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Evaluation Report 11

Sperry New Holland Model 379 Tub Grinder

A Co-operative Program Between
ALBERTA FARM MACHINERY RESEARCH CENTRE
PAMI
PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

NEW HOLLAND MODEL 379 TUB GRINDER

MANUFACTURER:
Easy Engineering Corporation
2685 Industrial Lane
Broomfield, Colorado 80020
U.S.A.

DISTRIBUTORS:
Sperry New Holland
-- Box 777
Winnipeg, Manitoba
R3C 2L4

-- Box 1907
Regina, Saskatchewan
S4P 3E3

--Box 1616
Calgary, Alberta
T2P 2M7

RETAIL PRICE:
$12,850.00 (December 1, 1977, f.o.b. Humboldt, with 51 mm (2 in) screen.)

FIGURE 1. Sperry New Holland 379 Tub Grinder.

SUMMARY AND CONCLUSIONS

Overall functional performance of the New Holland 379 was good in both baled and stacked hay and straw. Ease of operation was good, but was reduced by difficulty in unplugging the screen.

Maximum grinding rates with a 51 mm (2 in) screen were about 6.5 t/h (7.2 ton/h) in baled alfalfa, 8.0 t/h (8.8 ton/h) in stacked alfalfa, 6.5 t/h (7.2 ton/h) in stacked barley straw and 7.6 t/h (8.4 ton/h) in baled barley straw. With most tractors, grinding rates were usually limited by tractor power rather than by feeding characteristics.

As with most tub grinders, power consumption was high and specific capacity was low. Specific capacity varied from 0.32 t/kW•h (0.26 ton/hp•h) in stacked alfalfa hay to 0.08 t/kW•h (0.07 ton/hp•h) in round barley straw bales, when using a 51 mm (2 in) screen.

As with most tub grinders, the method of feeding the hammer mill imposed heavy shock loads on the power train and resulted in wide power fluctuations. For example, at the maximum feedrate of 7.6 t/h (8.4 ton/h), with a 51 mm (2 in) screen in round barley straw bales, the average power input was 98 kW (131 hp), however, a tractor with a maximum power take-off output of at least 144 kW (193 hp) was needed to prevent tractor stalling due to the wide power fluctuations. By adjusting the tub governor, smaller tractors could be used at reduced grinding rates.

The New Holland 379 was safe to operate if the manufacturer's recommendations were closely followed. The location of the tub speed control adjacent to the PTO shaft required additional caution when adjusting tub speed.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Modifying the discharge chute to reduce plugging of material below the screen.
2. Providing access doors to allow unplugging of the screen.
3. Relocating the inspection platform away from the winch cables and the guide rack so it is more accessible.
4. Investigating the possibility of installing a suitable flywheel on the hammer mill to reduce drive train shock loads.

Chief Engineer -- E. O. Nyborg

Senior Engineer -- L. G. Smith

THE MANUFACTURER STATES THAT

With regard to recommendation number:

This model of tub grinder has been discontinued and, consequently, the recommendations that are suggested will not be followed. We have subsequently brought out the Model 393 and Model 396 Tub Grinders.

GENERAL DESCRIPTION

The New Holland Model 379 Tub Grinder (FIGURE 1) is a portable power take-off driven hammer mill with rotary feed tub, designed to grind loose, stacked or baled straw and hay.

The manufacturer recommends use with tractors up to 112 kW (150 hp) at 1000 rpm power take-off speed.

The New Holland 379 is designed to be batch fed with a suitably equipped front end loader. The hydraulically driven, variable speed tub regulates feed to a belt driven hammer mill. An electronic governor automatically controls the tub speed and stops tub rotation when the tractor speed drops below a preset level.

Fineness of grind is determined by the size of screen used below the hammer mill. Ground material falls through the screen onto a hydraulically driven apron conveyor, which delivers it to an adjustable elevating conveyor.

Detailed specifications are given in APPENDIX I.

SCOPE OF TEST

The New Holland 379 was operated for 48 hours while processing about 430 t (475 tons) of hay and straw. It was used to process small square bales, large round bales, and stacked hay.

