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PULP CHIP QUALITY FROM IN-WOODS CHIPPERS COUPLED WITH CHAIN FLAIL DELIMBERS-DEBARKERS: DOES IT MATCH CONVENTIONAL WOODYARD QUALITY?

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ABSTRACT

Chain flail delimber-debarkers have gained a degree of acceptance in the Southern U.S.A., especially for processing thinnings from pine plantations. This Technical Release compares the quality of chips produced by in-woods chippers teamed with chain flail delimber-debarkers, with chips produced in conventional large-scale woodyards, to g&e a guideline as to what may occur with similar processing of radiata pine in New Zealand Pine chips from the chain flail and in-woods disc chipper compared favourably with pine chips produced from drum debarker and disc chippers in woodyards. These in-woods chips were similar in bark content and in he production of chips of an acceptable size. The flails, however, were less effective in debarking hardwood stems than were the drums in the woodyards.

INTRODUCTION

Chain flails teamed with in-wood chippers have become a significant source of chips for pulp mills, particularly in the Southeast region of the U.S.A. Currently, a total of 90 chain flail units have been manufactured by the three commercial firms supplying these units - Manitowoc, Peterson Pacific and ForestPRO (Twaddle et al, 1989) - with over 50 of these operating in the South. Other firms have recently begun to offer brands of flails (for example, Chiparvestor has just introduced an integral flail-chipper unit). Each flail-chipper pair is capable of producing 60,000 tonnes of chips annually; thus, the 75 units in place in North America will probably produce about 4.5 million tonnes of chips for use in the manufacture of pulp.

The typical chain flail operation in the South consists of :

(1) Feller-btmchers for felling the trees

(2) Grapple skidders which move the trees with the tops intact to a processing area

(3) A knuckleboom loader .to feed the trees into the flail

(4) A chain flail delimber-debarker which removes the limbs and the bark

(5) An in-woods chipper which receives the delimbed and debarked stems and converts the stems to chips, and

(6) Haul units with chip vans to transport the chips to the pulp mill

The total cost of one of these in-woods operations is 1 to 1.5 million dollars (U.S.) when all of the support equipment is included.

The commercially available chain flails have two drums mounted either horizontally or vertically. The chains are attached to these drums, and the drums turn at a rate of about 500 rpm when in operation.

The flails were designed to carry 36-39 chains on each drum with the chains being arranged in six rows along the drums. Most Southern contractors, however, are now doubling the numbers of chains to improve debarking quality. The chains currently used were designed for skidder tyres and have an average life of 1,300 tonnes in a single configuration to 2,500 tonnes in a double chain configuration when delimbing-debarking pine (Carte et al, 1990).

The in-woods chippers preferred in the South are Trelan 23 and Chiparvestor 23 models. These have the capacity to handle stems up to 58 cm in diameter. Both are disc chippers and have 400 to 550 kilowatt diesel-powered plants. The chippers were equipped with separators in all of the trials reported in this Technical Release. Most of the material rejected by the chipper separator consists of slivers of wood, up to 10 cm long.

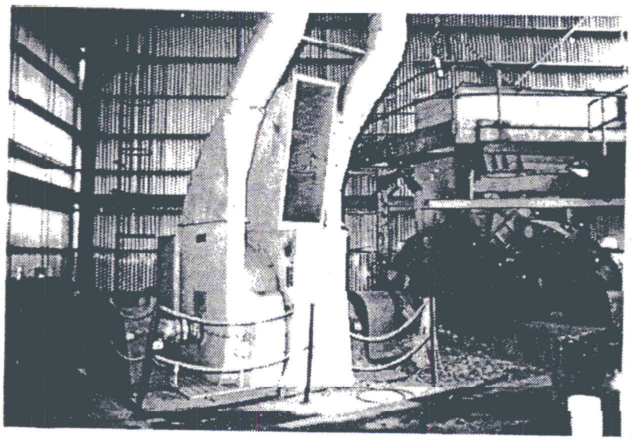

Figure 1 - Large fixed chippers operating in conventional woodyards, such as this 295cm-12 knife unit, are more like& to be well maintained than mobile in-woods chippers

The users of the chips are usually more concerned with the quality of those chips produced outside the mill gates, as compared to the quality of those chips produced in the more controlled environments of the woodyards. To assess the quality of the woods-produced chips in the Southern U.S.A., the Forestry Department at Mississippi State University and the Forest Engineering Project at the USDA Forest Service at Auburn, Alabama, have co-operated in monitoring these operations since the first commercial flail was introduced in the Southern U.S.A. in December 1986. The monitoring of the operations: including utilisation and wood recovery studies, has been reported elsewhere (Stokes and Watson, 1990).

These, and other data (Stokes and Watson, 1989; Carte et al, 1989) are presented here to give the New Zealand forest industry some guidelines as to what may be expected from similar in-woods processing of radiata pine, and how the output from these systems compares to conventional drum debarking and disc chipping at a wood yard.

