

BEATING WITH RODS¹

By
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The most important factor in the beating of paper pulp with rods is the consistency of the stock; and the second factor, the regularity of the feed. These factors have been brought out in a recent paper by the writer.³ While the strength factor is materially increased by working at a consistency of between 7-1/2 and 8-1/2 per cent, the uniformity of the beating is also increased, provided the stock is fed at a uniform rate. By the operation of the rod mill at consistencies above 5 or 6 per cent, there is practically no pool at the foot of the pile of rods in the mill. At lower consistencies a large pool exists, which, in the case of mills with small trunnion outlets, is almost as deep as the internal radius of the mill. Under such circumstances, there is more stock in the pool at the foot of the rods than there is between the rods themselves, and it is practically impossible to obtain uniform beating. With elimination of the pool by working at stock consistencies above 5 or 6 per cent, as is possible with a Marcy rod mill, there is no chance for the stock to escape the action of the rods by passage from the inlet to the outlet of the mill through the pool instead of between the rods. Another advantage of high consistencies is a very marked reduction in the noise of the rods, due to the cushioning effect of the thick stock. When operating at consistencies of 8 per cent, it is possible to hear conversation in the vicinity of the mill without raising the voice. This is impossible when working at lower consistencies, and is one of the objections most frequently expressed to some installations of the rod mill. The cushioning effect of the stock at high consistencies not only reduces the wear on the rods and lining but by the reduction of wear, discoloration is very remarkably reduced. Where even slight discoloration is objectionable, however, it is advisable to use either stainless steel or manganese silicon bronze lining and rods.

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³The Marcy Rod Mill in the Paper Industry, by Sidney D. Wells, Paper Trade Jour., Oct. 27, 1927.

In an earlier article³ it was stated that a saving of from 50 to 70 per cent of the power required by beaters can be effected by the use of the rod mill. Installations since then have further confirmed that statement, and experimental work has explained it. Work at the U. S. Forest Products Laboratory has shown that a 20-minute treatment of kraft pulp in a 3 by 5 foot rod mill shortened the time required to develop maximum strength tests in the standard pebble mill by 1 hour; furthermore, the maximum tests capable of being developed by the pebble mill were increased by 4 per cent. Observations of tests made by a 5 by 10 foot rod mill have demonstrated that it is capable of imparting to 17 tons of pulp per day a beating treatment 20 per cent greater than that imparted in 20 minutes in the 3 by 5 foot mill. This would indicate that a 5 by 10 foot mill would be capable of treating 20 tons of pulp to the same degree as a 20-minute treatment in the 3 by 5 foot mill. The largest size of rod mill made at the present time is 7 by 15 feet. On this basis such a mill is capable of treating 55 tons of pulp to the same degree with only 160 horsepower required for operation. These figures are almost unbelievable, but experiments and performances have confirmed them.

In the development of the felting properties of paper-making fiber, the phenomenon known as hydration is invariably an accompaniment. In the use of short-fibered pulps, whatever hydration occurs is of benefit to the paper, because, at most, only a very short beating treatment is given. In the treatment of long-fibered pulps, however, such as sulphite and sulphate pulps, cotton rags, manila, jute, linen, etc., large amounts of beating are necessary to develop proper felting properties in the manufacture of the tough and strong papers for which these fibers are demanded. Such prolonged beating invariably produces more hydration than is desired, and the removal of the water formation in the subsequent paper-making operation at the suction boxes, couch roll, presses, etc., is very much retarded. The sheet, consequently, contains more water than it otherwise would and the production capacity of the driers is very much reduced. In addition to the reduced production encountered, the quality of the product is often impaired by excessive stiffness, dullness in appearance, and, in some cases, brittleness. The time the stock has been agitated in the system to develop the proper felting properties, has produced excessive hydration. On the other hand, if the beating tackle is sharper and is lowered too rapidly, the strength of the resultant product is sacrificed by too drastic cutting of the fibers. With the use of the Hollander type of beater in conjunction with refining engines, the paper manufacturer has been between the horns of the dilemma. The rod mill offers to him the

solution of these troubles. By the passage of 25 tons of pulp through a 7 by 15 foot rod mill in 24 hours, a beating action is obtained equivalent to that given in the standard types of Hollander beaters in from 7 to 8 hours. In the rod mill there is no danger of cutting the fiber, even though the time taken in passage through the mill at the rate stated above would be only about 20 minutes. Freeness tests have demonstrated that the rod mill develops maximum strengths with two or three times the freeness of stock developed to equal strengths in the beater. The maximum felting properties are developed, and, at the same time, a stock is produced that will permit the easiest removal of water and maximum production on the paper machine.

An interesting application of the rod mill is in the manufacture of glassine or greaseproof papers. The stock prepared for these papers is hydrated to an extreme degree and enormous amounts of power are required in the beater. The use of the rod mill with stock at low consistency has produced rather indifferent results in this field, on account of the nonuniform results caused by certain portions of the stock escaping rod action by passing through the pool at the foot of the rod pile. By the use of proper consistency, as already explained, excellent results are obtained with great saving in power. Not only is the parchment effect produced with from 50 to 75 per cent less power, but the fibrous character of the pulp has not been so completely destroyed, and the paper is not so brittle as when made in the Hollander.

Not only is the rod mill a very effective instrument for the beating of paper pulp, but it is also especially efficient as a refining agent in the conversion of wood-pulp screenings to paper pulp, or the refining of semicooked chips from wood waste or other sources, straw, cornstalks, rags, cottonseed hulls, etc., in the manufacture of paper products. For those who care to look into the subject further, the U. S. patent⁴ granted to cover the application of the rod

⁴U.S. Patent No. 1,654,624, January 3, 1928.

mill to the pulping and beating of paper stock will be of interest.

The inquiry is often made as to what is the expense of mechanical upkeep in the operation of the rod mill, and how it compares with beaters and jordans. The forces involved

are very great, and the shock occurs continuously. When rod mills were first introduced in the mining field it was not realized how heavily and perfectly they must be built and their life was exceedingly short. Each new unit was built heavier than its predecessor, but it was years before mills were built that were reasonably rugged. The wear on the rods in a rod mill 5 feet in diameter, when operated on stock at proper consistency, can be compensated by opening the door at the end, a matter of a few minutes, and throwing in one 3-inch rod every two or three months. The linings are replaceable and replacement will be necessary only once every three or four years. The gears are cut steel gears and can be turned around when one side is worn. They will last many years unless injured by accident or negligence. The rest of the mill should last indefinitely. It is consequently evident that the upkeep on rod mills is very much less than on beaters or jordans. In the mining industry, where the wear from abrasion is obviously more severe, rod mills frequently show 98 and 98-1/2 per cent operation seven days in the week and 24 hours per day.

In summing up we can say that:

1. The rod mill is capable of handling stock at any rate and at any consistency that can be furnished from deckers or thickeners.
2. At 8 per cent consistency, the rod mill will beat stock with from 50 to 70 per cent less power than is at present used by beaters of the Hollander type.
3. The rod mill will develop greater strength from standard pulps than any other equipment known at present.
4. The rod mill will yield freer stock capable of producing paper of any specified test, on account of most rapidly developing maximum felting properties.
5. The rod mill will develop the parchment effect with less brittleness, destruction of fiber, and loss of strength and toughness, than any other equipment now used.
6. The rod mill will operate seven days in the week for 24 hours per day for years, with less than 2 per cent time lost for repairs.