THE DEFIBERING OF RECLAIMED ROPE CABLE PAPERS

By
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Introduction

The purpose of this study was to determine the effectiveness and the economics of various cooking and various processing treatments, particularly of the rod mill, in defibering reclaimed rope cable paper. Beater-treated stuff from the cooperator's mill contained a small amount of fiber bundles which had not been separated sufficiently to be formed into a clear sheet of paper. A waterleaf hand sheet from this beaten material is shown as sheet No. 1.

Apparatus, Materials and Procedure

Apparatus

The following equipment was used in this study:

A horizontal cylindrical steel digester, of the rag boiler type, of 325 gallons capacity. A maximum charge of material in this digester is about 500 pounds of wood chips or 250 pounds of the reclaimed cable paper (air-dry basis). The digester rotates at 1 r.p.m. The charge is heated directly by means of steam introduced through one of the trunnions. At the end of the digestion the pressure is relieved and the contents are cooled sufficiently by admission of cold water, to permit the removal of the manhole cover. The contents are then emptied into a shallow drainer provided with a perforated tile bottom, where the pulp is washed. A photograph of the digester is shown in Figure 2.

A semicommercial rod mill shown in Figure 4 was used. It is 3 feet in diameter and 5 feet long, inside measure, and can be rotated at speeds varying from 17 to 28 r.p.m. A charge of pulp equivalent to 25 pounds oven

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dry and at consistences ranging from 4 to 8 per cent is the proper charge for this mill. It can be run both continuously and batchwise, and when operated continuously the material is introduced by a screw feeding device through one trunnion of the mill (fig. 1), the milled pulp flowing out through the opposite trunion. Sufficient water is fed with the material to form a pulp suspension of the desired consistence. When operated batchwise, the material to be milled with water sufficient to give the desired consistence is added through a side manhole. At the completion of a batchwise operation the manhole cover is removed and the mill contents dumped into a shallow screened drainer where the pulp can be washed.

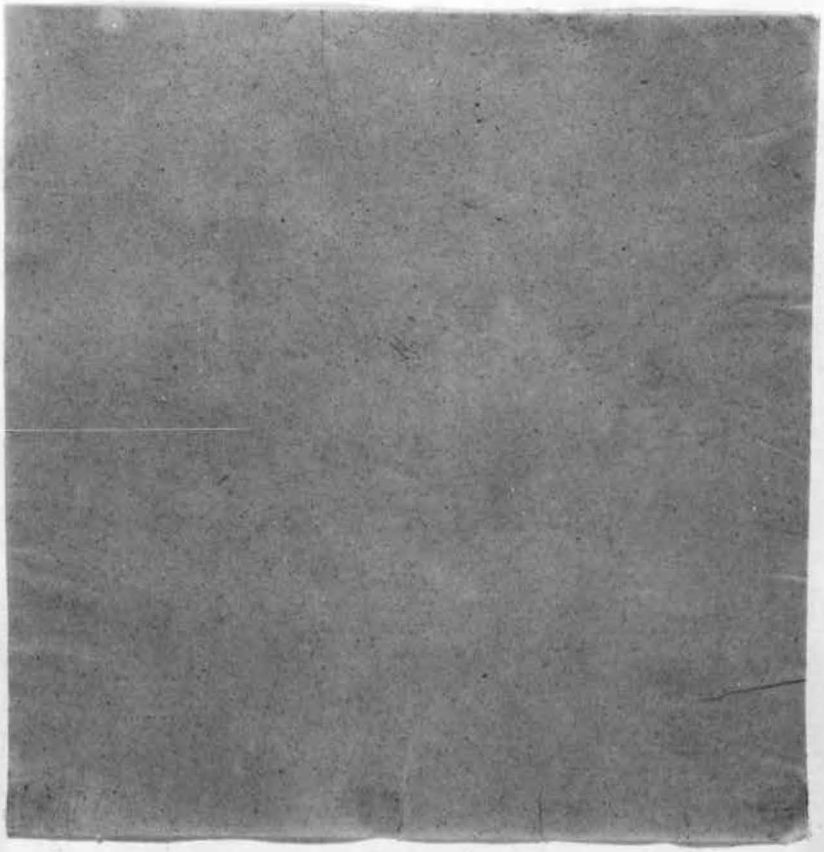
A 50-pound experimental Marx beater having a roll 24 inches in diameter with 18 inches face, and a bed plate of the elbow type was used. The roll is fitted with 52 steel fly bars, 3/8 inch thick, arranged in clusters of four. The bed plate is fitted with 14 steel fly bars each 15/32 inch thick at the base but bevelled at an angle of 25 degrees to an outer edge of about 1/16 inch thick. The maximum dead load weight of the roll, without using the counterbalancing device, is 1800 pounds. The tub of the beater is of concrete construction with a trough of special cross section designed for rapid circulation of the stock. The roll is driven at 300 r.p.m., which corresponds to a peripheral speed of 1950 feet per minute, by a 15-horsepower motor. The beater is equipped with a motion recorder for roll settings and a power meter. The beater is shown by Figure 3.

