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Information Report BC-X-292
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FERIC Special Report No. SR-41

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Victoria, B.C. V8Z 1M5

1987

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ISSN 0830-0453
ISBN 0-662-15664-1
Cat. No. Fo46-17/292E

Foreword

ENFOR is the acronym for the Canadian Government's ENergy from the FORest (ENergie de la FORet) program of research and development aimed at securing the knowledge and technical competence to facilitate in the medium to long term a greatly increased contribution from forest biomass to our nation's primary energy production. This program is part of a much larger federal government initiative to promote the development and use of renewable energy as a means of reducing dependence on petroleum and other non-renewable energy sources.

The Canadian Forestry Service (CFS) administers the ENFOR Biomass Production program component which deals with such forest-oriented subjects as inventory, harvesting technology, silviculture and environmental impacts. (The other component, Biomass Conversion, deals with the technology of converting biomass of energy or fuels, and is administered by the Renewable Energy Branch of the Department of Energy, Mines and Resources). Most Biomass Production projects, although developed by CFS scientists in the light of ENFOR program objectives, are carried out under contract by forestry consultants and research specialists. Contractors are selected in accordance with science procurement tendering procedures of the Department of Supply and Services. For further information on the ENFOR Biomass Production program, contact ...

ENFOR Secretariat
Canadian Forestry Service
Ottawa, Ontario
K1A 1G5

This report, on ENFOR Project P-327, was produced under contract (DSS File No. 11SB.KH603-5-0481) by the Forest Engineering Research Institute of Canada, Vancouver, British Columbia. The scientific authority for the contract was G.H. Manning, Pacific Forestry Centre, 506 West Burnside Road, Victoria, British Columbia, V8Z 1M5.

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Abstract

A prototype rock separator designed to separate rocks greater than 2.5 cm was built and tested at Nicholson Murdie Machines Limited. The prototype demonstrated that a rubber-belted conveyor can be used to separate rocks from woody material when operated with a side tilt, speed and slope greater than those normally used to transport wood waste. Rock separation rates greater than 90% with wood loss of 29% were achieved during the field tests. Average production rates of 8.8 tonnes per hour were achieved during prototype testing.

Résumé

La compagnie Nicholson Murdie Machines Limited a construit un prototype de séparateur de roches de plus de 2,5 cm et elle en fait l'essai. Le prototype a permis de montrer qu'un convoyeur à bande en caoutchouc peut servir à séparer les roches des morceaux de bois, pourvu que l'inclinaison latérale, la vitesse et la pente du convoyeur soient supérieures à celles des convoyeurs utilisés pour transporter les déchets de bois. Des taux de séparation des roches supérieurs à 90 % avec pertes de bois de 29 % et des débits moyens de 8,8 tonnes par heure ont été obtenus durant les essais sur place.

Acknowledgements

The authors would like to acknowledge the assistance, advice and cooperation of the following organizations:

British Columbia Forest Products Co. Ltd.,
Shoal Island Division
H. Vaux Contracting Ltd.
Nicholson Murdie Machines Ltd.
Nicholson Manufacturing Co.

Executive summary

Field tests were conducted in early 1986 at Nicholson Murdie Machine Limited at Victoria, British Columbia on a prototype rock separator system. The rock separator consisted of a rubber belt conveyor built so that belt speed, side tilt, and slope could be readily adjusted. In earlier ENFOR projects on biomass processing, it was observed that rocks separated from woody material when rubber belt conveyors were operated at nonstandard slopes and belt speeds. These tests were conducted to determine rock-removal efficiency when a flat, rubber belt conveyor was operated with a side tilt and at belt speeds and slopes above those normally recommended for transport of wood waste.

Several conclusions were drawn from the field tests:

- A rubber-belt conveyor, operated with a side tilt and at a speed and slope that are greater than those normally used to transport wood waste, can effectively separate rocks greater than 2.5 cm in size from sortyard debris. Rock-separation rates greater than 90% with a wood loss of 29% were achieved during field trials.

- Increases in belt speed and side-tilt angle were more effective than increases in belt slope in increasing rock-separation rate.

- Wood loss probably can be reduced by passing the separated rocks and wood chunks over a secondary rock separator.

- Debris was processed at an average rate of 8.8 tonnes per hour. More productive feeding equipment could increase the production rate of 8.8 tonnes per hour that was achieved during the trial.

The system tested is at the prototype stage. Further development will depend on the interest of potential users and manufacturers.

