

Roll Splitting as an Alternative Intermediate Process
For Wood Fuel

In an effort to develop mobile equipment for harvesting and processing woody biomass from power line rights-of-way and precommercial thinnings, numerous alternative concepts were evaluated by Tennessee Valley Authority's Timber Harvesting Project.

A review of the literature indicated that, though extensively used, field chipping using either a disk or drum chipper is a high-energy consumption function and therefore requires a large engine and heavy carrier. In addition, chips can be difficult to economically handle in the field. Economical handling usually requires that the system be "hot" from a portable chipper to chip van. Drum chippers, as used on the Nicholson Mobile Chip Harvester, the University of Maine's feller/chipper, and the Pallari swath harvester, have the advantage of being largely self-feeding. Disc-type chippers are utilized on Georgia Pacific's brush harvester and on the Tyovaline TT 1000F terrain chipper. Most portable chippers such as Morbark's and Omark's Blue Ox use disc chippers. Stirrup type cutters, as found on Texas Tech's biomass combine, are used for severance and chipping. This type cutter/chipper has not been widely accepted because of poor chip quality and low efficiency. The combination of these problems caused us to look in other directions for field processing of biomass.

Both Virginia Polytechnic Institute (VPI) and the Forest Engineering Research Institute of Canada (FERIC) had recently worked on crushing or roll splitting as a method of processing and recovering harvesting residues. Both indicated that the crushing process required less energy than chipping. VPI found that the processed wood dried twice as fast as roundwood in the field.

For these reasons, TVA entered into a cooperative agreement with FERIC to evaluate the feasibility of roll crushing of biomass. The FERIC roll splitter/crusher was delivered to TVA's facilities at Norris, Tennessee, in early 1984. A FERIC engineer worked with TVA personnel in developing the study plan and collecting the data presented here.

Briefly, the roll crusher/splitter test bed is comprised of a trailer frame, two sets of 45.7 cm diameter rolls, hydraulic motors with speed reducing gear drives to power the lower crush rolls, and a 130 KW gasoline engine with three gear driven hydraulic pumps to supply power to the various components. Crushing force is provided by four hydraulic rams that act on the moveable upper crush rolls. Control valves permit the control of the degree and speed of crushing. During the test, the speed of the rolls would be set; the upper rolls raised to permit start of feeding of the stems to be processed; then the gap between the rolls would be adjusted to provide the desired degree of crushing.

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Weighed bolts were processed by the roll splitter. Split bolts and all solid particles (bark and splinters) were gathered and weighed to determine the weight of water removed during the process. Split bolts and particles were set on pallets and weighed daily to determine moisture loss rates.

Following the evaluation of drying rates of crushed material, a cooperative agreement between TVA and the U S Forest Service (USFS), Southern Forest Experiment Station at Auburn, Alabama. was executed. The Forest Service is evaluating the horsepower requirements of the crushing process and developing alternative (more efficient) roll surfaces and roll geometry (placement) for improving the design for mounting on a mobile harvester.

To document the horsepower required to crush small trees, pressure transducers and tachometers were connected to the FERIC Roll Splitter and the data recorded using a multichannel recorder. The digitized data was used for calculating power requirements. In the tests, three species were used: hybrid poplar, red maple (Acer rubrum), and chestnut oak (Quercus prinus). Complete stems were crushed while stem diameter, hydraulic-pressures, and feed rates were monitored for each of the two set's of rolls. Stems of each species were crushed singly, in pairs, and three at a time.

The preliminary findings indicate that by applying minimal power during the harvesting phase by a machine similar to that shown, small diameter biomass (less than 7 inches) may be adequately processed using a splitting and crushing technique to accomplish a significant amount of drying in the field. Though the physical characteristics of processed material have not been evaluated, it seems feasible that a satisfactory level of flexibility can be achieved to allow baling or modulating using existing or modified agricultural equipment. Research by others has shown that green forest biomass can be baled to a density of 336 Kg/m³ using an average of 0.83 KW.hr/tonne.

These developments need significantly more evaluation from engineering, productivity, and cost standpoints, as well as potential impacts on the site of a multiple-pass harvesting system ((1) cut and crush; (2) bale; and (3) primary transport). Advantages and disadvantages may accrue as a result of any of these operations, depending on objectives of harvest and the characteristics of the operating system.

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