Sulphonation of sgw rejects from chinese southern pine

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ABSTRACT

Screen rejects from SGW mill have been laboratory treated with 11 to 15% of sodium sulphite at a concentration of 8% for 0.5–2.5 hours, and a liquor to wood ratio of 11.5, at 95°C. A sulphonate content up to 0.93% was obtained while pulp yield was superior to 96.5% Treated and untreated rejects were refined at different freeness levels in a laboratory refiner. Sulphonation of rejects prior to refining was found to improve pulp strength and surface properties. Under these mild treatment conditions, sodium sulphite has a bleaching effect. A low cooking temperature for an extended time, and a high chemical charge were found to be acceptable conditions for reject sulphonation of chinese southern pine.

INTRODUCTION

Over the last years, a substantial amount of experimental results have been published on the sulphonation of mechanical pulp rejects (1—16), demonstrating the numerous benefits of pulp sulphonation and promoting its application on a commercial basis (14, 17, 18).

Chiness mechanical pulp mills use screen to reject fibers bundles. These rejects are normally thickened, refined in a disk refiner and recirculated back with the screen accepted pulp. Chinese pulp and paper industries are more and more interested to sell their products or international markets, they have to compete with the pulp quality of other countries, and therefore have to improve their pulp characteristics. Due to the wood species available in South China, the pulp brightness is relatively low. Sulphonation of screen rejects appears as one of the ways to upgrade their SGW quality.

The objective of this research was to investigate the feasibility of an economical treatment of SGW screen rejects from Chinese southern pine, and more specifically, to determine the sulpnonate content which can be obtained at low temperature treatment (under 100°C). This is justified by China's shortage and high cost of energy. An experimental progrm was designed to that purpose.

LITERATURE SURVEY

The strength properties of the mechanical pulp rejects can be improved by a mild chemical treatment to increase fibre cohesiveness and flexibility. Several chemical treatments have been compared for such a treatment in earlier investigations (3, 19-22). Among the used chemicals, ClO_2, O_3, $NaHSO_3$, Na_2SO_3, NaOH H_2O_2 + NaOH, sulphite is the most popular. A recent work (3) has shown that ozone sulphonation is a promising method, but it is not still economically justified. A list of experimental parameters used for sulphonation by different searchers was presented by Garceau (23).

Sulphonation of mechanical pulp rejects usually increases wet fibre flexibility and fibre conformability (4). This contributes to improve wet and dry sheet strengths and to lower sheet density. Pulp brightness may either improves or deteriorates upon certain conditions, but light scattering coefficient is reduced(11). Refiring energy requirements to reach a freeness level of about 100 ml are about 1/3 less for sulphonated fibres than for untreated fibres (12, 16, 17).

Sulphonation can be performed either before or after reject refining ; Gummerus (2) found that sul-

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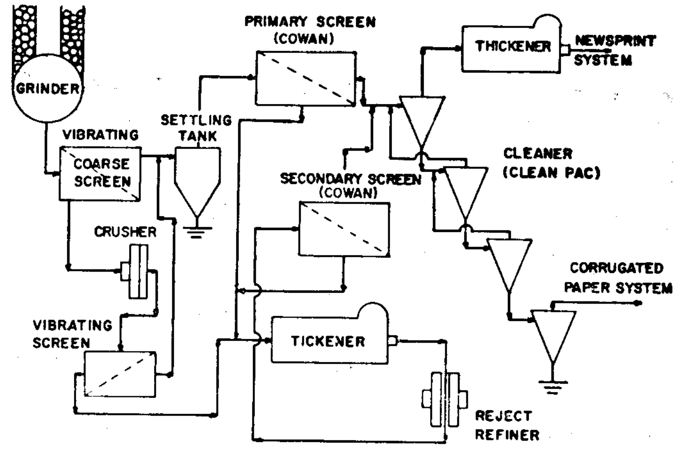
phonation prior to reject refining was a better way of improving the strength properties of TMP. He attributed this to greater fibre flexibility, and compressibility, and to a lower degree of fibre breakage during refining. The increase in fibre conformability improves the bonding ability.