Introduction

The objectives of this project were (1) to design and build a machine that would remove rocks greater than 2.5 cm in size from sortyard debris; and (2) to test the machine and determine its rock-removal efficiency.

The concept behind the design of the rock separator came from field observations made during earlier projects (Sinclair 1982; 1984). From these projects, a separator/shear system was developed that made sortyard debris more attractive as a feedstock for hog fuel by reducing the dirt content and increasing size uniformity. Dirt content was reduced by using a disc screen to remove the fines content of sortyard debris and size uniformity was increased by using a hydraulically powered shear to cut the longer pieces of woody material. However, the system could not remove rocks greater than 2.5 cm, which was the spacing set on the disc screen. These rocks are undesirable in the feedstock for a hog mill.

During these earlier trials of the separator/shear system, a series of conveyors were used to transfer material from one processing unit to another. It was observed that when a rubber-belt conveyor was operated at a speed and slope greater than that recommended for transfer of wood waste, rocks tended to roll backward, rather than move up the conveyor. Therefore, it was decided to undertake a project to determine if effective rock separation could be achieved by modifying the normal angles and speeds used for rubber belt conveyors.

Description of prototype system

Figure 1 is a flow diagram of the prototype system.

A Bobcat Model 722 Skid-Steer Loader with a 0.25-m^3 bucket was used to feed the system, clean up between trial runs, and mix rocks into the debris. The infeed conveyor was a 18.3 m long by 76 cm wide rubber belt, troughing conveyor. A disc screen was situated after the infeed conveyor. The discs were scalloped and set to separate material less than 2.5 cm in size from the sortyard debris. Material less than 2.5 cm was collected in a bin below the disc screen. Material greater than 2.5 cm moved down a steel chute at the exit of the disc screen and fell onto the rock separator. The rock separator was a flat, rubber-belt conveyor and was 7.5 m long by 233 cm wide. The second roller of this conveyor was removed to increase the likelihood of the rocks bouncing when they fell on the conveyor from the disc screen. The slope, side tilt, and belt speed of the rock separator were adjustable. The adjustment range and field test adjustments are shown in Table 1.

Table 1. Adjustment range and field test adjustments used.

	Adjustment Range		Test Adjustments Used		
	Min.	Max.			
Slope (deg)	15	30	19	23	25
Side Tilt (deg)	0	45	12	15	18
Belt Speed (m/min)	75	150	90	120	150

A series of 1-m-long bins was attached to the side of the rock separator to catch the rocks as they were separated. The material exiting from the rock separator was collected in a 1.4-m^3 container.

Test method

The field tests lasted three weeks. The first week was spent assembling and debugging the system, and sampling the sortyard debris for size and type distribution, moisture content, and density. The final two weeks were spent conducting a series of trials at various slopes, side tilts, and belt-speed settings on the rock separator.

All material longer than 60 cm was reduced in size or removed from the sortyard debris in order to simulate the material that would normally come from the separator/shear system. Rocks (15 cm and less in size, round and angular) were mixed with the sortyard debris to simulate the natural rock content of the debris found in British Columbia coastal sortyards with a gravel surface.

A trial run consisted of:

1. Adjusting and recording the slope, side tilt,

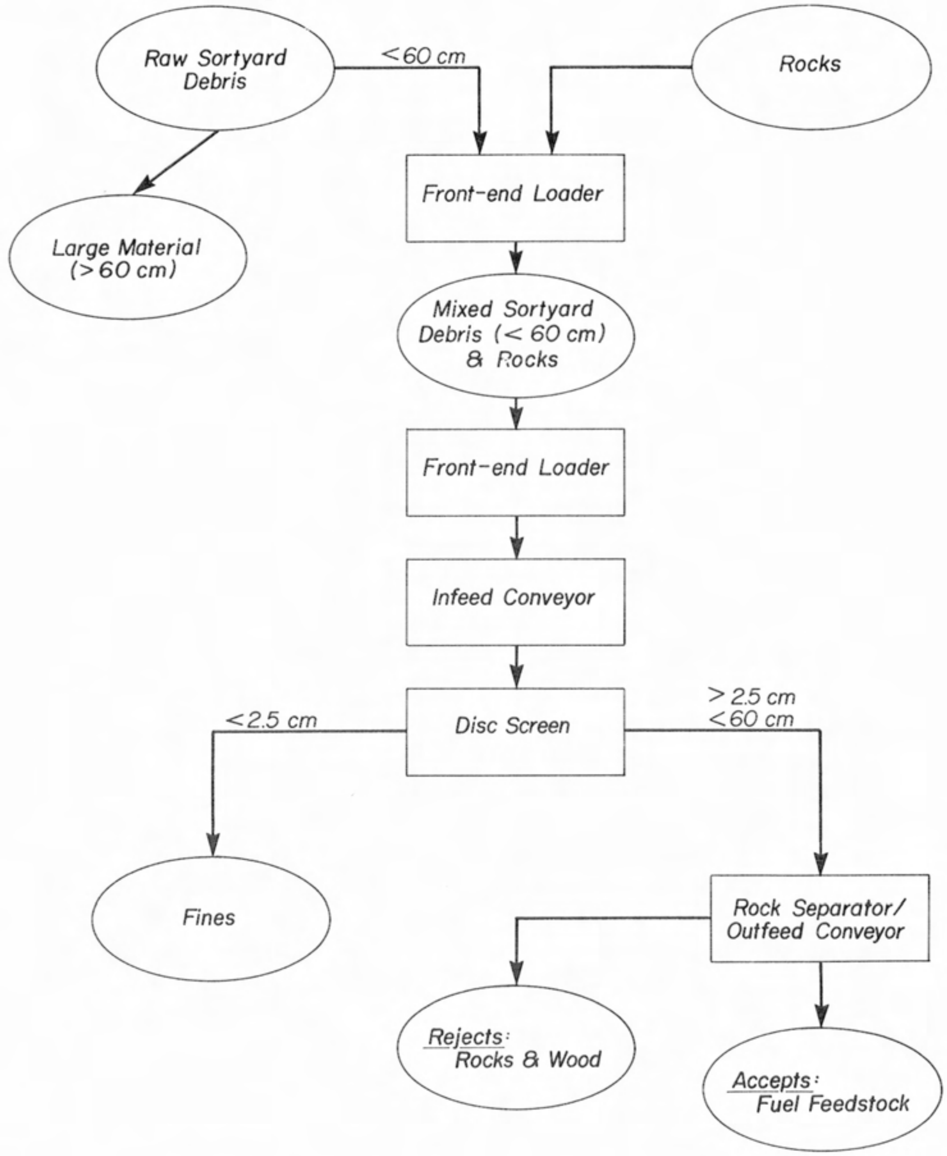

Fig. 1. Flow diagram of rock-separator test system

and belt speed settings on the rock separator.

2. Starting the conveyors and disc screen.

3. Feeding sortyard debris onto the infeed conveyor until the 1.4-m^3 container at the rock separator outfeed was full.

4. Recording the time taken to process the material through the system.

5. Separating the wood and rocks in the outfeed container and weighing them.

6. Separating and weighing the wood and rocks in each of the six bins on the side of the rock separator.

Usually, three trials were performed at each setting. The finer material (less than 2.5 cm) that passed through the disc screen was not weighed. Therefore, separation efficiency results for the rock separator relate only to the material that passed over it.

Table 2. Type and size distribution of unprocessed sortyard debris

Size class	Type of material	Percentage weight distribution
> 100 cm	Wood	3.73
	Cedar bark	0.68
	Other bark	0.01
	Branches	0.79
	Non-wood	0.00
	Class total	5.21
60-100 cm	Wood	1.64
	Cedar bark	0.77
	Other bark	0.28
	Branches	0.46
	Non-wood	0.00
	Class total	3.14
30-60 cm	Wood	2.93
	Cedar bark	0.97
	Other bark	1.25
	Branches	0.32
	Non-wood	0.00
	Class total	5.47
15-30 cm	Woody material	7.06
	Non-wood	trace
	Class total	7.06
7.5-15 cm	Woody material	1.50
	Non-wood	0.12
	Class total	1.62
< 7.5 cm	> 28.6 mm	11.39
	22.2 – 28.6 mm	5.18
	15.9 – 22.2 mm	6.55
	9.5 – 15.9 mm	11.70
	4.8 – 9.5 mm	17.45
	< 4.8 mm	25.22
	Class Total	77.50
	Grand Total	100.00
	Moisture content (fines only)	59.16%
	Density	469 kg/m³

Table 3. Size distribution and density of fines from disc screen

Size class	Percent weight distribution		
	Infeed end	Outfeed end	Average
> 28.6 mm	2.71	16.19	9.45
22.2 – 28.6 mm	2.15	7.72	4.94
15.9 – 22.2 mm	4.29	8.76	6.53
9.5 – 15.9 mm	13.20	14.76	13.98
4.8 – 9.5 mm	29.23	20.44	24.84
< 4.8 mm	48.41	32.11	40.26
Moisture content	55.53	58.86	57.10

Results & discussion

Table 2 gives the results of the analysis of the sortyard debris. Five, 1.8 m^3 samples were analyzed using a statistical, quartering technique. Compared to previous results on sortyard debris analysis this debris had a higher proportion of fines than normal. Rocks were added to this debris in order to simulate the debris from a sortyard with a gravel surface.