ACKNOWLEDGEMENTS

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METHODS

Over the past four years chip samples have been collected from the operations of Southern chip contractors who utilised chain flails. Over 400 chip samples have been collected in seven different States, and six different species are included in the Studies (see Tables 1, 2, and 3 for a summary of the sources of these data).

The chips were collected at the end of the blower spout. A thick-walled PVC pipe with a 90° elbow glued to the end was used to catch the chips as they were being blown into a chip van. The chip samples were collected in a bucket and then- transferred to plastic bags to be transported back to a laboratory for analysis.

Classifiers available for analysing the chips have varied over the life of the study. The chip samples collected prior to 1990 were classified on a Universal vibrator screen. During most of this period, classification

Table 1 - Summary of data collected prior to 1990 (other than chain wear trials) - (Universal Classifier)

Location	Flail	Chipper	Month / Year	Species	Bark (%)	Pins (%)	Fines (%)
Georgia	Peterson Pacific 4800	Morbark	December / 1986	Loblolly pine	1.5	10.0	2.8
South Carolina	Peterson Pacific 4800	Morbark	January / 1987	Slash pine	3.4	5.3	2.0
				Loblolly pine	2.8	5.9	1.7
Arkansas	Weyco	Morbark 23	October / 1987	Loblolly pine	1.1	2.1	1.5
Oklahoma	Weyco	Morbark 23	January / 1988	Loblolly pine	1.0	2.9	1.8
					3.5	2.0	1.4
Oklahoma	Weyco	Trelan 23	January / 1988	Loblolly pine	5.5	1.9	1.3
Texas	ForestPRO	Morbark 23	April / 1988	Slash pine	0.8	2.4	1.0
Oklahoma	Manitowoc	Trelan 23	April / 1988	Loblolly pin	.9	1.2	0.6
Oklahoma	Weyco	Trelan 23	April / 1988	Loblolly pin	.5	1.9	1.5
Oklahoma	Weyco	Morbark 23	April / 1988	Loblolly pin	.4	2.4	1.5
Arkansas	ForestPRO	Morbark 23	August / 1988	Loblolly pin	.9	1.9	0.8
Oklahoma	Manitowoc	Trelan 23	October / 1988	Loblolly pin	.5	1.7	1.2
Oklahoma	Weyco	Trelan 23	October / 1988	Loblolly pin	.8	1.7	1.3
Oklahoma	Weyco	Morbark 23	October / 1988	Loblolly pin	.4	2.3	1.5
Florida	Manitowoc	Blue Ox	November / 1988	Delimbed Tuelo gums	.3	0.5	0.7
				Delimbed swet gums	.6	1.2	0.8
Alabama	Peterson	Morbark 27	July / 1989	Sycamore	.1		

Table 2 - Chip quality results of 1989 chain wear trials (Universal Classifier)

tion	Flail	Chain	Chain configuration	Chipper	Month/Year	Species	Bark	Pins	Fines	Overs	
										Lgth	Width (12 mm)
							(%)	(%)	(%)	(%)	(%)
ansas	Manitowoc	Beacon 7	Single/7 link	Chiparvester 23	July*/1989	Loblolly pine	0.3	0.9	0.4	13.8	6.2
ansas	Manitowoc	Beacon 7	Single/7 link	Chiparvester 23	July/1989	Loblolly pine	0.8	1.6	0.8	3.7	5.7
ansas	Manitowoc	Beacon 7	Double/7 link	Chiparvester 23	July/1989	Loblolly pine	0.5	1.7	0.7	7.8	7.4
ansas	Manitowoc	Super Campbell	Single/9 link	Chiparvester 23	July/1989	Loblolly pine	0.5	1.3	0.5	2.8	5.4
ansas	Manitowoc	Trawlex	Double/7 link	Chiparvester 23	July/1989	Loblolly pine	1.4	0.5	0.3	3.1	9.7
ansas	Manitowoc	A8A Alloy	Single/9 link	Chiparvester 23	July/1989	Loblolly pine	1.3	1.5	0.6	1.9	6.2
asas	Manitowoc	Canadian	Single/8 link	Chiparvester 23	July 1989	Loblolly pine	0.9	0.7	0.3	3.8	7.2
la	Peterson	Super Campbell	Single/9 link	Chiparvester 23	July/1989	Mixed hardwoods	3.1	1.7	1.5	2.3	2.9
la	Peterson	Campbell alloy	Single/9 link	Chiparvester 23	July/1989	Mixed hardwoods	3.1	1.3	1.2	2.7	3.8
ansas	ForestPRO	Beacon 7	Double/7 link	Trelan	July/1989	Loblolly pine	0.4	0.6	0.3	6.3	7.8
nsas	Manitowoc	Super C	Single/9 link	Chiparvester 23	July/1989	Loblolly pine	0.8	0.9	0.6	3.1	5.9