It was evaluated for ease of operation, rate of work, power consumption, quality of work, operator safety and suitability of the operator's manual.

RESULTS AND DISCUSSION

EASE OF OPERATION

Hitching: The New Holland 379 was easily hitched to a tractor. The hitch jack was safe and convenient to use. The 1000 rpm power take-off shaft was attached with a spring loaded pin and the governor cables could be connected to any convenient 12 volt source on the tractor.

Tub Control: The reversible hydraulic tub drive was equipped with a proportioning valve to control the tub speed and consequently the feedrate. The valve had to be set to obtain steady tub rotation while utilizing the available tractor power. The valve had to be adjusted to suit both the type of material being ground and the tractor size. It was quite easy to determine the proper setting by opening the valve until the tractor was suitably loaded.

The electronic governor reduced hammer mill slugging if the proportioning valve was properly set. As engine speed dropped under load, the governor stopped tub rotation if power take-off speed fell below 975 rpm. As with most tub grinders, slugging and high drive train loads occurred if excessive feedrates were attempted.

A hydraulic motor driven solid rubber tire rotates the tub through contact inside the lower channel ring of the tub. Pressure against the tire is maintained by a spring loaded roller.

When grinding damp material or material containing snow, the tire and tub ring would become wet, causing tire slippage and consequent toss of capacity.

Loading the Tub: The tub (FIGURE 2) had straight sides with a flare top and a rear guide rack to facilitate loading large round bales. The height to the top of the tub was 2800 mm (9.2 ft). When loading loose hay with grapple forks, hay often caught on the flare top if large loads were used. Most effective feeding was obtained by taking small loads, which would easily drop within the flare top.

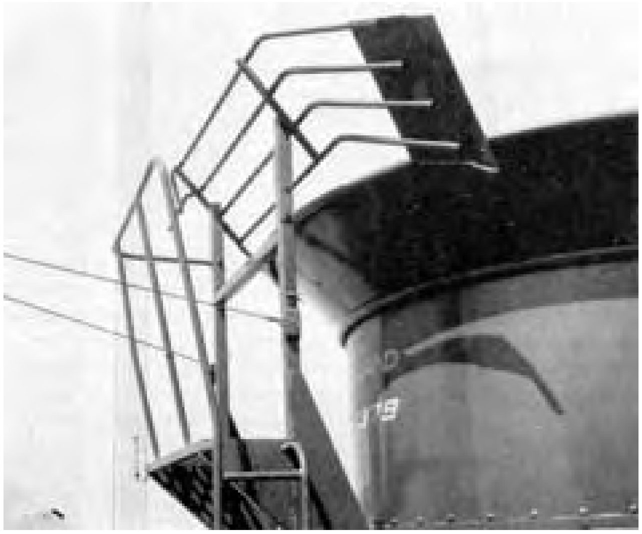


FIGURE 2. Tub and Guide Rack.

Occasionally, a large round bale placed in the centre of the tub would not contact the tub fins and no grinding would occur. A minor adjustment to the fin on the side of the tub would initiate grinding.

Screen Removal: Three screen sizes from 51 to 102 mm (2 to 4 in) were available for the New Holland 379. Changing the screens (FIGURE 3) required the removal of six bolts, restrictor bars and deflector plate and the use of a bar to pry the screens up and around the mill. Screens could be removed and replaced by one man in about 30 minutes.

FIGURE 3. Hammer Mill and Screen.

Hammer Mill: The hammer mill contained four rows of swinging hammers, with 12 hammers per row. When worn, the hammers could be turned to present a new wear surface. This could be accomplished from within the tub by sliding each pivot shaft through a hole provided to a man outside the tub. Turning a complete set of hammers took two men about 1.5 hours.

Discharge Chamber: The hammer mill discharged ground material onto a rough top apron conveyor (FIGURE 4) beneath the screen. If ground material was not dry, it tended to build up at the top of the cavity between the screen and the chute. Limited access made clean out below the screen difficult.

