the solubility of poorly soluble substances (such as lignin), compared to pure water at the same temperature (ANDELIN, 1989), appear as a good alternative for use as a pretreatment of wood chips. The most widely used hydrotropic compound for the recovery and extraction of lignin is the sodium xylenesulphonate. Akia and Feyzi (2006) mentioned that the application of this hydrotropic compound in industrial plants is attractive, due to its high selectivity, low flammability and easy recovery by dilution with polar solvent.

In view of this, it is required to develop studies using such compound as the wood chips pretreatment, in particular to eucalyptus, which is the main raw material used in the Brazilian cellulosic industry, aiming to analyze the effect of the compound use in the produced pulp quality.

Therefore, among the purposes of the wood chips pretreatment is the lignin extraction, aiming to optimize the pulping process, increasing its efficiency by using lower alkaline loads, which directly impacts on the economic and mainly environmental issue, because with the reduction in the need for reagents the subsequent procedures of the generated effluents treatment is improved.

A point that deserves special attention is the pulp quality, because the pretreatment can affect its features. Therefore, this study aimed to evaluate the effect of sodium xylenesulphonate application as a pretreatment in wood chips of *Eucalyptus grandis* x *Eucalyptus urophylla* in the kraft cellulosic pulp quality.

MATERIAL AND METHODS

Material collection and characterization

For performing this study the wood of an *Eucalyptus grandis* x *Eucalyptus urophylla* hybrid clone was used, at the age of five, from a forest stand located in the city of Telêmaco Borba/PR, (South Latitude: 24° 08' 46" and West Longitude: 50° 31' 57").

Five trees were cut down from the concerned hybrid, from which logs of 1 m of length between the base positions and 100% of the commercial height were extracted, which were submitted to the Chemistry, Pulp and Energy Laboratory – LQCE/USP, to be transformed into a composite sample of wood chips in a laboratory chipper. These wood chips were classified in bar sieves (thickness) and those that passed through the 6 mm sieve were used, retaining those in the thickness of 4 mm. Subsequently the selected wood chips underwent an air drying and storage in polyethylene bags to be submitted to the other stages of the study.

For the wood characterization the chemical composition was determined, following the methodologies described by standards TAPPI T 204 cm-97 (Total extractives), TAPPI T 211 om-02 (Ashes), Gomide and Demuner (1986) (Insoluble Klason lignin) and Goldschimid (1971) (Soluble lignin).

For determining the chemical composition a homogeneous sample of 100g of chips was used, which were transformed into sawdust in the laboratory mill, being classified in a set of 40 and 60 mesh sieves; the analyses were conducted with five repetitions each.

Wood chips pretreatment: hydrotropic method

Wood chips were pretreated with sodium xylenesulphonate (SXS) hydrotropic compound, purity degree of 90%, Fluka Analytical brand.

First a solution with concentration of 40% (weight/weight) was prepared, that is, 40 grams of SXS and 60 grams of distilled water, according to the methodology described by) Gordon et al. (1997), Korpinen and Fardim (2009), McKee (1946), Traynard (1955) e Traynard and Eymery (1955) Subsequently the concentrated solution was diluted at a concentration of 30% of SXS, in order to act in the lignin dissolution.

Wood chips pretreatment was conducted in triplicate in rotating autoclave, with a capacity of 20 liters, containing 8 individual stainless steel capsules, which were loaded with 70g of wood chips (dry mass) and extraction solution (30% of SXS), with a liquor/wood ratio of 4:1, maintained during 12 hours, at a temperature of 130°C (progressive increase in temperature of 3°C.min⁻¹ until reaching the set temperature).

After the pretreatment was finished, the capsules solution was drained for determining the pH, and wood chips were weighted for calculating the yield and then subjected to chemical analysis to determine the lignin, extractives and ash contents according to the same methods above mentioned.

