Research Note

Effect of Surface Preparation On Gas Permeability of Wood

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ABSTRACT. Surface preparation has a profound effect on the rate of flow of fluid through wood, particularly in the longitudinal direction of flow. For best results, the surface must be devoid of any debris and/or obstruction. The use of a sharp, thin knife appears to be an effective way of preparing samples for natural permeability measurements.

It has been fairly well established that within a single tree sapwood is more permeable than heartwood and that permeability in the longitudinal direction is much greater than that in the radial or tangential directions. Other factors affecting gas permeability of wood are well documented in the literature (Choong and Fogg 1972; Comstock 1967, 1970; Sebastian, Côté, and Skaar 1965; Siau 1971).

The literature, however, does not mention the importance of surface preparation. For this reason, a study was undertaken to explore how surface preparation affects the flow of gas through wood.

Experimental Procedure

Twenty-seven longitudinal and 15 transverse (radial and tangential) permeability samples, measuring 5/8 inch in diameter and 0.5 inch in length, were prepared from several small disks of tupelo gum (*Nyssa sylvatica* Marsh.). A bandsaw was used to cut surfaces perpendicular to the direction of gas flow. After conditioning to 10 percent equilibrium moisture content (EMC), permeability was measured with purified nitrogen gas in an apparatus described by Choong, Tesoro, and Manwiller (1975). The bandsawn surfaces were then microtomed, and permeability was remeasured at the same equilibrium moisture condition.

In addition, two pieces of southern pine (*Pinus* sp.), about 0.5 inch thick, were obtained from material used in a study by McMillin and Harry (1971). Both were cut with an airjet-assisted carbon dioxide laser. One was cut across the grain, so that five longitudinal permeability samples were obtained. The other was cut along the grain, and four tangential permeability samples were obtained. After measuring gas permeability, the laser-machined surfaces of each sample were cut clean with a scalpel, reconditioned to 10 percent EMC, and then permeability remeasured. The next surface preparation was by bandsawing a very thin section from both ends of each sample. The last method of preparation was by lightly sanding the samples on fine sandpaper.

Results and Discussion

The mean permeability values for sawn and microtomed tupelo gum are tabulated in Table 1. In the longitudinal direction of movement, permeability was greater for microtomed surfaces (avg. 6.4492 Darcys)

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TABLE 1. – *Average permeability values between sawn and microtomed sections in tupelo gum.*

Flow direction	No. of samples	Permeability	
		Sawn	Microtomed
Longitudinal	27		
Tangential	15		
Radial	15		

than for bandsawn surfaces (avg. 3.2196 Darcys). A paired t-test indicated the difference was significant at the 5 percent level. Scanning electron micrographs show that the bandsawn surface is covered with loose fibers (Fig. 1(A)) that could inhibit the flow of fluids. When surfaces were microtomed, considerably more pore structure was observed (Fig. 1 (B)).

In the transverse directions, there was no difference in permeability between the two surface preparations (avg. 0.0007 Darcy). The micrographs in Figure 1 (C) and 1 (D) show that microtoming the surface may improve surface smoothness slightly, but the fluid encounters resistance as it passes through the cross-wall structure, and apparently the condition of the outer surface does not affect flow significantly.

The permeability values for various surface conditions in southern pine are summarized in Table 2. In the longitudinal direction, there was no significant difference in permeability between laser-cut and scalpel-cut surfaces, but the permeability of sanded surfaces was significantly (1 percent level) lower than for sawn surfaces. Moreover, surfaces cut with the laser and the scalpel had