Elevating Conveyor: The rough top rubber belt conveyor had ample conveying capacity at lift angles up to 25°. In most materials, at lift angles greater than 25°, the material slipped and tumbled on the belt. At a 25° angle, the conveyor had a discharge height of 3300 mm (10.8 ft) and a corresponding reach of 6072 mm (19.9 ft).

The conveyor was equipped with self cleaning pulleys which effectively reduced the buildup of fines between the conveyor belt and the belt trough. The sides of the conveyor trough prevent the blowing of fines. The hooded discharge also reduced scattering of the ground material as it left the conveyor.

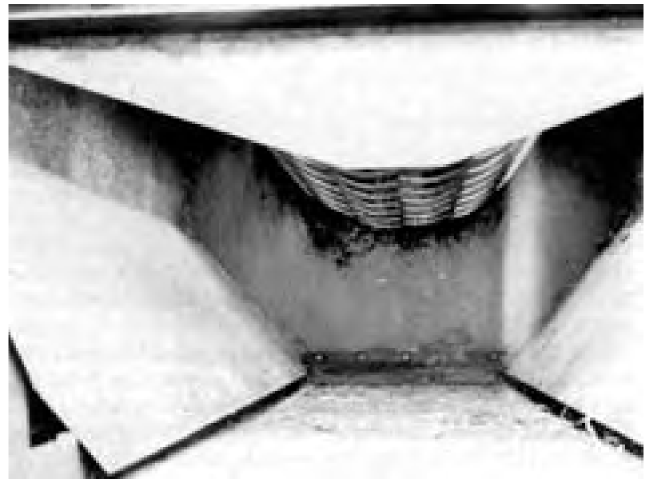


FIGURE 4. Mill Discharge and Apron Conveyor.

The conveyor speed could be controlled by setting the flow divider supplying oil to the conveyor and tub drives. The setting of this flow divider was quite critical since increased flow to the tub would reduce flow to the conveyor until a point was reached where the conveyor would not remove the material as fast as it was ground. A higher flow rate in this circuit would have increased the capacity under many conditions.

Winter Operation: All evaluation was conducted in winter conditions, typical of most tub grinder use in the prairie provinces. All components, including the hydraulic tub control, worked well, even at temperatures of -30°C.

During winter operation, accumulated snow should be removed from the tub and rotating parts checked for ice accumulation before starting. It is also recommended to start the grinder with the tub control in neutral position.

As is common with all tub grinders, excessive snow mixed with ground hay can result in heating problems. If ground hay is to be stockpiled, the moisture content must be low enough to ensure that the stockpile will not heat and spoil.

Transporting: The New Holland Model 379 was equipped with tandem axles with springs. The springs effectively absorbed shock loads in transport or when material was loaded into the tub.

Due to the large overhang of the conveyor behind the rear wheels, extreme care had to be exercised in turning corners. The conveyor was safely held in position by a pair of stabilizer bars during transport.

RATE OF WORK

Maximum Grinding Rate: The maximum grinding rate for a tub grinder depends on the type of hay being ground, whether the hay is baled or loose, its moisture content and temperature, the screen size used, and the available tractor power. In general, grinding rates are higher at very low temperatures as hay becomes more brittle at reduced temperatures.

Maximum grinding rates obtained with the New Holland 379, when equipped with a 51 mm (2 in) screen were 6.5 t/h (7.2 ton/h) in baled alfalfa, 8.0 t/h (8.8 ton/h) in stacked alfalfa, 6.5 t/h (7.2 ton/h) in stacked barley straw and 7.6 t/h (8.4 ton/h) in baled barley straw. In general, the capacity was directly related to the screen size used and increasing the screen size by 50% also increased the capacity by about 50%.

POWER CONSUMPTION

Power Take-off Requirements: FIGURE 5 shows the average power take-off input for the New Holland 379 in alfalfa and barley straw. The power input is plotted against the grinding rate up to the maximum rate reached for each test. The average power input, at maximum grinding rate, with a 51 mm (2 in) screen varied from 25 kW (34 hp) in stacked alfalfa hay to 98 kW (131 hp) in round barley straw bales.

