

ABSTRACTS (MASTER THESIS)

Effect of water hammer on liquid permeation into wood in impregnation process

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Introduction

Impregnation of wood with chemical liquids has been used to improve the disadvantages of wood. After the impregnation process, however, there often exist some areas without being filled with the liquid, leading to the inadequate improvement. This is mainly caused by the obstacle that blocks the liquid flow, e.g., the aspirated pits in tracheid of coniferous wood. This study focuses on the water hammer to penetrate the obstacle as follows. If the liquid fills up the cell cavities between the wood surface and the tip of the liquid permeation in wood, or the obstacles, the abrupt increase in the liquid pressure from one to another on the wood surface is expected to cause the damping oscillation in the liquid pressure at the obstacles, which is expected to penetrate them. The purpose of this study is to promote the liquid permeation into wood by applying the water hammer. The test equipment was fabricated to generate the water hammer. The change in pressure with time was examined for various conditions of the equipment, and was analyzed using the fluid dynamics. Effect of the water hammer on the liquid permeation into wood was also examined.

Materials and methods

The test equipment is shown in Figure 1. Distilled water was used as a liquid.

To generate water hammer, vessel B filled with liquid at an ordinary pressure (0.1 MPa) was connected by a valve to vessel A filled with liquid at higher pressure (1.1 MPa). The change in liquid pressure in the vessel B as a function of time was measured just after the valve was opened with various rate. The maximum pressure and the maximum pressure-increasing rate was estimated from the temporal change in pressure, and analyzed by the fluid dynamics.

To examine liquid permeation, wood samples with a dimension of 15 mm (T) × 15 mm (R) × 100 mm (L) were prepared from a block of yellow cedar (*Chamaecyparis nootkatensis* Spach), and dried at 105 °C for 24 h to oven-dry state. The container with the dried samples inside was evacuated by a rotary pump for 1 h, injected with distilled water so that all the samples were immersed in the liquid, and introduced with the air to be an ordinary pressure. The samples were subsequently remained to be immersed in the liquid for 48 h. A sample after immersed was fixed directly under the pressure gauge P_1 in the vessel B with an ordinary pressure (Fig. 1). The valve was opened with various rate after the vessel A at higher pressure (1.1 MPa) inside. Amount of the liquid taken up to the sample was measured for each rate.

Results and discussion

The pressure P_1 without specimens showed damping oscillation behavior when the valve was opened quickly, called quick pressurization. While with slow opening of the valve, called slow pressurization, the pressure gradually increased to a constant value. These findings indicate that the water hammer occurred by the quick pressurization. The amount of the liquid taken up to the wood sample, however, showed no significant difference between the quick and slow pressurization.

With the increase in the maximum pressure-increasing rate, the maximum pressure increased up to about 1.1 times larger than the equilibrium pressure. It was indicated from analyzing this relation that the maximum pressure can reach to twice the equilibrium pressure. Thus, there remains the possibility that the water hammer in this experiment is not so much large as affecting the penetration of the obstacle in wood. Being based on the analysis, the valve opening rate and the aperture of the valve are required to be higher in order to enhance the strength of the water hammer.

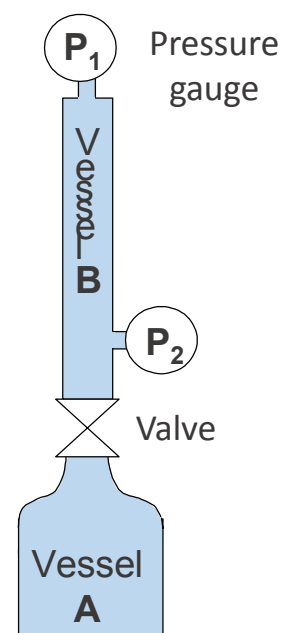


Figure 1. Schematic diagram for test equipment.