Table 3 gives the size-distribution of the material passing through the disc screen. Seven 0.1-m^3 samples were taken throughout the field trials. There is a gradient of size separation from the infeed to outfeed ends of the disc screen; the infeed end has a higher proportion of smaller material.

Table 4 is a summary of the results of the rock separation trials for various belt settings. The rock separation is the weight of rocks in the reject bins (on the side of the rock separator) divided by the total weight of rock processed over the rock separator. The wood loss rate is the weight of wood in the same bins divided by the total weight of woody material processed over the separator. The Appendix gives the details of each individual trial.

As can be seen from Table 4 and Figures 2 to 4, increases in belt speed and side tilt cause greater improvement in rock separation than increases in the belt-slope above 19 degrees. In these trials, the best rock separation rate was achieved

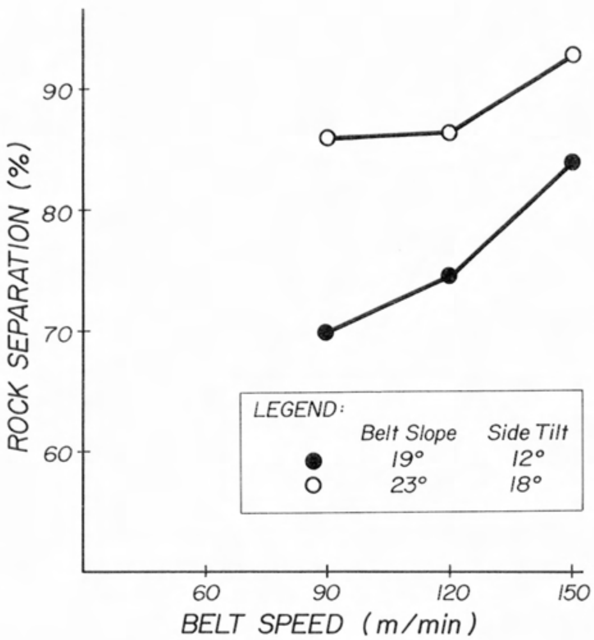

Fig. 2. Rock separation versus belt speed at fixed slope and side tilt

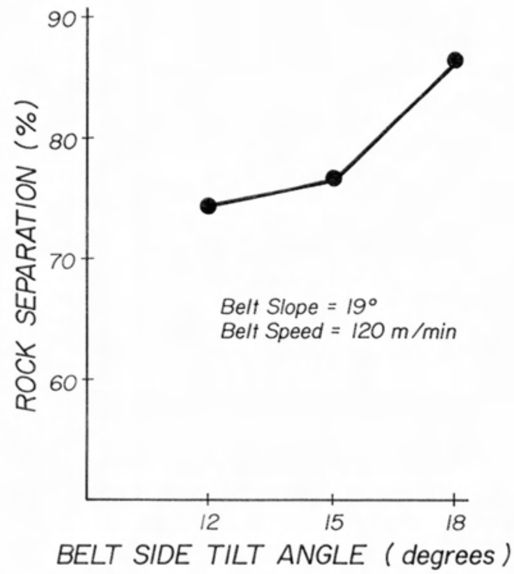

Fig. 3. Rock separation versus side tilt at fixed slope and belt speed

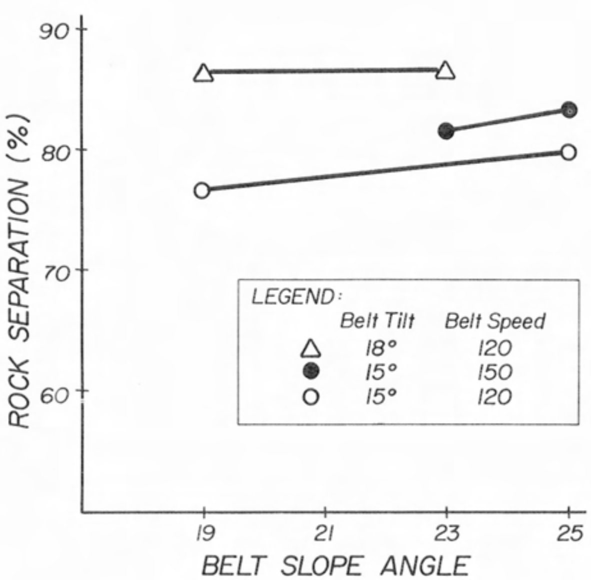

Fig. 4. Rock separation versus slope at fixed side tilt and belt speed

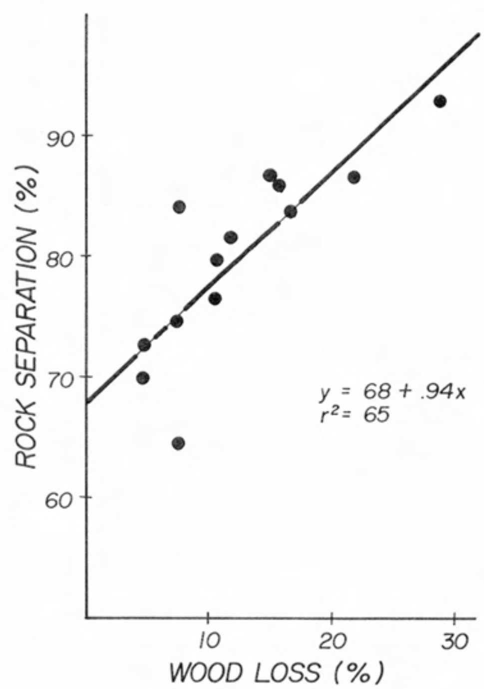

Fig. 5. Rock separation versus wood loss

Table 4. Rock separation rates and wood-loss rates at various belt settings

Belt settings Slope (deg)	Side tilt (deg)	Belt speed (m/min)	No. of trials	Rock separation rate %	Wood loss rate %
19	12	90	1	69.9	4.7
19	12	120	2	74.5	7.3
19	12	150	3	83.9	7.8
19	15	120	2	76.5	10.9
19	18	120	2	86.4	15.0
23	15	90	2	64.1	7.3
23	15	150	3	81.4	11.9
23	18	90	3	85.9	15.6
23	18	120	3	86.3	21.8
23	18	150	3	92.9	29.0
25	15	120	3	79.3	10.8
25	15	150	3	83.3	16.6

with slope, belt speed, and side-tilt settings of 23°, 150 m/min, and 18°, respectively. However, given the variability in moisture contents and the particle size and type distributions of sortyard debris, the optimum combination will probably be site specific.