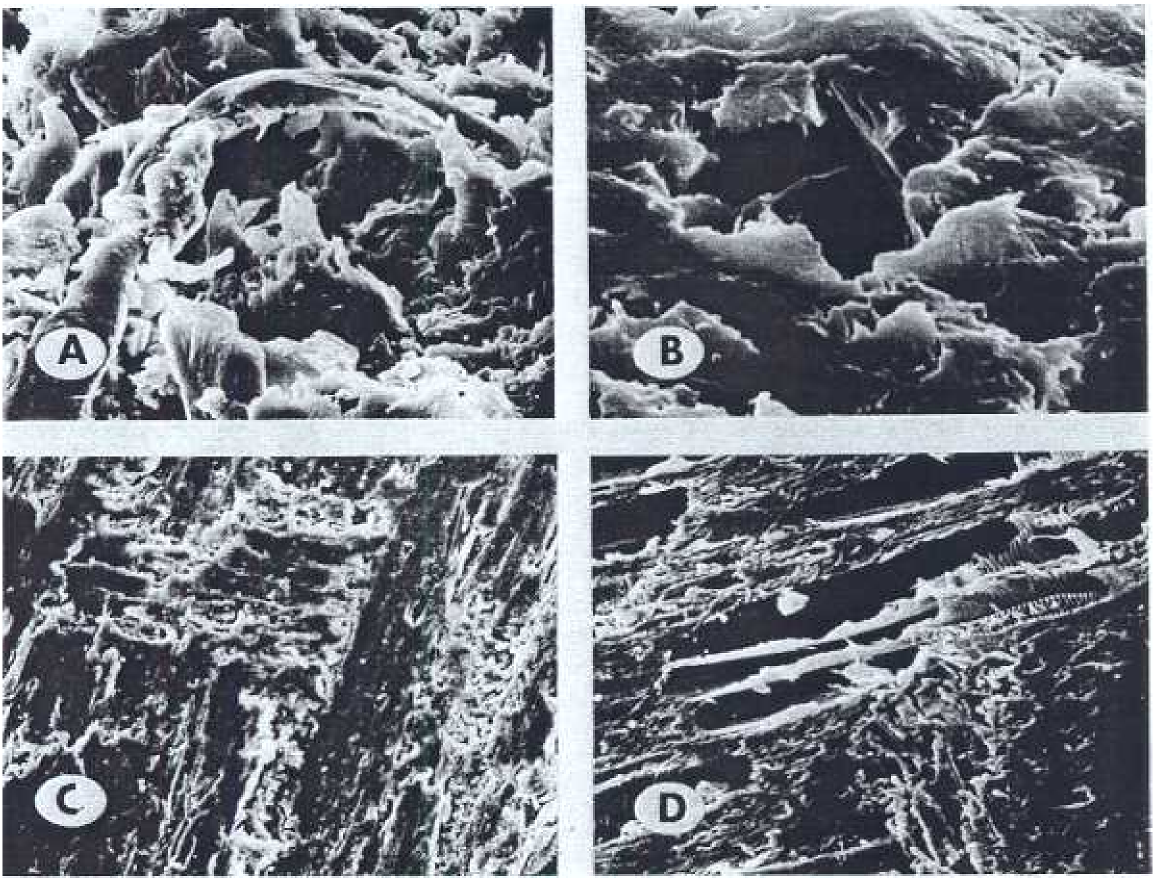

Figure 1. – Scanning electron micrographs of tupelo gum surfaces cut across the grain by bandsawing (A) and microtoming (B) and cut along the grain by bandsawing (C) and microtoming (D).

TABLE 2. – *Average permeability values for various surface conditions in southern pine.*

Flow direction	No. of samples	Permeability			
		Laser-cut	Scalpel-cut	Sawn	Sanded
Longitudinal	5				
Tangential	4				

significantly higher permeability values than did the sawn and sanded surfaces. The greater flow for surfaces prepared with a laser or with a scalpel is due to opening of the pore structure. Scanning electron micrographs show that laser-cut (Fig. 2(A)) and scalpel-cut (Fig. 2(B)) surfaces are far smoother than bandsawn surfaces (Fig. 2(C)). The pore