The power consumption at reduced grinding rates, corresponding to smaller tractors, may be read from FIGURE 5. As mentioned previously, the capacity was directly related to the screen size for a certain power input. For example, a power input of 98 kW (131 hp) in round barley straw bales corresponds to a maximum capacity of 7.6 t/h (8.4 ton/h) with a 51 mm (2 in) screen and a maximum capacity of about 11.4 t/h (12.5 ton/h) with a 76 mm (3 in) screen.

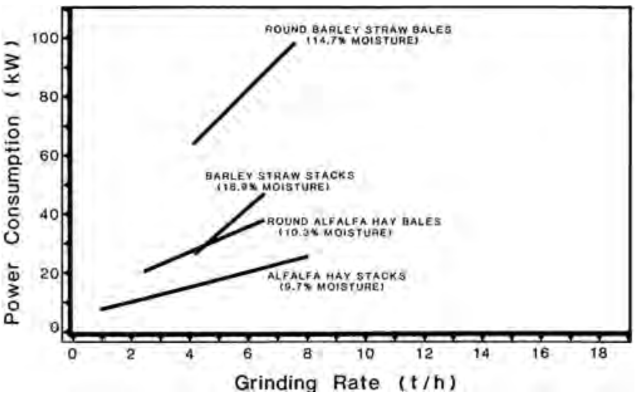


FIGURE 5. Power Consumption of the New Holland 379 at Various Grinding Rates, when Equipped with a 51 mm (2 in) Screen.

Specific Capacity: Specific capacity is a measure of how efficiently a machine performs a task. A high specific capacity indicates efficient energy use while a low specific capacity indicates inefficient operation. Tub grinders, in general, are inefficient machines.

The specific capacity of the New Holland 379, with a 51 mm (2 in) screen, varied from 0.32 t/kW•h (0.26 ton/hp•h) in stacked alfalfa hay to 0.08 t/kW•h (0.07 ton/hp•h) in round barley straw bales. These values represent average operating values and not peak outputs.

Instantaneous Power Requirements: FIGURE 5 shows the average power consumption at various feedrates. Instantaneous power input fluctuates rapidly due to non-uniform feeding to the hammer mill and governor sensitivity. Peak power requirements are much greater than those shown in FIGURE 5. A typical one minute long, instantaneous record of power input while grinding baled alfalfa hay is shown in FIGURE 6. As can be seen, input power fluctuated rapidly during one minute of operation at a fixed governor setting. These wide power fluctuations represent shock loads to the tractor and grinder drive train and indicate the amount of reserve power needed to prevent tractor stalling.

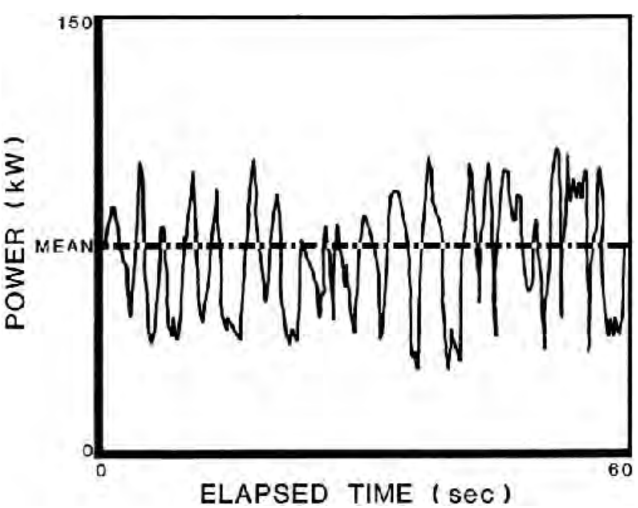


FIGURE 6. Typical Instantaneous Power Requirements for a Tub Grinder.

The coefficient of variation[1] (TABLE 1) may be used to compare the power train shock loads and to show the possibility of tractor stalling when grinding various materials. The larger the coefficient of variation, the higher the shock loads and the greater the possibility of tractor stalling. Large variations in power requirements may be partially controlled with the tub governor. Most of the variation, which is beyond operator control, is due to the erratic nature of feeding in most tub grinders.