The yield was determined in two manners: 1) total, according to Equation 1, taking into account the wood chips mass before and after the pretreatment; calculated (Equation 2), in which the ash and extractives contents present in the wood chips after the pretreatment were considered.

$$TY = \frac{M_f}{M_i} \cdot 100 \quad (1)$$

$$CY = \frac{M_f - (M_f \cdot (Ex + As))}{M_i} \cdot 100 \quad (2)$$

Whereas: TY – total yield, %; CY – calculated yield, %; M_f – final dry mass, g; M_i – initial dry mass, g; Ex – extractives, %; As – ashes, %.

Kraft pulping process

After the pretreatment application, the kraft pulping of pretreated chips (called “Pretreated” and “Pretreated AQ”), and reference chips (called “Normal” and “Normal AQ”) were performed, both with and without the addition of anthraquinone (AQ). The desired degree of delignification (kappa number) for the brown pulp was set as 15 ± 0.5, being obtained for both materials (normal and pretreated chips, with and without anthraquinone) from the characterization curve and trial, aiming the possibility of comparing both.

The kraft cooking was performed in the same rotating autoclave used in the pretreatment. Tests were performed in triplicate, according to the cooking conditions shown in Table 1.

Table 1. Pulping parameters for obtaining pulp with kappa number 15 ± 0.5.

Tabela 1. Parâmetros de polpação para obtenção de polpa com número kappa 15 ± 0,5.

Parameters	Conditions
Active alkali, % (such as NaOH)	*
Sulfidity, %	25
Chips dry mass, g	70
Liquor/wood ratio	4:1
Maximum temperature, °C	166
Heating time, minutes	90
Cooking time, minutes	60
H factor	780
Anthraquinone load, % (wood dry basis)	0 and 0.05

Whereas: *active alkali obtained by experimentation until achieving kappa number 15 ± 0.5, for the chips with and without pretreatment, and also with and without addition of anthraquinone.

For evaluating the material performance compared to the pulping process, the following parameters were considered, according to Table 2. Among the parameters determined in the kraft pulping process are the gross yield, screened yield, reject content, kappa number (delignification level), pulp viscosity and hexenuronic acids, and process selectivity.

Table 2. Parameters determined in the kraft pulping process.
Tabela 2. Parâmetros determinados no processo de polpação kraft.

Parameters	Standards/calculations
Gross yield, %	Ratio between pulp dry weight and wood dry weight
Screened yield, %	Ratio between depurated pulp dry weight and wood dry weight
Reject content, %	Ratio between reject dry weight (material retained on the sieve with 0.2 mm mesh of the laboratory depurator) and wood dry weight
Kappa number	TAPPI Methods T 236 om-99
Viscosity, cm ³ .g ⁻¹	TAPPI Methods T 230 om-04
Selectivity	Ratio between viscosity and kappa number
Hexenuronic acids, µmol.g ⁻¹	TAPPI Methods T 282 pm-07

Whereas: TAPPI Methods – Technical Association of Pulp and Paper Industry.

For the chips subjected to pretreatment the process global yield was calculated, according to Equation 3, which takes into account the pretreatment yield (calculated) and the kraft pulping gross yield. This was used to compare the normal (control) and the pretreated chips pulping yield.

$$GY = \frac{CY.GY}{100} \quad (3)$$

Whereas: GY – global yield, %; CY – calculated yield obtained in the pretreatment, %; GY – gross yield of the pulping process, %.

The black liquor was analyzed both in the normal chips cooking and in the cooking carried out with the pretreated chips, both with and without anthraquinone. For this, the liquor was collected at the end of each cooking, being analyzed according to the parameters and standards described in Table 3.

Table 3. Parameters determined in the black liquor.
Tabela 3. Parâmetros determinados no licor negro.

Parameters	Standards/calculations
Residual active alkali, NaOH and pH base	Method described by Segura (2012), Vivian (2015)
Total solids content	TAPPI Methods T 650 om-89
Organic solids content	TAPPI Methods T 625 cm-85
Inorganic solids content	TAPPI Methods T 625 cm-85

Whereas: TAPPI Methods – Technical Association of Pulp and Paper Industry.

Based on the previously determined parameters, the consumed active alkali was calculated according to Equation 4.

$$AAC = AAA - AAR \quad (4)$$

Whereas: AAC – consumed active alkali, g.L⁻¹; AAA – applied active alkali, g.L⁻¹; AAR – residual active alkali, g.L⁻¹.