In 1987, Beaulieu (17) reported from industrial system that a high sulphonate level reduces reject refining energy and improves most handsheet characteristics ; then thershold level of 0.8 to 1.0% sulphonate content is required. According to Franzen and Li (5), in order to reach the maximum level of sulphonate at a high pulp yield level, a strong liquor should be used under mild alkaline conditions, either paired with low cooking temperature and long cooking time or with high temperature and short time. Franzen suggested (24) that the optimum conditions for a sulphonation treatment are a moderate cooking temperature for extended time and high chemical charge. The cooking time and size of the sulphonation reactor can be reduced, at higher temperature but pulp brightness is reduced. Recently Olander et al. (15) reported that the properties of paper are affected not only by the degree of sulphonation but also by the way in which the sulphonation is carried out. Pulp sulphonated for longer times has stiffer fibers and gives sheets of lower density with higher tensile stiffness index. It seems that longer reaction time favors cross linking reactions.



FIGURE—I

PULP (SECONDARY SCREEN)	ACCEPTED	REJECTED
C.S. FREENESS, ———— ml	83	560
FRACTIONS (BAUER McNETT)		
L_{30} ———— %	8	32
L_{50} ———— %	20.8	21.4
L_{100} ———— %	20.4	27.5
L_{200} ———— %	13.4	8.2
P_{200} ———— %	37.4	10.9
BREAKING LENGTH ———— km	3.1	1
TEAR INDEX, ———— $mN \cdot m^2/g$	3	2.9
BRIGHTNESS, ———— %	42	42

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EXPERIMENT

Materials

Stone groundwhood screen rejects were collected from Guangzhou paper mill which is producing 260t/d from 16 chain grinders using 100% of southern pine. The flow sheet is shown in figure 1. Respectively, 17% and 5% of pulp are rejected from primary and secondary Cowan screen. The properies of accepted and rejected pulp are given in Table 1.

Sulphonation and refining

Sulphonption was performed in an elcctrically heated 151 rotating digester. For each batch, 2kg of rejects were sprayed with sodium sulphite and hand mixed. Untreated and sulphonated rejec ed were refined at a concentration of about 10% in a 30kW KRK experimental refiner equipped with 30 cm diameter plates. To achieve different freeness levels, plates clearances were adjusted between 0.4 and 0.7 mm.

Testing

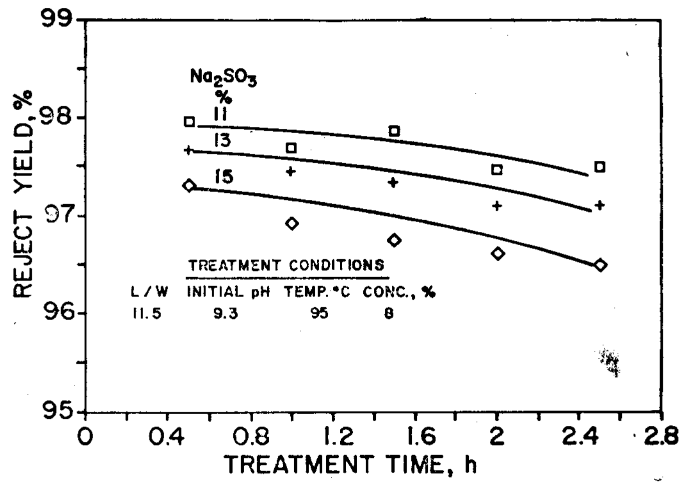
Pulp properties were determined at 25°C and 60% relative humidity according to TAPPI standards. Brightness levels were determined using a Chinese SBD 1 brightness tester, results are similar to GE's. The sulphonate content of the pulp was measured by potentiometric titration (25).

Treatment optimization

Because of energy cost and shortage in China, low treatment temperature had to be used for an extended time and would high chemical charge. Preliminary studies allowed to screen out some experimental conditions, namely chemical charges of 4%, 5% and 6% with treatment time of 0.5—2 5 houes, and cooking temperature of 65°C, 75°C and 85°C. Under these conditions, the sulphonate content was lower than 0.5%. According to literature (17), a sulphonate level of 0.8 to 1.0% is required for a minimum lignin thermoplastic modification to affect fibre conformability and flexibility. Selected experimental conditions are shown in table 2.

SULPHITE CONCENTRATION, g/l	124
SULPHITE CHARGE, (ON. O.D. PULP) %	11, 13, 15
pH VALUE (before treatment),	9-9.5
TREATMENT TEMPERATURE, °C	95
TREATMENT TIME h	0.5, 1, 1.5, 2, 2.5
REJECT TREATMENT CONCENTRATION, %	8