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Table 3 - Summary of chip quality data collected in spring 1990 (Price Classifier)

ocation	Flail	Chipper	Month / Year	Species	Overthick (8 mm) (%)	Accepts (%)	Pins (%)	Fines (%)
labama	ForestPRO	Trelan 23	April / 1990	Loblolly pine	15.0	82.0	2.1	0.9
klahoma	Manitowoc	Trelan 23	May & June / 1990	Loblolly pine	39.7	58.8	1.0	0.6
klahoma	Manitowoc	Chiparvester 23	June / 1990	Loblolly pine	26.6	71.6	1.1	0.6
rkansas	Manitowoc	Chiparvester 23	June / 1990	Loblolly pine	23.3	74.0	2.0	0.7
rkansas	Weyco	Trelan 23	June / 1990	Loblolly pine	24.0	73.0	2.0	1.0
rkansas	Manitowoc	Trelan 23	June / 1990	Loblolly pine	11.7	86.6	1.2	0.4
rkansas	Manitowoc	Trelan 23	June / 1990	Loblolly pine	27.7	70.2	1.7	0.8
rkansas	Manitowoc	Trelan 23	June / 1990	Mixed hardwoods	12.8	84.9	1.7	0.7
kansas	Manitowoc	Chiparvester 23	June / 1990	Loblolly pine	18.4	76.4	3.1	2.1
kansas	ForestPRO	Trelan 23	June / 1990	Loblolly pine	23.7	73.7	1.8	0.7

was carried out on length of chips only. The chip samples collected in 1990 have been analysed with the use of a Price Chip Classifier provided by Price Industries of Monticello, Arkansas. The use of the Price, which classifies primarily by thickness, allowed a direct comparison of flail delimbed-debarked in-woods chips with the chips gathered and analysed by Twaddle (1990) in his South-wide woodyard survey as this latter study also used a Price classifier. Direct comparisons of chip dimensions can only be made using identical classifiers with the same sample sizes and screen retention times.

The Price Classifier defines pin chips as those less than 2mm thick but not able to pass through a 5mm-round hole. Fines are able to pass through.

Pins and fines are both generally undesirable in the pulping process. Pins can plug digestor screens and refiner plates while fines, because of their small size, can restrict liquor circulation and return little useful pulp fibre.

Oversize chips also cause considerable problems in the pulping process, and almost always are screened from the chip flow and rechipped or sliced.

Figure 2 - In-woods chippers processing chain flailed pine are capable of producing a high quality pulp chip matching those from a conventional woodyard.

ANALYSIS

Bark Content

The results of the bark content of the samples taken prior to 1990 (Table 1) show evidence of the work that was ongoing in the refinement of operational strategies in debarking with flails. The first three studies reported in Table 1 were experimental operations, and bark contents ranged as high as 3.4%. By 1989 when the chain trials were conducted (Table 2), the contractors and equipment manufacturers had developed strategies for using the flails which. would maintain the bark content at less than 1% for the pine stems and at 3% for the soft hardwood species. In control tests where no flails were used, the bark content of chips produced from whole-tree loblolly pine was 10% and chips produced from whole-tree soft hardwoods was 12%. Thus, the flails are now reducing the bark content of the chips by 90% in the loblolly pine and 70% in the soft hardwoods.

The bark contents observed in the chain wear tests (Table 2) can be considered as representative of debarking that is currently attainable for operations using chain flails for debarking. Comparing these observations to those obtained by woodyard survey, we find that the debarking capability of the flails is equivalent to woodyard drum debarking for pine stems, but the flails are not as effective as drums in debarking hardwoods.

Analyses of the bark content in the early studies (Table 1) showed that debarking with the chain flails was most difficult in the winter months. A one-way analysis of variance of the pine bark content data showed that month of year was significant in accounting for differences ($F_{4,156}$ = 12.65). However,onIy January (winter in the U.S.A.) was significantly different from the remaining months. The contractors using the flails now double the numbers of chains and are able to overcome this difficulty.

When chip samples were taken during a utilisation study, the average diameter at breast height (DBH) of the stems being processed was recorded. These data were available for a total of 52 loblolly pine samples that were collected prior to 1989. The bark content in these samples was significantly related to the diameter of the stems being processed, with chip bark content increasing as stem diameter decreased. This shows the flails are not as efficient in delimbing when several small stems are fed at once into the unit.

Chip Size

The samples collected in 1990 (Table 3) were analysed using a Price Classifier and therefore could be compared directly with the information gathered by Twaddle (1990) in his Southern woodyard survey as identical classification techniques were used. A possible confounding problem was that these latter data were collected in the autumn and the flail data were collected in the spring, so additional matching measurements of the flail were made in the autumn of 1990.