It is difficult to achieve complete separation of the desirable and undesirable material with most separation devices. Also, the amount of desirable material lost will increase as the amount of undesirable material rejected increases. This is true of the rock separator as well (Figure 5); at a 90% or greater rock separation rate, there is a 29% loss in woody material. The woody material that was removed along with the rocks was chunky and free of fines and bark. A two-stage rock separator would reduce wood loss while retaining rock separation efficiency.

Linear regression analysis was applied to the rock separation and wood loss results and the resulting line and equation are also shown in Figure 5. There was almost a 1:1 ratio between an increase in rock separation and an increase in wood loss.

An average production rate of 8.8 tonnes per hour was achieved during the trial runs. This could be increased in a production system through the use of more productive feeding equipment.

The majority of the rocks separated into the bins at a distance of 1 to 3 m from the infeed of the rock separator. However, some rocks required the full length of the belt to separate out and dropped into the last bin located 5 to 6 m from the infeed. Therefore, a provision for collecting and removing rocks should be provided over the full length of the rock separator in any commercial operation.

Conclusions

A rubber belt conveyor, operated with a side tilt and at a speed and slope that are greater than those normally used to transport wood waste, can effectively separate rocks greater than 2.5 cm in size from sortyard debris. Rock separation rates greater than 90% with a wood loss of 29% were achieved during field trials.

Increases in belt speed and side-tilt were more effective than increases in belt slope in increasing the rock separation rate.

Wood loss probably can be reduced by passing the separated rocks and wood chunks over a secondary rock separator.

The trial runs processed debris at an average rate of 8.8 tonnes per hour. More productive feeding equipment could increase the production rate.