Table—2



FIGURE—III

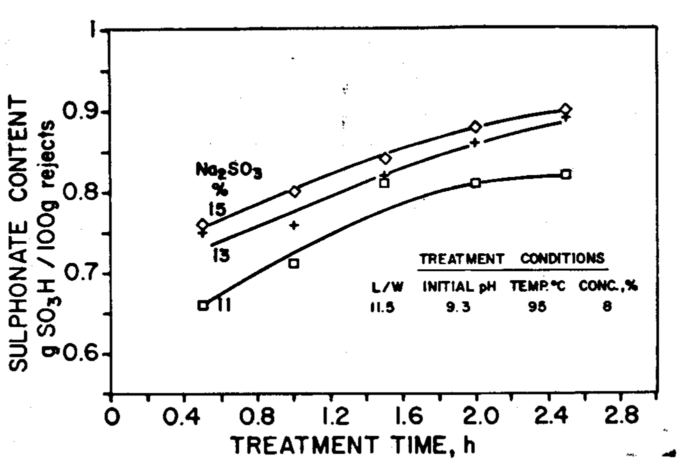
RESULTS AND DISCUSSION

Pulp yield and sulphonate content

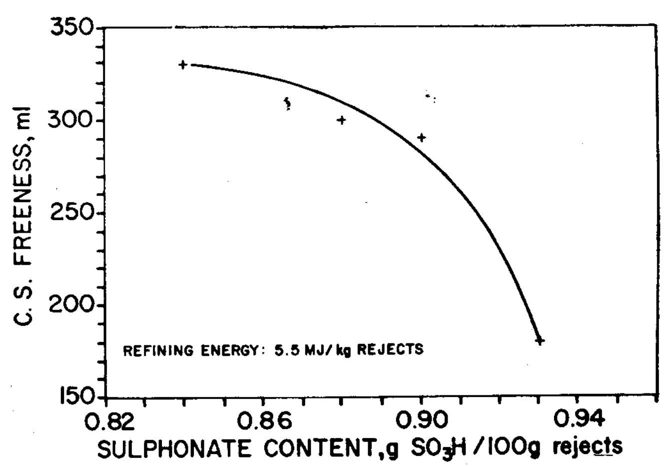
The effect of the sulphite charge and treatment time on the sulphonate content and yield respectively are shown in figure 2 and 3. The sulphonate content of pulp increased and reject yield decreased with an increase of chemical charge and treatment time. Reject yield averaged 96.5—97.5%. Sodium sulphite buffered the pulp and sulphonated lignin (11). Both effects therefore contributed to preserve yield. However, sodium sulphite, as any other delignifying agents, ultimately lowered the pulp yield. Similar results have been reported for southern pine (17), slash pine (5), and radiata pine (8).

Refining:

Relationships between pulp properties of sulphonated refined rejects and sulphonate content are illustrated in figures 4 to 7. Figure 4 shows that at same refining energy consumption (5.5 MJ/kg), the freeness of sulphonated refined SGW rejects decreased rapidly with the increase of sulphonate content. In other words, to reach a given freeness level, less refining energy was required for rejects with a high sulphonate level than for low or untreated rejects (table 3). As the sulphonate content was increased with the sulphite treatment of rejects, fibre flexibility increased, subsequent to refining, and specific refining energy consumption was gradually reduced. At the higher sulphonate contents energy consumption seemed



