THE ROD MILL AS A REFINER AND BEATER[1]

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Refining Knots and Screenings

Refining Partially Cooked Extracted Chestnut Chips

A rod mill 6 feet in diameter by 12 feet in length has been in operation at a plant in Tennessee for several months grinding extracted chestnut chips. Only about 25 per cent of the original weight of the chips is lost in the mild chemical treatment employed to soften them before they are ground. That the refining is very thorough is evidenced by the fact that after leaving the rod mill a light jordan treatment is sufficient to prepare the pulp for the board machine. The pulp is not even screened but goes directly to the cylinder vats.

This rod mill refines as much as 15 tons of chips in 24 hours and requires less than 90 horsepower; i.e., as little as 6 horsepower-days per ton of pulp.

Refined Uncooked Extracted Chestnut Chips

Extracted chestnut chips without any chemical treatment have been ground in the laboratory's 3 by 5 foot mill to a fairly satisfactory pulp. The board made from it is harsher and more brittle than that prepared from the chemically softened wood. The pulp when blended with 30 per cent kraft produces a board of fair strength and toughness.

It is probable that heavier rods, say 3 or 4 inches or larger in diameter, would be more effective in refining this harder material than was the combination of 2, 2-1/2, and 3 inch rods actually used.

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Refining Partially Cooked Gum Chips

At the commercial plant to which reference has already been made, some 15 cords of gum chips were given a mild chemical treatment with sodium sulphite and soda ash and the softened chips, representing 75 per cent or the original weight of the chips, were refined in the 6 by 12 foot rod mill. The chips were fed to the mill at the rate of 9 tons in 24 hours, and the mill consumed less than 90 horsepower, or 10 horsepower-days per ton of pulp. The product was given a very light brush in a jordan and dried to 15 per cent moisture content on a board machine. The fibers were not completely separated at this stage, but the bundles were soft and readily brushed out in the beater and jordan treatment incident to making paper from the pulp. The paper secured in this test was of excellent quality and good white color.

Refining Partially Cooked Aspen Chips

Aspen chips were softened chemically in a manner similar to that used for the gum chips. They were ground in the Laboratory's rod mill and run directly into paper of excellent quality on the Laboratory's fourdrinier machine. The power required to refine the softened chips, reduced to the basis of 6 by 12 foot rod mill operation, was approximately 10 horsepower-days per ton, the same as that already noted for refining the gum chips.

Refining Kraft Screenings

Screenings are not unlike the softened chestnut, gum, and aspen chips, except that the former are somewhat less uniformly softened by reason of the uneven penetration of the cooking liquors. They respond satisfactorily to the refined action of the mill.

Through the courtesy of a Wisconsin pulp mill the Laboratory had the opportunity to refine some kraft screenings. They were passed through the laboratory mill at various rates, viz., 26.8, 17.8, and 8.9 pounds, oven-dry, per hour. The mill contained 3,720 pounds of steel rods and was rotated at 28 r.p.m. The power consumption corresponding to the three rates of feeding was 31.4, 47.4, and 94.6 horsepower-days, respectively, per ton of pulp. On the basis of the power relationships noted in connection with chestnut and gum chips, the degree of refining obtained in the small mill should be secured in the large mill with 10.5, 15.8, and 31.5 horsepower-days, respectively, per ton of pulp.

The product from the test at the first feeding rate, 26.8 pounds per hour, was well refined except for a sprinkling of soft fiber bundles that would brush out readily in the beater. In the second and third tests the fiber bundles were more thoroughly eliminated, although the improvement in the degree of refining obtained in the third test was not commensurate with the additional power consumed. In addition to the greater degree of refining obtained with the slower rates of feeding, a very appreciable amount of hydration was accomplished, as was evidenced by the higher strength of the hand sheets made from the pulps. The results of Mullen tests for the three pulps were 0.57, 0.78, and 0.75 points per pound per ream, respectively.

It may be concluded, therefore, that by using a 6 by 12 foot rod mill the kraft screenings tested could have been satisfactorily refined with an energy input of approximately 10 horsepower-days per ton and that with an additional 5 horsepower-days the product would require very little beating to prepare it for the paper machine.

Refining Sulphite Screenings

Through the courtesy of a Wisconsin paper mill the Forest Products Laboratory had the opportunity of grinding some sulphite screenings in the rod mill. From the short test it may be concluded that a satisfactorily refined product can be obtained with a 6 by 12 foot mill with an expenditure of not to exceed 15 to 18 horsepower-days per ton of pulp.

Refining Ground-wood Screenings

Ground-wood screenings are essentially raw wood. The forces binding the fibers together are as great as they are in the log. It is far more difficult to rub the fibers apart than it is in the case of chips or screenings which have been subjected in some degree to a chemical treatment. It is believed, however, that the rod mill can be used to advantage in refining ground-wood screenings. Some indication of the effectiveness is given by the fair quality of products obtained from this material in the Laboratory mill. Rods of larger diameter would doubtless be more efficient than the mixture of 2, 2-1/2, and 3 inch rods used in the experimental mill. From the brief qualitative test made at the Forest Products Laboratory it is estimated that satisfactory refining could be accomplished in a 6 by 12 foot mill with a power consumption of approximately 25 horsepower-days per ton. At that rate, therefore, the commercial mill would have a capacity of only 3.6 tons per 24 hours.

General Observations on the Rod Mill as a Refiner

In using the rod mill as a refiner there are several points that should be observed if the best results are to be obtained. In the first place the mill must not rotate too fast, as otherwise the rods will drop rather than roll down the surface of the rod bed. Some free fall is desired in crushing brittle mineral material to secure the desired shattering effect, but with fibrous material sudden blows are to be avoided. There is desired rather the rubbing and pounding action which comes from the rolling of the rods over each other. The speed of rotation will, therefore, be found to be somewhat less than recommended for ore grinding. The rods will not be lifted so high at the lower rate of revolution and the power required will be less.

In the second place a feeding device should be used that will insure positive transfer of the material to the interior of the mill. A worm screw has been found satisfactory.

In the next place it is important that water be fed into the mill with the material to be refined and that the two be properly proportioned. Too dilute suspensions do not provide sufficient cushioning action between the rods to avoid excessive cutting of the fibers. On the other hand, too dense suspensions provide so much of a cushion that the action of the rods will not be efficient. Moreover, the material will in such cases be unevenly distributed through the mill and cause the rods to lose their parallel position with respect to each other, a condition resulting in low refining capacity and a possible tendency of the rods to work out through the hollow trunnion. It has been found that a consistence between 4 and 8 per cent insures good operation.

Finally, the size and weight of the rods must be adjusted to the work to be done. Tough material, the fibers of which will withstand severe rubbing and pounding, should be refined with heavy rods of large diameters, whereas material whose fibers are rather brash or brittle should be refined with rods of small diameter or even with tubes with a virtual density lower than that of rods.