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APPENDIX (Details of trials)

Test No.	Conveyor adjustments: Slope (deg)	Side-tilt (deg)	Belt speed (m/min.)	Loading time (min)	Feeding time (min)	Total sample: Total (kg)	Rocks (kg)	Wood (kg)	Initial rock content (%)	Separation results: Accepts: Total (kg)	Rocks (kg)	Wood (kg)	Rock content (%)	Rejects: Total (kg)	Rocks (kg)	Wood (kg)	Rock content (%)	Rock removal rate (%)	Wood loss rate (%)	Productivity (kg/min)	Productivity (t/h)
10	19	12	90			1478.0	243.3	1234.7	16.5	1258.3	73.3	1177.1	5.9	222.7	170.0	5.7	74.7	69.9	4.7		
11.1	19	12	150	6.0	2.0	363.2	43.8	319.4	12.0	311.2	21.5	289.7	6.9	52.0	22.3	29.8	42.8	50.9	9.3	182	10.9
11.2	19	12	150			323.2	51.0	272.2	15.8	262.9	6.3	256.7	2.4	60.3	44.8	15.5	74.3	87.7	5.7		
11.3	19	12	150	23.0	9.8	533.3	150.9	382.4	28.3	380.9	30.3	350.7	7.9	152.4	128.7	31.8	79.2	80.0	8.3	54	3.3
12.1	19	12	120	13.3	7.8	476.5	111.7	364.8	23.4	358.4	26.3	332.1	7.3	118.2	85.5	32.7	72.3	76.5	9.0	61	3.7
12.2	19	12	120	9.4	6.8	383.5	86.1	297.4	22.5	304.1	22.0	282.1	7.2	79.4	64.1	15.3	88.8	74.4	5.1	77	4.6
12.3	19	12	120	9.2	4.0	285.4	36.8	248.6	12.9	239.4	10.1	229.3	4.2	46.1	26.7	19.4	58.0	72.6	7.8	71	4.3
13.1	19	12	120	9.5	4.8	550.9	114.6	436.3	20.8	409.2	33.4	375.8	8.2	141.7	81.2	60.5	57.3	78.9	13.9	115	6.9
13.2	19	15	120	11.3	5.1	607.3	105.2	502.1	17.3	481.2	18.9	462.3	3.9	126.1	86.3	39.8	68.4	82.1	7.9	119	7.1
14.1	19	18	120	12.6	5.2	492.3	136.9	355.5	27.8	311.4	14.3	297.2	43.6	180.9	122.6	58.3	67.8	89.6	16.4	95	5.7
14.2	19	18	120		6.7	479.9	88.9	399.8	16.9	358.3	13.6	344.7	3.8	121.7	67.3	54.4	55.3	83.2	13.6	72	4.3
16.1	23	18	120		6.7	570.1	11.3	558.8	2.0	440.8	2.3	438.5	8.5	129.3	9.0	120.3	7.0	80.0	21.5	85	5.1
16.2	23	18	120	8.1	3.0	422.3	6.8	415.6	1.6	342.0	8.8	341.3	8.2	88.3	6.0	74.3	7.5	88.9	17.9	141	8.4
16.3	23	18	120	13.6	6.5	435.5	85.8	349.8	19.7	267.2	8.5	258.7	3.2	168.3	77.3	91.1	45.9	90.1	26.0	67	4.0
17.1	23	18	90	9.2	4.3	559.6	91.8	467.9	16.4	404.3	9.5	394.8	2.3	155.4	82.3	73.1	52.9	89.6	15.6	130	7.8
17.2	23	18	90		4.6	538.2	58.4	487.9	9.4	417.6	5.5	412.1	1.3	128.7	44.9	75.8	37.2	89.1	15.5	117	7.0
17.3	23	18	90	8.5	4.4	545.6	54.5	491.1	10.0	429.3	11.5	417.8	2.7	116.3	43.0	73.3	37.0	78.9	14.9	124	7.4
18.1	23	18	150	5.8	3.1	483.2	46.5	356.7	11.5	235.7	2.8	233.8	1.2	167.5	43.8	123.8	26.1	94.1	34.7	130	7.8
18.2	23	18	150	6.6	2.8	418.7	96.6	322.1	23.1	225.8	2.8	223.0	1.2	193.0	93.9	99.1	48.6	97.2	30.8	140	8.4
18.3	23	18	150	6.5	2.8	445.9	51.3	394.7	11.5	316.5	6.5	310.0	2.1	129.4	44.8	84.7	34.6	87.3	21.4	159	9.6
19.1	23	15	150		2.2	512.3	111.8	400.6	21.0	374.5	22.3	352.2	5.9	137.9	89.5	48.4	64.9	80.1	12.1	233	14.0
19.2	23	15	150	13.0	2.8	371.2	63.8	387.5	17.2	270.7	9.3	261.4	3.4	100.6	54.5	46.1	54.2	85.5	15.0	133	8.0
19.3	23	15	150		2.2	485.6	47.8	437.9	9.8	410.2	18.3	399.9	2.5	75.5	37.5	38.0	49.7	78.5	8.7	221	13.2
20.1	23	15	90		2.4	449.0	67.0	382.0	14.9	372.6	22.8	349.8	6.1	76.5	44.3	32.2	57.9	66.8	8.4	187	11.2
20.2	23	15	90		2.5	385.1	43.9	341.2	11.4	336.7	16.6	328.1	4.9	48.4	27.3	21.1	56.4	62.1	6.2	154	9.2
21.1	25	15	120		2.5	407.4	43.4	364.1	18.6	331.0	6.0	325.0	1.8	76.4	37.4	39.1	48.9	86.2	18.7	163	9.8
21.2	25	15	120		1.3	357.0	95.0	262.0	26.6	247.5	17.8	229.8	7.2	109.5	77.3	32.2	70.6	81.3	12.3	275	16.5
21.3	25	15	120		1.8	381.3	95.1	286.2	24.9	287.2	28.1	259.1	9.8	94.1	67.0	27.1	71.2	70.5	9.5	121	12.7
22.1	25	15	150		1.8	326.9	63.6	263.3	19.5	247.4	16.6	238.8	6.7	79.6	47.0	32.6	59.1	73.9	12.4	182	18.9
22.2	25	15	150		3.0	521.0	119.5	481.5	22.9	309.0	8.8	300.2	2.8	212.0	110.8	101.3	52.2	92.7	25.2	174	18.4
22.3	25	15	150		1.5	546.1	71.5	474.6	13.1	430.3	14.0	416.3	3.3	115.8	57.5	58.3	49.7	80.4	12.3	364	21.8