Material

The reclaimed paper was composed of small multi-colored bundles and sheets as well as short lengths of cotton twine. Occasionally small pieces of fine copper wire were found. The moisture content of the paper as received was 8.95 per cent on the wet basis. A sample of this paper in the form of a hand sheet held together with animal glue containing a small amount of glycerin is shown as sheet No. 2.

Procedure

The plan of study embodied the cooking of the paper to soften it to pulp and the processing of this pulp as well as of the raw paper in the rod mill or in the beater to determine the effectiveness of each in defibering the material.



Sheet No. 1 -- Beater treated stuff from the cooperator's mill.

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Sheet No. 2 -- Raw reclaimed rope cable paper

Three cooks were made. The first, using a chemical ratio of 3 per cent of caustic soda and a 5.6 to 1 ratio of water to fiber, was cooked for 1 hour at a temperature of 126° C.; the second, using 3 per cent of caustic soda at a 2.23 to 1 ratio of water to fiber, was cooked for 4 hours at a temperature of 116° C.; and the third, without chemical but with a 5.6 to 1 ratio of water to fiber, was cooked for 1-3/4 hours at a temperature of 121° C. The exact weights of the materials used and the cooking conditions are shown in Table 1.

Table 1.--Cooking data

Cook No.	Materials			Conditions			
	Paper	Water	Caustic soda	Temperature	Digester pressure	Time	Water-fiber ratio
	Lbs.[1]	Lbs.	Lbs.	° C.	Lbs.[2]	Hours[3]	
4001	227.5	1267.0	6.83	126	[4]55	1	5.6 to 1
4002	227.5	508.0	6.83	116	30	4	2.23 to 1
4003	227.5	1267.0	None	121	25	1-3/4	5.6 to 1

[1] Oven-dry weight which is equivalent to 250 pounds as received.

[2] Air pressure was relieved shortly before the desired temperature was reached.

[3] From the time the digester reached the desired temperature until the pressure was relieved.

[4] Clogged relief line prevented air pressure relief.

The processings in the rod mill consisted of milling both the raw paper and cook No. 4001 with plugged steel pipe rods having a total weight of 1080 pounds and with solid bronze rods having a total weight of 3566 pounds. With the pipe rods the operation was carried out batchwise at a consistence of 6.0 per cent. At various intervals the mill was sampled, and hand sheets were made to show the degree of defibering. Representative hand sheets as well as others mentioned form a part of this report.