RESULTS AND DISCUSSION

Wood chips pretreatment

In Table 4 the parameters regarding the liquor pH, total yield and also the calculated yield of the chips pretreated with SXS can be observed (12 h, 30% SXS, 130°C), and also the original chemical composition of hybrid wood of *E. grandis* x *E. urophylla*.

The pretreatment showed an extraction liquor with alkaline initial pH of 9.6 and final acid of 3.6; which is a sign of wood components links break, leading to the formation of acid compounds, among which are the formic and acetic acids (CARVALHO et al., 2008), fatty acids, unsaturated acids, benzoic acids (BARBOSA et al., 2005).

Table 4. Yield, pH of pretreatment liquor and wood chemical composition.**Tabela 4.** Rendimento, pH do licor de pré-tratamento e composição química da madeira.

Material	Liquor pH		TY (%)	CY (%)	Ashes (%)	Extractives (%)	Lignin (%)	Extraction yield (%)*
	Initial	Final						
Normal	-	-	-	-	0.21	2.63	27.12	-
Pretreated	9.6	3.6	100.20	67.69	7.54	26.21	16.51	39.12

Whereas: TY = total yield; CY = calculated yield; *calculated based on the wood original lignin content (27.12%).

Korpinen and Fardim (2009) while working with the lignin extraction from fir and birch wood biomass with the hydrotropic solution of SXS mention that it is possible to recover lignin through precipitation and filtration. According to the same authors, after the lignin separation the hydrotropic solution can be reused, being as efficient as the original.

The pretreatment yield was determined in two different manners: the total yield, which considered the chips mass before and after the pretreatment, and the calculated yield, which considered the extractives and ash content, which were subtracted from the chips mass after the pretreatment to determine the process yield. This was the procedure since the pretreatment total yield presented a value greater than 100%. This fact can be explained by the incorporation of SXS in the chips, which is evidenced by the high contents of ashes and extractives present in the pretreated chips, as shown in Table 4. The calculated yield obtained for the chips pretreated with SXS was 67.69%, which was considered a real yield, used to calculate the global yield in the subsequent kraft pulping process.

As it can be observed in Table 4, the chips pretreated with SXS showed a high content of ashes when compared with the original wood, which is a sign that it was kept inside the chips, and which raises the inorganic compounds content. The extractives content followed the same trend, being high in the chips pretreated with SXS. Such issue can be explained by the fact that the chips washing cannot remove the SXS present inside them, because they were kept in their original state after the application of the pretreatment.

The pretreatment with SXS was efficient in the removal of lignin, extracting 39.12% of it when compared with the wood initial content. This efficiency in the removal of lignin is explained since the SXS increases the solubility of organic molecules in water (ARANTES, 2009; HODGDON; KALER, 2007). According to Arantes (2009), normally the hydrotropic agents, which include the SXS, consist of polar and nonpolar groups, which allow dissolving the lignin through the formation of strong inter-molecular interactions, ion-dipole type, with the water and strongly interacting with lignin.

Parameters obtained for kappa pulp 15 ± 0.5

Table 5 shows the results regarding the pulping processes with the normal chips and pretreated with SXS, both with and without anthraquinone, for the pulp with kappa number 15 ± 0.5 .

Table 5. Parameters obtained from the pulping for the kappa number 15 ± 0.5 .**Tabela 5.** Parâmetros obtidos a partir da polpação para número kappa $15 \pm 0,5$.

Parameter	Material			
	Normal	Normal AQ	Pretreated	Pretreated AQ
Kappa number	15.2	15.5	14.9	14.8
Active Alkali (NaOH base), %	18.1	17.0	11.8	11.3
Gross / global yield, %	54.6	55.2	30.2*	30.5*
Screened yield, %	54.6	55.2	30.2	30.5
Reject content, %	0.0	0.0	0.0	0.0
Hexenuronic acids, $\mu\text{mol.g}^{-1}$	55.7	51.2	8.9	7.2
Viscosity, $\text{cm}^3.\text{g}^{-1}$	1049	1131	1239	1259
Selectivity	69.2	72.8	83.4	85.3

Whereas: *global yield, considers the pretreatment (67.69 %) and pulping yield.

