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HENRY S. GRAVES, Forester.

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THE GRINDING OF SPRUCE FOR MECHANICAL PULP.

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ILLUSTRATIONS.

PLATES.

TEXT FIGURES.

THE GRINDING OF SPRUCE FOR MECHANICAL PULP.

COMMERCIAL GRINDING PRACTICE.

The commercial manufacture of ground-wood pulp is generally not conducted according to any fixed standards of practice. Each superintendent or manager has his own theories about the method of grinding. As a result, scarcely any two mills operate under the same conditions, even when grinding the same species and turning out similar products. This is strikingly shown in Table 2, which gives the operating conditions of a large number of mills throughout the United States. For example, one mill producing news paper has 15 grinders, to each of which is applied 135 horsepower; the pressure computed to the basis of a 14-inch cylinder is 17.5 pounds per square inch, and the peripheral speed of the stone is 2,660 feet per minute. In another mill, also producing news paper, each of the 16 grinders has 625 horsepower applied to it and uses a pressure of 72 pounds on a 14-inch cylinder and a peripheral speed of 3,540 feet. A variation of from 135 to 625 horsepower to the grinders is seen in the example cited. While these two mills also show much variation in other conditions of grinding, they do not show the extreme conditions, where the pressure applied to the wood in grinding varies, as shown in the table, from 17.5 to 115.8 pounds on a 14-inch cylinder, and the peripheral speed of the stone from 1,360 to 4,310 feet per minute. The variation in pressure per square inch of pocket area would be more significant, but the data on which to base this computation were not available in all cases.

The reports of power consumption show a range of from 31 to 125 horsepower per ton in 24 hours. Very few mills, however, are able to determine accurately the amount of power consumed in the production of a ton of pulp, for the grinders are nearly always either geared or direct-connected to water wheels or turbines. When turbines are new it is possible to calculate approximately the amount of power produced, but as they become old their efficiency decreases, and it is impossible to calculate the power with any degree of accuracy. It is very probable that many of the reported values are erroneous, especially some of the lower ones, since it has been demonstrated that pulp can not be produced under conditions of present commercial

practice with a power consumption as low as some of the values reported.

In view of the extreme variation in the conditions of manufacturing mechanical pulp it is probable that some of the mills are operating under conditions of low efficiency. While the tests discussed show that approximately the same degree of efficiency may be reached by different combinations of the several variable factors, consistent combinations of these factors do not prevail in the industry.

PURPOSE OF EXPERIMENTS.

The cost of producing mechanical pulp from spruce must necessarily increase with the cost of the wood. In order to cut down the price of mechanical pulp, therefore, it is necessary either to substitute a cheaper wood for spruce or to increase the efficiency of converting spruce into pulp. Experiments are being conducted in the use of woods other than spruce by the mechanical process, but before these can be carried to a definite conclusion it is necessary that the influence of many variable conditions of manufacture be determined. This can best be done by tests of a standard wood like spruce. Coniferous woods are enough alike to warrant grinding them under approximately similar conditions, and the results of the grinding tests on spruce should be applicable to the production of mechanical pulp from other conifers. The study of spruce, however, is of value not only in establishing relations and standards by which to compare the results of tests of proposed substitutes, but also in developing methods of increasing the efficiency of grinding spruce itself.

The general influence of the variable factors of grinding on the quality and production of pulp has been described in a previous publication[1] of the Forest Service, in which the need for a more thorough study of the conditions of grinding was indicated. The most important factors which enter into the production of mechanical pulp from any species of wood are:

(1) Surface of stone; whether rough or smooth, sharp or dull, or of coarse or fine grit.

(2) Pressure with which the wood is forced upon the revolving pulpstone.

(3) Peripheral speed of the stone.

(4) Temperature of grinding and thickness of stock in the grinder pit.

(5) Physical condition of the wood.

As a result of operating under different combinations of these factors, certain other factors are developed, and it was the purpose of

[1] "Experiments with Jack Pine and Hemlock for Mechanical Pulp," by J. H. Thickens.

the experiments to determine the influence of variation of these upon:

(1) Power applied to the grinder.
(2) Amount of pulp produced in 24 hours.
(3) Power consumption per ton of pulp in 24 hours.
(4) Yield of pulp and screenings per cord of wood ground.
(5) Quality of the pulp.

EXPERIMENTAL APPARATUS.[1]

EQUIPMENT FOR WOOD PREPARATION.

For treating woods prior to grinding a steaming or treating tank, holding between one-fourth and one-half cord of wood, is available. This tank is so designed that the wood can be loaded from the top and discharged from the bottom. To carry out tests under different conditions the tank is provided with steam, water, and vacuum connections. A 40-inch swing cut-off saw and a Roberts and Lieberts Green Bay barker are available. A view of the wood room is shown in Plate II, figure 1.

PULP-MAKING EQUIPMENT.

For grinding, a Friction Pulley & Machine Works 3-pocket grinder, with cylinders 14 inches in diameter, and taking a stone 54 inches diameter by 27 inches face, is used. The grinder cylinders are supplied with water by two Gould triplex pumps. Suitable relief valves are provided for the regulation of the water pressure, and pressure gauges are attached to each cylinder. A graphic recording thermometer connected with the grinder pit gives the temperature of grinding. A Lombard medium-grit stone was used.

The grinder is driven by a direct-connected, direct-current, variable-speed motor, regulated by adjusting the armature voltage. Electric current, alternating, is obtained at 2,300 volts. This is converted by a motor generator set to direct current, the voltage of which can be fixed at any value between 100 and 750 volts by means of a rheostat in the generator field. The measurement of power and the control and regulation of the motor are accomplished by means of carefully calibrated recording, indicating, and integrating instruments. A graphic record is taken of the power applied to the grinder motor, and an integrating watt-hour meter provided in the same circuit makes possible a check on power consumption.

The pulp-screening system consists of a Ruth's centrifugal screen with a plate perforated with holes 0.065-inch in diameter, and operated at 500 revolutions per minute, and a Harmon 12-plate flat

[1] A more complete description of the equipment of the Forest Service laboratory at Wausau, Wis., is given in an unnumbered publication of the Forest Service, "Experiments with Jack Pine and Hemlock for Mechanical Pulp."