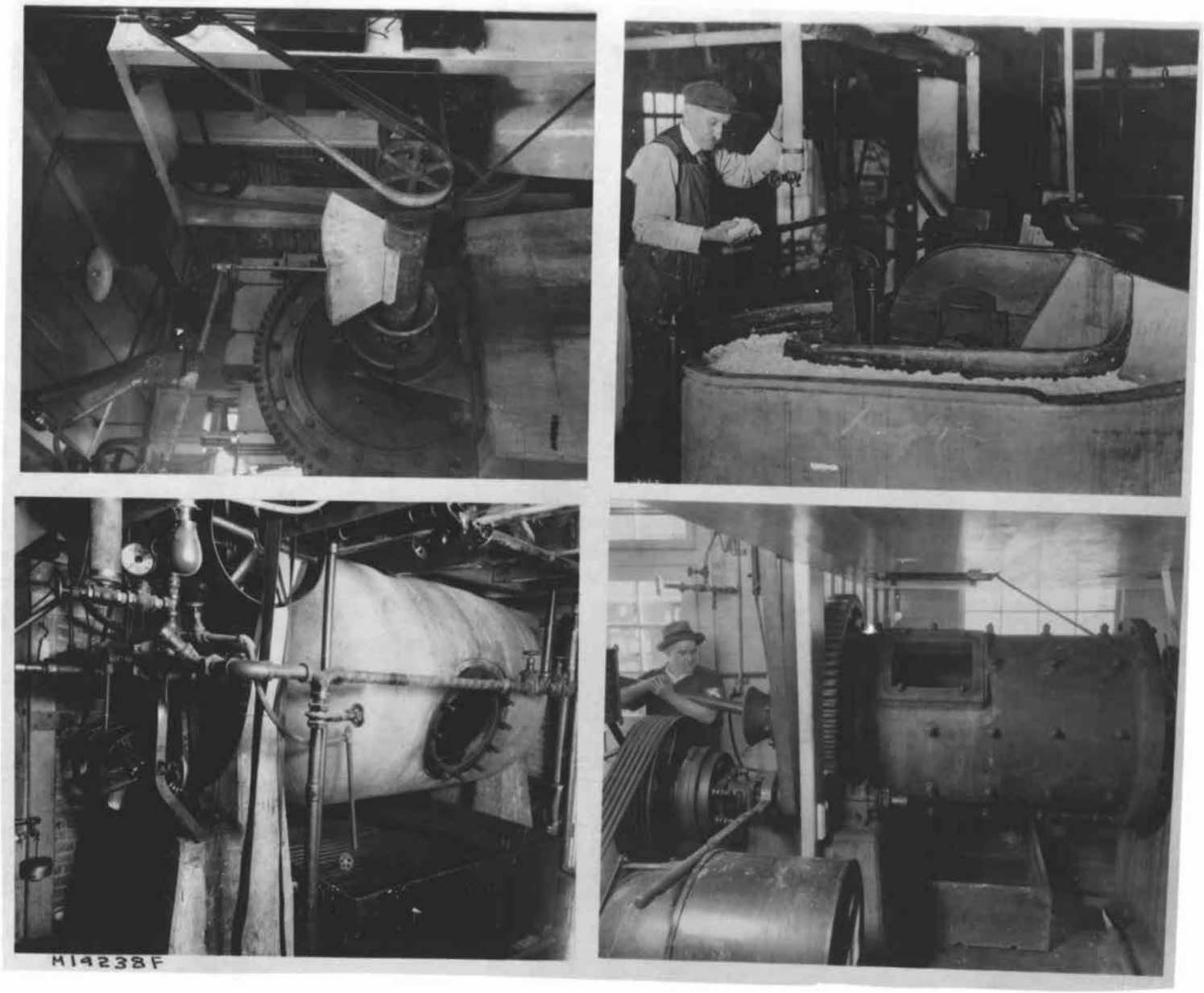


Fig. 1.--Rod-Mill Feed.
Fig. II.--Rag Boiler.

Fig. III.--The Marx Beater.
Fig. IV.--The Rod Mill.

Using the heavy rods the operation was carried out continuously to simulate full mill-scale conditions. An attempt was made to add material at the rate of 25 pounds (oven-dry basis) per hour but some difficulty was encountered at times due to the long strings of paper becoming wrapped around the edges of the screw in the feeding device and choking the feed. The consistence was held as closely as possible to 6.0 per cent but this varied somewhat due to the additional water required to help free the screw. At the end of 1 hour of continuous operation a sample of discharged pulp was taken and formed into hand sheets.

A portion of cook No. 4001 taken from the discharge at this time was passed through a 9-cut screen and formed into hand sheets.

The rod mill conditions are shown in detail in Table 2.

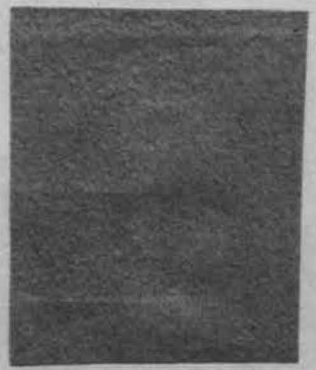
The processings in the beater consisted of brushing the raw paper, cook No. 4001 and cook No. 4003, each at a consistence of 3.25 per cent with the roll raised 0.054 inch above the bed plate. The temperature was maintained at about 38° C. during the treatment. At the end of 40 minutes samples were taken for hand sheets to show defibering. The brushing of the raw paper and cook No. 4001 was stopped at the end of 40 minutes, but cook No. 4003 was processed for an additional 60 minutes with the roll lowered so that it just cleared the bed plate.

Sheet No. 3

Sheet No. 4

Sheet No. 5

Sheet No. 6



Sheet No. 7

Sheet No. 8

Sheet No. 9

Sheet No. 10

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Rod Milled Cable Papers

Table 2.--Rod mill processing conditions

Rod mill run No.	Cook No.	Rods: Kind	Rods: Size: Diameter	Rods: Size: Length	Rods: Number	Rods: Total weight	Material added: Paper [1]	Material added: Water	Consistence	Time	Sheet sample No.
			Inches	Inches		Lbs.	Lbs.	Lbs.	Per cent	Min.	
[2]43	4001	Plugged steel pipe	2.37	58	45	1080	[4]25	283.8	6.0	50	3-10 incl.
[2]44	Raw paper	Plugged steel pipe	2.37	58	45	1080	25	414.2	6.0	25	11
[3]45	Raw paper	Solid bronze	2.5 3.0	58 59	23 12	2024 1542	[5]25	...	[4]...	60	12
[3]46	4001	Solid bronze	2.5 3.0	58 59	23 12	2024 1542	[5]25	...	[4]...	60	13

[1] Oven-dry equivalent.

[2] Batchwise at 28 r.p.m.