TABLE 1. Coefficients of Variation of Input Power for the New Holland 379 with 51 mm (2 in) Screen

Straw Bales	Straw Stacks	Alfalfa Stacks
23.6%	19%	13.5%

In general, smaller variations in power requirement occurred with loose hay or straw than with bales, due to more uniform feeding. It is recommended that the manufacturer investigate the possibility of installing a suitable flywheel on the hammer mill to reduce drive train shock loads.

Determining Expected Grinding Rate for Certain Tractor Size: FIGURE 7[2] may be used to estimate the average grinding rate, which may be expected for a certain tractor size in a certain type of material when using a 51 mm (2 in) screen. FIGURE 7 presents the same data as given in FIGURE 5, but has been corrected to include the peak power fluctuations shown in TABLE 1. For example, a tractor with maximum power take-off output of 120 kW (160 hp) at 1000 rpm, expected maximum grinding rate without tractor stalling is 5.9 t/h (6.5 ton/h) in round straw bales. As previously discussed, changing to a 76 mm (3 in) screen would increase the expected grinding rates to about one and one-half times those shown in FIGURE 7, for the same power input.

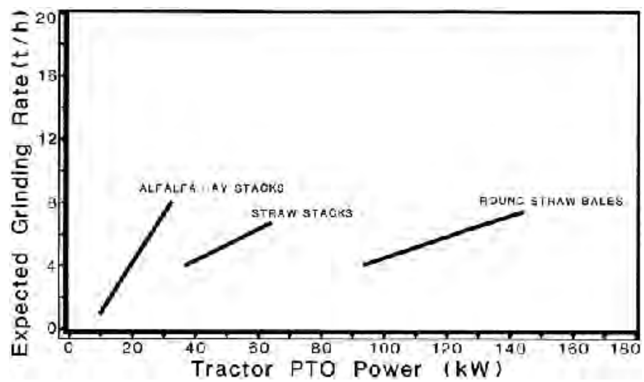


FIGURE 7. Determining Expected Average Grinding Rates With the New Holland 379 for Various Tractor Sizes when Using a 51 mm (2 in) Screen.

QUALITY OF WORK

Length of Cut: For a certain screen size, tub grinders produce chopped hay of varying particle lengths. FIGURE 8 shows a typical particle size distribution for the New Holland 379 when grinding stacked alfalfa hay with a 51 mm (2 in) screen. TABLE 2 shows the percent by weight of each of the particle sizes given in FIGURE 8, when grinding various materials with a 51 mm (2 in) screen.

TABLE 2. Size Distribution of Ground Material when Using a 51 mm (2 in) Screen

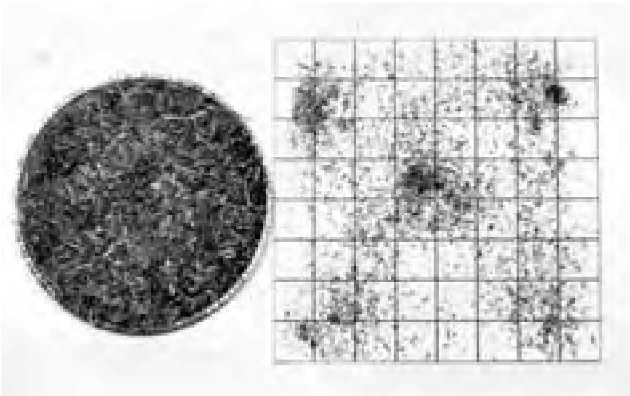
Length of Particle	Percent of Total Sample Weight				
	Stacked Barley	Round Barley	Stacked Alfalfa	Round Alfalfa	Stacked Sweet Clover
Less than 3 mm long (FIG. 8a)	10.9	17.5	16.8	14.8	31.7
3 to 10 mm (FIG. 8b)	34.5	40.2	39.5	48.2	43.0
10 to 18 mm (FIG. 8c)	17.8	17.2	13.8	12.7	11.1
18 to 25 mm (FIG. 8d)	14.5	12.0	11.6	12.3	6.8
25 to 38 mm (FIG. 8e)	17.6	11.1	14.8	10.5	2.7
Greater than 38 mm (FIG. 8f)	4.7	2.0	3.5	1.5	0.8

OPERATOR SAFETY

The New Holland 379 was generally safe to operate and service as long as common sense was used and the manufacturer's safety recommendations were followed. Rotating parts were well shielded, the unloading conveyor could be fixed in position for transport and the cable winch had a friction drag for safety in FIGURE

[1]The coefficient of variation is the standard deviation of the power fluctuation expressed as a percent of the mean power at one feedrate setting. The coefficients of variation given in TABLE 1 are the average of the coefficient of variation for at least six different feedrates in each material.