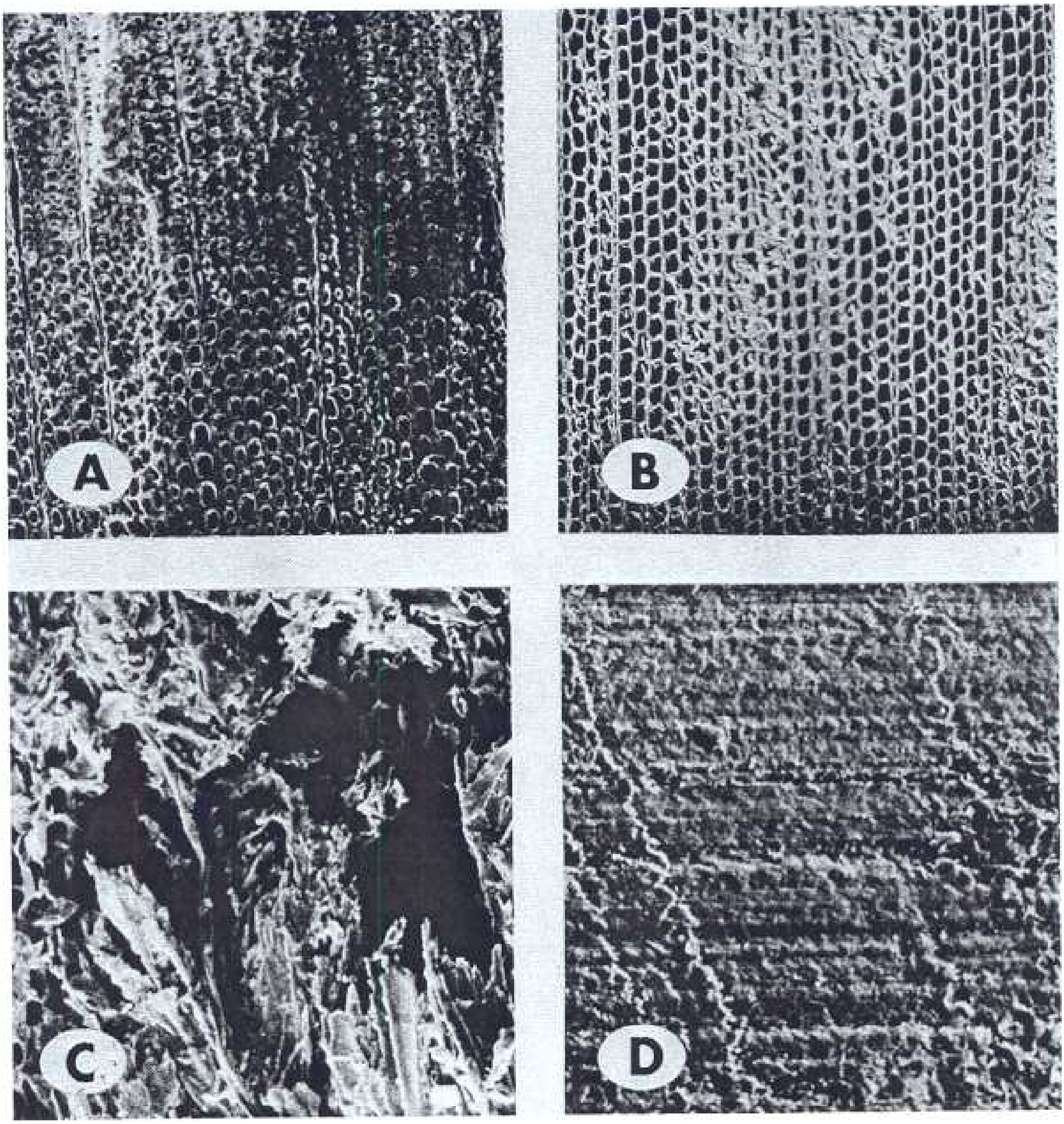

Figure 2. – Scanning electron micrographs of southern pine surfaces cut across the grain by a laser (A), scalpel (B), bandsaw (C), and sanding (D).

structure of sanded surfaces appears completely blocked (Fig. 2(D)). In the transverse direction, differences in permeability between surfaces were slight.

It is concluded that the method of surface preparation has a profound effect on the rate of flow of fluids through wood, particularly in the longitudinal direction of flow. The surface must be devoid of any obstruction in studies dealing with natural permeability of wood. A sharp, thin knife appears to be an effective way of preparing samples for such permeability measurements.

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