APPENDIX (Cont)

Test No.	Conveyor adjustments: Slope (deg)	Conveyor adjustments: Side-tilt (deg)	Conveyor adjustments: Belt speed (m/min.)	Conveyor adjustments: Loading time (min)	Conveyor adjustments: Feeding time (min)	Total sample: Total (kg)	Total sample: Rocks (kg)	Total sample: Wood (kg)	Total sample: Initial rock content (%)	Separation results, Accepts: Total (kg)	Separation results, Accepts: Rocks (kg)	Separation results, Accepts: Wood (kg)	Separation results, Accepts: Accepts rock content (%)	Separation results, Rejects: Total (kg)	Separation results, Rejects: Rocks (kg)	Separation results, Rejects: Wood (kg)	Separation results, Rejects: Rejects rock content (%)	Rock removal rate (%)	Wood loss rate (%)	Productivity (kg/min)	Productivity (t/h)
10	19	12	90	58.4	45.3	99.8	21.4	37.9	21.5	16.4	5.6	2.3	3.4	3.5	1.3	2.3	1.3	0.0	1.3	13.1	121.1
11.1	19	12	150	2.8	2.3	2.8	9.5	23.3	13.8	9.5	6.5	1.3	5.3	3.5	2.3	1.3	3.8	0.0	3.8	8.5	12.3
11.2	19	12	150	3.3	2.5	28.3	5.3	15.3	11.5	3.8	9.3	5.5	3.8	6.0	4.5	1.5	1.0	0.5	0.5	0.8	25.5
11.3	19	12	150	12.5	10.8	38.4	9.5	43.9	37.1	6.8	28.4	19.1	9.3	12.9	9.9	3.0	7.0	5.5	1.5	1.8	47.9
12.1	19	12	120	12.5	10.3	30.0	13.1	38.9	30.0	8.9	15.4	9.6	5.8	5.1	4.1	1.0	3.3	1.5	1.8	2.3	43.1
12.2	19	12	120	4.0	3.0	21.1	4.0	25.6	22.4	3.3	16.7	10.7	6.0	4.0	3.5	0.5	4.0	3.5	0.5	1.0	25.1
12.3	19	12	120	4.5	2.8	16.4	5.5	8.9	4.4	4.5	8.8	2.3	6.5	1.9	1.0	0.9	0.3	0.0	0.3	1.8	21.9
13.1	19	15	120	9.0	6.5	37.9	11.5	66.1	28.9	37.3	13.8	6.5	7.3	2.5	1.5	1.0	1.0	0.0	1.0	2.5	49.4
13.2	19	15	120	14.5	12.1	41.5	20.5	32.1	21.6	10.5	13.4	8.9	4.5	4.0	2.3	1.8	0.2	0.0	0.2	2.4	62.0
14.1	19	18	120	21.9	16.3	65.6	27.6	49.1	33.5	15.6	12.0	6.8	5.3	3.0	0.5	2.5	1.8	0.0	1.8	5.6	93.2
14.2	19	18	120	19.6	12.6	33.9	18.0	30.4	12.6	17.8	13.8	6.0	7.8	5.4	2.3	3.1	0.8	0.0	0.8	7.0	51.9