[2]FIGURE 7 is a plot of the mean power requirements plus twice the standard deviation of the power fluctuations. Instantaneous power requirements should fall below the line 98% of the time.



8a. Less than 3 mm long.

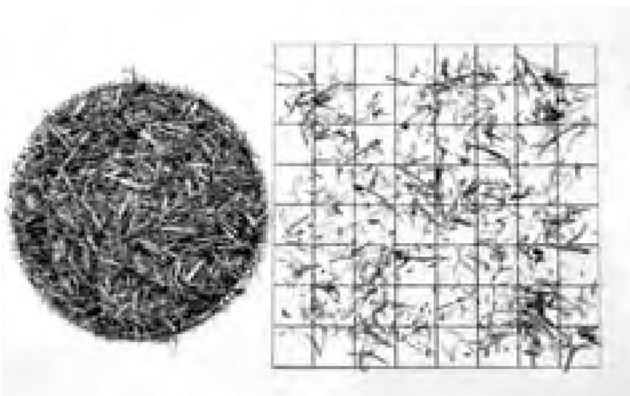


FIGURE 8b. 3 to 10 mm.

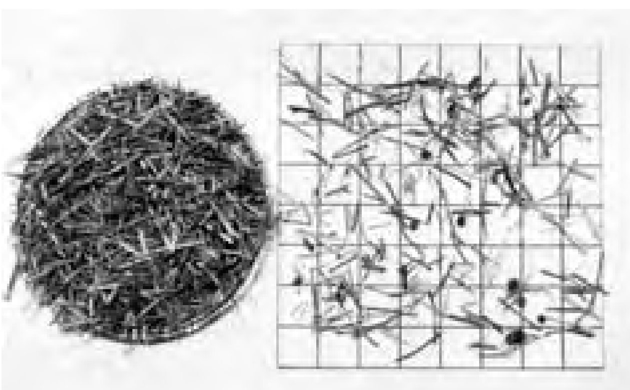


FIGURE 8c. 10 to 18 mm.

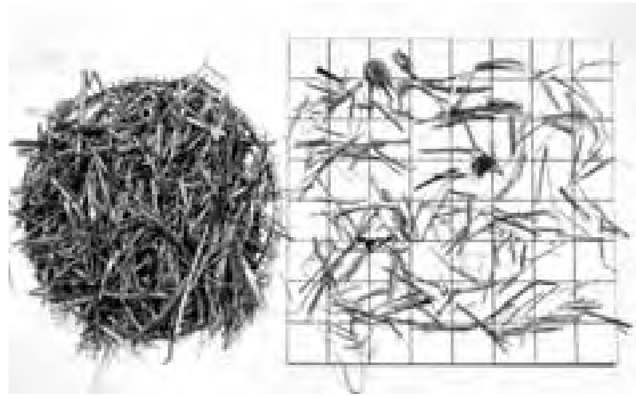


FIGURE 8d. 18 to 25 mm.

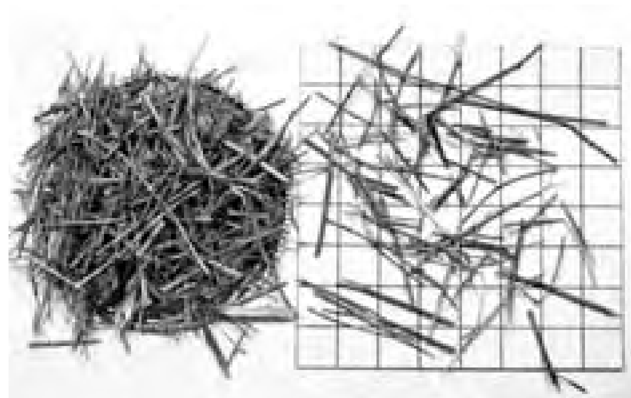


FIGURE 8e. 25 to 38 mm.