FIGURE—II

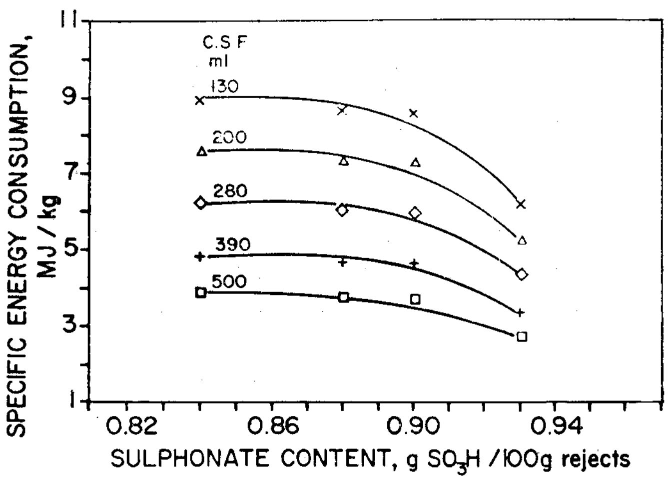


FIGURE—IV

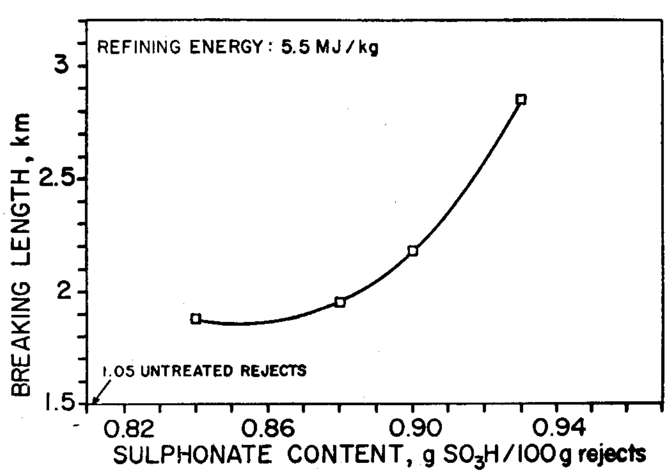
SULPHONATE CONTENT g SO_3H /100g rejects	SPECIFIC ENERGY CONSUMPTION, MJ/kg				
C.S.F, ml	500	390	280	200	130
0	5.4	6.7	8.6	10.5	12.5
0.84	3.8	4.8	6.2	7.5	8.9
0.88	3.7	4.7	6.0	7.3	8.6
0.90	3.7	4.6	5.9	7.3	8.6
0.93	2.7	3.3	4.3	5.2	6.2

Table—3

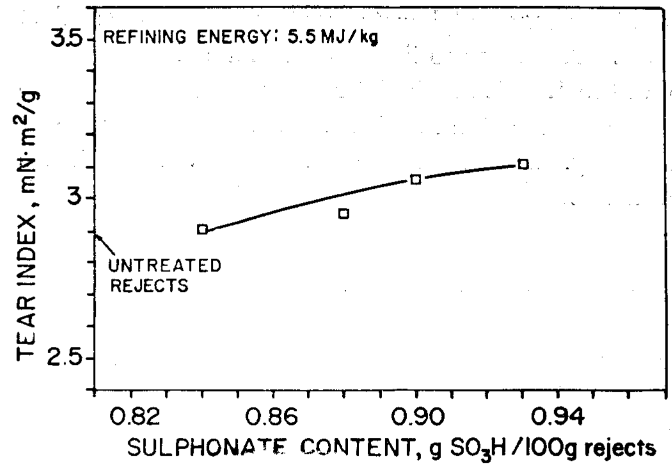
to decrease faster (figure 5). The breaking length of the pulp produced by refining the treated rejects increases with the sulphonate content and is much higher than for the untreated rejects (figure 6). The major effect of sulphonation is to introduce permanent softening in the fibre by increasing the hydrophilicity of the lignin structure (26). The increase in wet fibre flexibility is reflected in the increased breaking length of the paper sheet (4). The higher fibre flexibility of sulphonated rejects improves tensile strength (11). However, the sulphonate content had little effect on the tear index (figure 7). It is known that the tear index is mainly a function of fibre length.



FIGURE—V



FIGURE—VI



FIGURE—VII

The sulphonation did not change the proportion of long fibres (<30 mesh) in reject pulps (24 to 26%). With other wood species, a reduction of the tear index at high sulphonate contents was reported (5); this was attributed to higher sheet density. Helle (27) showed that for sufficient bonding, more flexible fibres are giving a lower tear index. By refining sulphonated rejects, fibre sheet density is further increased and long fibres are reduced, giving higher tear reduction. Nevertheless, under the present test conditions, all strength properties are improved.

Optical properties

The brightness of the untreated stone groundwood rejects was 42% (table 1), and the mild treatment conditions had a favorable bleaching effect. Sulphonation of rejects increased pulp brightness by about three points (table 4). It is known (4) that sodium sulphite a weak reducing agent, can change chromophoric ortho and para-quinones in the lignin structure to the corresponding non-chromophoric hydroquinones.

CHEMICAL CHARGE, %	11	13	15
PULP BRIGHTNESS	%		
TREATMENT TIME, h			
0.5	44.6	45.2	44.8
1.0	44.7	44.4	45.2
1.5	43.8	45.3	45.5
2.0	43.7	44.3	44.7
2.5	45.3	45.5	45.3

Table—4

CONCLUSION

The main conclusions are :

1. A high chemical charge, a low treatment temperature (under 100°C) and extended treatment time allow to obtain a sulphonate content of 0.8 to 1.0%.
2. Chemical treatment of Chinese pine rejects prior to refining improves pulp strength and surface properties.
3. Chemical treatment prior to refining reduces the specific energy consumption required for refining : for example, at 130 ml, 30-50% can be saved (table 3).
4. Under mild treatment conditions, sodium sulphite has a bleaching effect on stone groundwood screen rejects : 3 points are gained.

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