The results presented in Table 5 show that the alkaline load required to achieve the same level of delignification (kappa number) was 34.8 and 37.6% lower for the chips pretreated with SXS, without and with anthraquinone, respectively, when compared with the reference chips (NORMAL). It is pointed out that the greater efficiency of lignin removal in the pretreatments pulp was accompanied by an intense reduction of yield (30.2 and 30.5%), when compared with the normal wood

(54.6 and 55.2%); and no reject was observed in both materials. The lowest yield for the pretreated chips is explained in part by the yield (67.69%) and lignin removal (39.12%) from the pretreatment, and also by the solubilization of part of the hemicellulose that occurs during this process.

In addition to the yield and delignification, other factors are important for the characterization of the cellulosic pulp, among them are the hexenuronic acids, which are formed during the alkaline pulping by the modification of 4-O methylglucuronic acids, present in xylans, which are influenced by the cooking conditions, especially the active alkali, sulfidity and temperature (SEGURA, 2012; SILVA et al., 2001). According to Costa et al. (2001) such compounds protect the xylans against the terminal depolymerization, therefore preserving the pulping process yield; Ventorim et al. (2006) mentions that the hexenuronic acids are undesirable in the bleaching processes, because they consume chemical reagents and cause a greater brightness reversion.

Regarding the hexenuronic acids, it was observed that the normal chips showed pulp with higher content of these compounds, when compared with the pulp obtained from the chips pretreated with SXS; the lower contents of hexenuronic acids observed in the pulps of treatments with SXS are evidences of reduced need of reagents for these pulps bleaching when compared with the pulps of NORMAL treatments. The lowest content of such compounds in the pulp obtained from the pretreated chips is an evidence that a great part of the hemicellulose was removed during the pretreatment, in particular the xylans, as mentioned before.

Viscosity is an important parameter for evaluating the cellulosic pulp quality, because it is associated with the average degree of cellulose chains polymerization, being used to indirectly estimate the degradation level of carbohydrates during the steps for obtaining the cellulosic pulp (DUARTE, 2007). According to the same author, the higher the viscosity value, the higher the conservation of carbohydrates and, consequently, the better the paper strength properties, especially those that depend on the link between fibers. The results presented in Table 5 show that the pulps obtained from the chips pretreated with SXS showed a greater viscosity ($1239 \text{ cm}^3.\text{g}^{-1}$), when compared with the pulps obtained from the normal chips ($1049 \text{ cm}^3.\text{g}^{-1}$). The addition of anthraquinone provided the increased viscosity in both cases (PRETREATED AQ = $1259 \text{ cm}^3.\text{g}^{-1}$; NORMAL AQ = $1131 \text{ cm}^3.\text{g}^{-1}$), because it acts protecting the cellulose chains during pulping. According to Gomide et al. (1987) anthraquinone has a protective action on terminal groups reducing carbohydrates, minimizing the terminal depolymerization reactions.

The lower load of active alkali used for the pretreated chips allowed obtaining a greater viscosity, preserving the cellulose chains. Alencar (2002) and Santos (2000) mention that woods with higher content of lignin may require a greater amount of alkali to achieve desirable levels of delignification in the kraft pulping process. This fact, according to Duarte (2007), implies a greater degradation of carbohydrates and the dissolution of low molecular weight polysaccharides, which will reflect in the yield reduction, reduction of viscosity and cellulosic pulp strength, and also generate a greater amount of solids for burning in the recovery boiler.

According to Silva Júnior (2005) the increase of the cooking alkaline load provides a significant reduction in the pulping process yield, which occurs due to the deterioration of xylans, which are sensitive to the increased alkaline load, causing negative impacts on the cooking selectivity, and which expresses the relation between viscosity and the kappa number; the results presented in Table 5 show that the pulping process selectivity of pretreated chips was higher than the NORMAL and NORMAL AQ treatments chips.