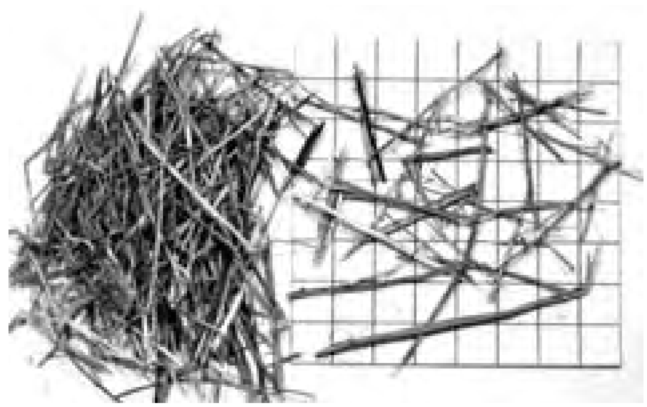


FIGURE 8f. Greater than 38 mm.

FIGURE 8. Distribution of Particle Lengths when Grinding Stacked Alfalfa Hay with a 51 mm (2 in) Screen. (Pictures were taken on a 2 cm grid.)

lowering the elevating conveyor. However, the location of the winch cables and guide rack made climbing onto the platform and into the tub for servicing somewhat hazardous (FIGURE 9).

The location of the tub speed control (FIGURE 10) adjacent to the pto shaft required caution when making adjustments to tub speed.

GENERAL SAFETY COMMENTS

The operator is cautioned that a tub grinder is potentially very dangerous. The following precautions should be observed when operating any tub grinder.

Never stand on the inspection platform or look into the tub while the grinder is in operation as dangerous objects may be thrown out of the tub by the hammer mill.

Never grasp loose baler twine that is hanging over the tub wall as it may be instantaneously reeled into the hammer mill causing injury.

Periodically remove twine buildup from the hammer mill rotor to reduce fire hazard and carry a fire extinguisher on the grinder at all times.

Tow the grinder behind a tractor or suitable sized truck at low speed. A light pickup truck is not suitable. Be especially careful of conveyor height and overhang when turning corners or passing under power lines.

Disengage the power take-off and stop the tractor to clear blockages or to make adjustments. The manufacturer can only go to certain limits in providing shielding and safety devices and must rely on the operator's common sense in following established safety procedures.

As is common with all tub grinders, great care must be taken to ensure that the hay is free of foreign material such as barbed wire or baling wire. This is especially true when processing large round bales. Although wire presents no problem to the tub grinder, the short pieces formed after grinding are a potential source of "hardware disease" in cattle.

OPERATOR'S MANUAL

The operator's manual was clear, well written and contained much useful information on operation, servicing, adjustments and safety precautions.

FIGURE 9. Guide Rack and Winch Cables.

FIGURE 10. Tub Speed Controls.

DURABILITY RESULTS

The New Holland Model 379 was operated for 48 hours while processing about 430 t (473 tons) of hay and straw. The intent of the test was to evaluate functional performance and an extended durability evaluation was not conducted. No significant mechanical problems occurred during functional testing.