16.2	23	18	120	21.1	8.3	8.0	59.0	26.6	0.8	25.9	10.4	0.0	10.4	3.0	0.0	3.0	1.3	0.0	1.3	20.9	67.0
16.3	23	18	120	11.8	1.5	5.0	35.6	16.0	0.5	15.5	9.9	0.0	9.9	2.8	0.0	2.8	1.1	0.0	1.1	9.5	39.6
17.1	23	18	90	63.1	38.0	42.5	35.4	10.1	1.8	8.4	2.1	0.0	2.1	0.1	0.0	0.1	2.1	0.0	2.1	25.1	77.9
17.2	23	18	90	47.8	25.0	16.0	38.4	13.1	3.9	9.3	3.9	0.0	3.9	0.8	0.0	0.8	0.9	0.0	0.9	22.8	54.4
17.3	23	18	90	37.9	15.3	23.5	37.4	14.4	4.3	10.1	2.0	0.0	2.0	0.5	0.0	0.5	0.8	0.0	8.8	22.6	60.9
18.1	23	18	150	65.5	17.5	11.0	12.8	41.1	9.5	31.6	18.1	1.8	16.4	11.4	3.3	8.1	7.6	8.8	6.9	48.1	23.8
18.2	23	18	150	16.1	9.8	55.4	51.1	43.4	18.5	24.9	20.0	10.0	10.0	4.5	0.3	4.2	2.6	0.0	2.6	6.4	106.5
18.3	23	18	150	18.9	4.0	19.0	42.9	26.5	11.3	15.3	17.6	5.5	12.1	8.0	3.8	4.3	4.6	1.3	3.4	6.9	61.9
19.1	23	15	150	14.0	9.8	35.0	16.9	51.3	36.8	14.5	13.3	7.3	6.0	5.0	0.8	4.3	2.5	0.0	2.5	4.3	51.9
19.2	23	15	150	8.0	6.3	24.0	14.1	25.3	13.3	12.0	11.6	4.3	7.4	11.6	4.3	7.4	6.0	2.5	3.5	1.8	38.1
19.3	23	15	150	4.8	3.0	22.5	13.0	17.6	5.3	12.4	10.0	5.5	4.5	5.6	1.3	4.4	1.3	0.0	1.3	1.8	36.3
20.1	23	15	90	24.9	12.0	25.0	12.3	10.1	5.0	5.1	2.8	2.3	0.5	0.5	0.0	0.5	1.0	0.0	1.0	12.9	37.3
20.2	23	15	90	12.5	8.0	15.5	9.4	9.5	3.8	5.8	1.5	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	4.5	24.9
21.1	25	15	120	6.4	4.0	13.5	15.8	24.4	15.5	8.9	9.0	3.5	5.5	6.6	8.9	5.8	0.9	0.0	0.9	2.4	29.3
21.2	25	25	120	15.6	12.3	39.3	20.8	25.1	22.3	2.9	5.3	2.3	3.0	1.5	0.0	1.5	2.0	1.3	0.8	3.4	60.0
21.3	25	15	120	12.5	9.3	32.0	18.1	24.8	14.5	18.3	9.0	7.3	1.8	5.3	4.0	1.3	8.5	0.0	0.5	3.3	42.1
22.1	25	15	150	4.4	3.8	16.8	9.8	33.4	22.0	11.4	9.0	3.0	6.0	5.1	1.5	3.6	1.3	0.0	1.3	0.6	26.5
22.2	25	15	150	25.7	15.0	57.5	36.6	57.1	25.0	32.1	24.5	11.5	13.0	7.6	1.8	5.9	3.0	0.0	3.0	18.7	94.1
22.3	25	15	150	9.4	5.0	24.5	25.3	28.6	17.3	11.4	21.5	10.0	11.5	4.9	0.8	4.1	1.8	0.0	1.8	4.4	49.8