Generally, balancing the pulping results with the pretreated materials the main negative point is the process low yield, and the positive points are the lower need of alkali to obtain the same kappa number, greater selectivity of the process, higher viscosity that indicates less degradation of carbohydrates, and also lower content of hexenuronic acids content, which possibly indicates a reduced need of beaching reagents of these pulps when compared with the conventional pulps.

In Table 6 the parameters regarding the black liquor of the pulping processes can be observed with the normal chips and pretreated with SXS, both with and without adding anthraquinone, for the pulp with kappa number 15 ± 0.5 . As it can be observed, the residual active alkali of pretreated chips was lower than for the normal chips, which is explained due to the lower alkaline load ap-

plied for obtaining the pulp with the same kappa number. According to some authors the residual active alkali values should not fall to very low levels, in order to avoid problems such as the lignin re-precipitation on the pulp; according to Lombardo and Padilha (1998), the residual alkali levels should be maintained between 5 and 13 g/L. The levels observed for the pulps obtained from the pretreated chips were a bit below the mentioned levels; and for the normal chips the values were maintained in the range mentioned by the authors.

Table 6. Parameters regarding the black liquor.

Tabela 6. Parâmetros referentes ao licor negro.

Parameter	Material			
	Normal	Normal AQ	Pretreated	Pretreated AQ
Residual active alkali, g.L ⁻¹	11.1	9.7	4.6	4.2
Consumed active alkali, g.L ⁻¹	34.2	32.8	24.9	24.1
pH	12.1	12.0	11.5	11.4
Total solids content, %	13.5	13.2	13.9	13.6
Organic solids content, %	9.3	9.2	9.0	8.9
Inorganic solids content, %	4.2	4.0	4.9	4.7

Regarding the black liquor final pH, according to Santos (2005), it must be maintained above 11, because an amount of alkali must remain as residue, in order to avoid the lignin re-precipitation on the fibers, making them more hydrophobic. The pH of liquors from the pretreated chips was lower, which is due to the lower initial alkaline loads applied and the lower levels of residual active alkali levels, however both materials presented pH above the minimum mentioned by the author.

Another important factor in the black liquor analysis is the solids content, which can be expressed as total, organic and inorganic solids. The total solids content was similar to the black liquor of both treatments. The inorganic solids content was higher to the pretreated materials, which is mainly due to the inorganic part of SXS that was trapped inside the chips (evidenced by the ash content of pretreated chips). SXS shows 63.1% of its total as an organic fraction and 36.9 as inorganic.

According to Duarte (2007), the alkali load is the main source of inorganic components in the black liquor and has a direct effect on the quantity of solids generated in the pulping, and the wood components dissolved during the pulping process; on the other hand, it represents the main source of organic components of the black liquor. Regarding the organic solids content, these were similar for both materials, both normal and pretreated chips.

CONCLUSION

The results obtained in this study allow concluding that:

- the pretreatment with sodium xylenesulphonate allows extracting 39.12% of lignin present in the wood of *E. grandis* x *E. urophylla*;
- for obtaining pulp with kappa number 15 ± 0.5 the alkali load required is 34.8 and 37.6 % lower for the chips pretreated with sodium xylenesulphonate, without and with anthraquinone, respectively, when compared with normal chips;
- the addition of anthraquinone increases the screened yield and intensifies the pulp delignification rate for the normal chips, not featuring a notorious effect for the pretreated chips;
- the pretreatment with sodium xylenesulphonate considerably reduces the hexenuronic acid content of cellulosic pulp;
- the pretreatment with sodium xylenesulphonate increases the cellulosic pulp viscosity;

By analyzing the results obtained from the pretreatment with sodium xylenesulphonate it is inferred that the concerned compound is an alternative to the cellulosic industry, because it combines its beneficial characteristics (biodegradable, odorless, non-incrustant, non-corrosive, low volatility, low flammability, easy recovery and high selectivity), to a reduction of reagents consumption in the pulping process, and also an improvement in the cellulosic pulp quality. The lignin removed during the pretreatment can be recovered and intended for other uses as its byproduct, applying the concepts of biorefinery, which need to be further studied aiming the best correct use.

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