All of the in-woods chippers working with pine in the 1990 spring and autumn studies were set up to produce a 22mm-long chip. Thus, all woodyards sampled which were manufacturing pine chips and whose chippers were set up to produce 22mm chips were selected to compare with the in-woods chippers. Altogether 15 chippers in conventional pulpmill woodyards were identified for this comparison.

Chip analyses for the three groups are compared in Table 4. Note that the percentages of pins and fines were significantly lower for the in-woods chippers. The reason for this could be related to the freshness of the wood. The in-woods chippers were producing a significantly higher percentage of overs. While chip thickness increases with increasing moisture content (Hartler, 1962), the higher overs production is probably also related to the inexperience of the contractors and their limited knowledge of chipper maintenance compared to their woodyard counterparts.

CONCLUSIONS

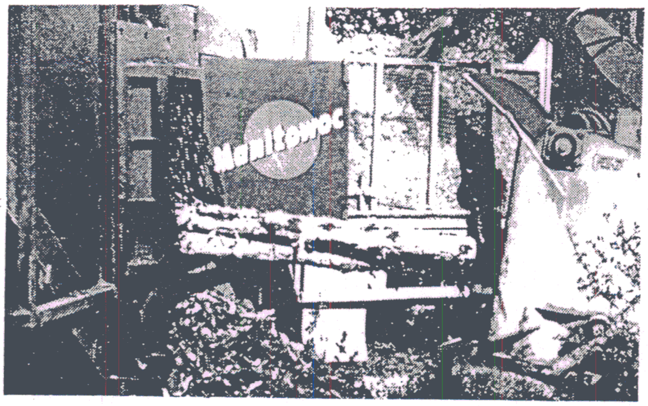
Southern U.S.A. experience is that chain flail delimber-debarkers teamed with in-woods chippers can produce pine chips comparable in quality to those produced in the woodyards, although inexperienced contractors can produce poor quality chips. The bark content of in-woods pine chips currently being produced with flail debarking is similar to the bark content of chips from the survey of wood yards (0.6% bark for in-woods chips as compared to 0.8% bark for woodyard chips). Although the

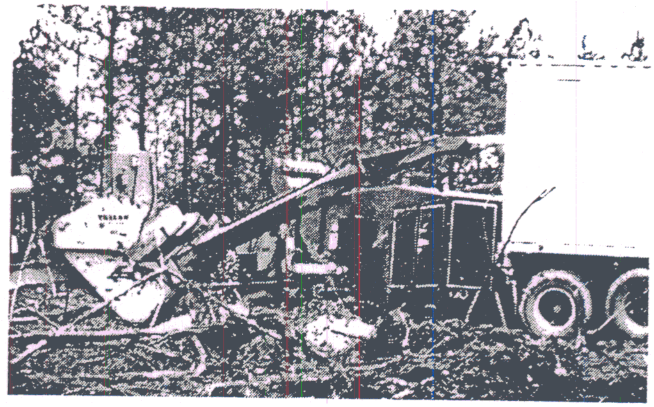
Table 4 - Comparison of dimensions of chips produced from pine stems at a woodyard with chips produced with flail delimbers-debarkers and in-woods chippers

	Woodyard chips (Autumn)	In-woods chips (Spring)	In-woods chippers (Autumn)	F	Significance
Number of samples	45	51	95		
Over.3 (%)	19.2	25.5	29.0	9.97	0.05
Accepts (%)	75.3	73.0	68.0	6.65	NS
Pins (%)	3.7	1.7	1.8	40.50	0.0 1
Fines (%)	1.8	0.8	1.1	28.38	0.01

Definitions:

Overs	retained on an 8 mm slot
accepts	retained on 2 mm slot, pass an 8 mm slot
pins	pass 2 mm slot, retain on a 5 mm round hole
fines	pass 2 mm slot, pass 5 mm round hole





Figures 3 and 4 - A typical Southern in-woods pulp chip operation consists of a loader feeding the flail where the stems pass straight through into a chipper. Chips are blown into the rear of the trailer. In this example the chain flail is a Manitowoc brand, und the chipper is a Trelan.

flails were less effective in debarking systems in the winter months, the debarking quality has been improved in current usage by doubling the chains. The in-woods chips contained a significantly lower percentage of pins and fines than were found in the woodyard chips, but the percentage of overs was significantly higher in the in-woods chips.

The chain flail units did not debark hardwoods as well as the drum debarkers in the woodyards. The average bark content of the chain flail debarked hardwood chips was a full percentage higher for the in-woods chips (3.1%) than for the wood yard chips (1.9%).

These data on southern pine would indicate that providing radiata pine will delimb satisfactorily in chain flails, and if chip contractors attend to chipper maintenance, high quality pulp chip should be able to be manufactured in the forest in New Zealand.

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