[3] Continuous at 26 r.p.m.

[4] An attempt was made to hold the consistence as nearly as possible to 6 per cent but when the screw feeding device clogged, a large quantity of water had to be added to wash it free.

[5] Paper was added at a rate of about 25 pounds per hour. Due to the strips winding around and clogging the screw feeding device, this rate varied considerably at times.

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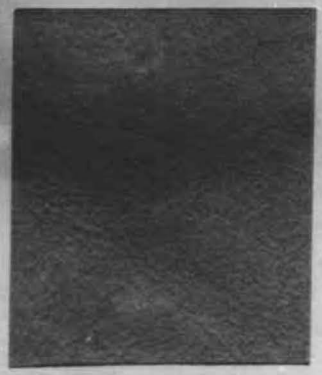
Sheet No. 11

Sheet No. 12

Sheet No. 13



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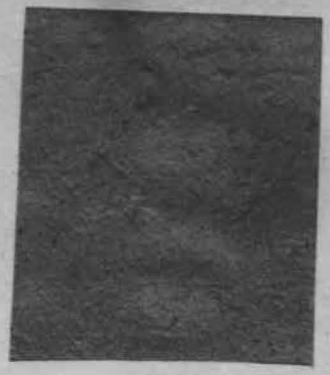
Sheet No. 15



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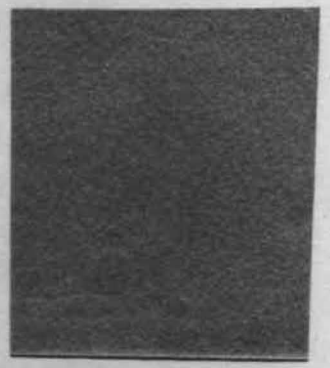
Sheet No. 17



Sheet No. 18

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Rod Milled Cable Papers

The beating conditions are shown in detail in Table 3.

Table 3.--Beater processing conditions

Beater run No.	Cook No.	Materials: Pulp	Materials: Water	Consistence	Temperature	Roll above bed plate	Time	Sheet sample No.
		Lbs.[1]	Lbs.	Per cent	° C.	Inches	Min.	
143	4001	50	1222	3.25	38	0.054	40	15
144	Raw paper	50	1531	3.25	38	.054	40	16
145	4003	50	1292	3.25	38	.054 to 0.00	[2]40 60	17 18

[1] Oven-dry equivalent.

[2] Beater was run the same as for runs Nos. 143 and 144 for 40 minutes; then the roll was lowered until it just cleared the bed plate.

From a casual examination of cook No. 4002, it was decided not to make any processing studies on it.

Hand sheet papers were made from the variously processed materials to show the degree of defibering obtained under the different conditions. These sheets were made to as uniform thickness as possible to give an exact comparison of residual fiber bundles or paper pieces.

Discussion of Results

The pulp from cook No. 4001 proved to be superior to the others processed for defibering treatments. This pulp when compared with the raw paper was very effectively defibered in the rod mill using heavy rods as shown when sheet No. 13 is compared with sheet No. 12. Likewise the response of this pulp as compared with that of cook No. 4003 and of the raw paper to the action of the beater is best shown by observing sheets Nos. 15, 16, and 17.

The action of the rod mill was studied by use of a consistence of 6.0 per cent and by varying the type of rod. The light pipe rods were ineffective in separating the fibers even after 50 minutes of milling action on the pulp from cook No. 4001 as shown by sheets Nos. 3 to 10 inclusive. As would be expected the action of the light rods on the raw paper was hardly noticeable up to a milling period of 25 minutes. At this time, as shown by sheet No. 11, the paper strips were considerably reduced in size but the pulp still contained a large proportion of the fiber bundles.

Treatment with the heavy rods operating the mill continuously was slightly more effective in defibering the raw paper than the treatment with light rods. With the pulp from cook No. 4001, however, the heavy rods caused a very high degree of defibering as shown by sheet No. 13. Although there was a small proportion of fiber bundles yet remaining in the pulp, these were readily removed by passing the milled pulp through a 9-cut screen. The relative absence of fiber bundles in this screened material is shown by sheet No. 14. One difficulty arose in the use of rods cast from bronze. Due to their brittle character, small pieces of the metal were broken off and deposited throughout the pulp. This metallic impurity would be highly objectionable in pulp to be reconverted into cable paper, but with the proper selection of milling element metals there probably would be no difficulty from this source.

The brushing action of the beater was very effective when the paper had been previously softened by cooking with caustic soda as in cook No. 4001. The pulp from this treatment is shown by sheet No. 15. Paper cooked without chemical as in cook No. 4003 was insufficiently softened to be completely defiberized in the beater. This is shown by sheet No. 17. Raw paper as such would require so much beating that the fiber would be too greatly hydrated and cut before complete defibering.