APPENDIX I
SPECIFICATIONS

MAKE:	Sperry New Holland Tub Grinder
MODEL:	379
SERIAL NUMBER:	1201.
MANUFACTURER:	Easy Engineering Corporation 2685 Industrial Lane Broomfield, Colorado U.S.A. 80020
OVERALL DIMENSIONS:	
-- width	3050 mm (120.1 in)
-- height	3240 mm (127.6 in)
-- length	10420 mm (410.2 in)
-- ground clearance	290 mm (11.4 in)
WEIGHT:	
-- hitch	210 kg (463 lbs)
-- left wheels	1062 kg (2341 lbs.)
-- right wheels	1172 kg (2587 lbs)
TOTAL	2444 kg (5391 lbs)
SUSPENSION:	Leaf springs
TIRES:	
-- size	4, 7 x 14.5, 8-ply rating
TUB:	
-- top diameter	3050 mm (120.1 in)
-- bottom diameter	2260 mm (89.0 in)
-- depth of flare at top	360 mm (12.2 in)
-- total depth	1350 mm (53.1 in)
-- loading height	2800 mm (110.2 in)
-- type of governor	Electro-Mechanical
-- tub speed range	0 to 4.6 rpm
-- drive	Hydraulic motor driving solid rubber tire
HAMMER MILL:	
-- length	1010 mm (39.8 in)
-- diameter (hammer extended)	580 mm (22.8 in)
-- shaft diameter	74.6 mm (2.9 in)
-- hammers	
-length	180 mm (7.1 in)
-thickness	7.94 mm (0.3125 in)
-type	Sharp non-reversible, 2 sides
-number of rows	4
-hammers per row	12
-total number of hammers	48
-pin size	23.8 mm (0.938 in)
-- drive train	Belt drive off PTO shaft
-- speed at 1000 rpm power take-off	2139 rpm
-- speed when governor engages tub	1875 rpm
-- speed when governor disengages tub	1741 rpm
HAMMER MILL APRON CONVEYOR:	
-- type	Rough top conveyor
-- length	1346.2 mm (53 in)
-- width	444.5 mm (17.5 in)
-- minimum clearance to screen	336.6 mm (13.25 in)
-- drive	Hydraulic motor
-- conveying speed	2.8 m/s (554 ft/min)
ELEVATING CONVEYOR:	
-- type	Rough top rubber belt
-- length	6700 mm (263.8 in)
-- height at 25 incline	3300 mm (129.9 in)
-- width	455 mm (17.9 in)
-- depth	320 mm (12.6 in)
-- drive train	Chain driven from hydraulic motor
-- speed (maximum)	3.1 m/s (610 ft/min)
SCREENS:	
-- type	one piece
-- length	1070 mm (42.1 in)
-- circumferential length	1270 mm (50 in)
-- thickness	6.35 mm (0.25 in)
-- hole size	50.8 mm (2 in)
-- open area/total area	0.403
-- screen area	1.37m² (2124 in²)
MANUFACTURER'S MAXIMUM RECOMMENDED POWER AT 1000 RPM Max.	112 kW (150 hp)

APPENDIX II
MACHINE RATINGS

The following rating scale is used in PAMI Evaluation Reports:

(a) excellent	(d) fair
(b) very good	(e) poor
(c) good	(f) unsatisfactory

APPENDIX III
METRIC UNITS

In keeping with the Canadian metric conversion program, this report has been prepared in SI Units. For comparative purposes, the following conversions may be used:

1 kilometre/hour (km/h)	= 0.62 miles/hour (mph)
1 kilogram (kg)	= 2.2 pounds (lb)
1 tonne (t)	= 2204.6 pounds (lb)
1 tonne/hour (t/h)	= 1.10 ton/hour (ton/h)
1000 millimetres (mm) = 1 metre (m)	= 39.37 inches (in)
1 kilowatt (kW)	= 1.34 horsepower (hp)
1 tonne/kilowatt hour (t/kW•h)	= 0.82 ton/horsepower hour (ton/hp•h)

ALBERTA FARM MACHINERY RESEARCH CENTRE

3000 College Drive South
Lethbridge, Alberta, Canada T1K 1L6
Telephone: (403) 329-1212
FAX: (403) 329-5562
http://www.agric.gov.ab.ca/navigation/engineering/afmrc/index.html

Prairie Agricultural Machinery Institute
Head Office: P.O. Box 1900, Humboldt, Saskatchewan, Canada S0K 2A0
Telephone: (306) 682-2555

Test Stations:

P.O. Box 1060
Portage la Prairie, Manitoba, Canada R1N 3C5
Telephone: (204) 239-5445
Fax: (204) 239-7124

P.O. Box 1150
Humboldt, Saskatchewan, Canada S0K 2A0
Telephone: (306) 682-5033
Fax: (306) 682-5080