

THE VAPOR DRYING PROCESS

by

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INTRODUCTION

Vapor drying is essentially the same as kiln drying except that organic vapors are employed in the place of steam. At present, no attempt is made to control the equilibrium moisture content, which is very nearly zero throughout the process.

The basic drying problems still prevail, although they may be altered to some extent when high temperatures (over 200° F.) are used; the effect of high temperatures on wood has not been fully investigated.

DEVELOPMENT OF THE PROCESS

Attempts were made to use organic vapors for drying wood as early as 1870, but they failed because of imperfect technique. Similar attempts were made in 1910 using low boiling point drying agents, such as ether and carbon disulphide; apparently no commercial application resulted. In 1937, a vapor process was employed for the removal of pitch.

The initial work on the present process was begun by Mr. Monie Hudson in the late 1930's and resulted in the issuance of a number of patents. The first commercial installation was completed in 1945 at the plant of the Taylor-Colquitt Company, Spartanburg, S. C.

At present there are four commercial plants in operation and another is under construction. Two plants, one in Australia and the other in New Zealand, are used exclusively for the drying of lumber. The remaining two operating plants, which are in the United States, are used for drying wood prior to preservative treatment.

DESCRIPTION OF PROCESS AND EQUIPMENT

The equipment and the general flow diagram for the process are shown in Figure 1. The organic liquid is boiled in the evaporator, and the vapors pass into the cylinders where a portion of the vapors condense on and in the wood. As the organic liquid continues to condense, the temperature of the wood is raised above the boiling point of the water which vaporizes and passes out of the drying chamber with the surplus of organic vapors. The mixture of water and organic vapor is condensed, and the liquids pass to the separator. The immiscible and lower specific gravity organic liquid floats on the water and drains continuously to the condensate return tank from which it is pumped to the evaporator for re-use. The amount of water removed is measured which, with the volume of the charge and its initial moisture content, permits the operator to determine when the material has reached the desired average moisture content. At the completion of the drying period, a vacuum is used to recover the organic liquid, and then the material may be steamed in an attempt to relieve stresses.

The temperature employed in the process can be varied either by selecting an organic liquid having the desired boiling point or by the use of a vacuum which reduces the boiling point of both the organic liquid and water. The temperature of vapors leaving the drying chambers (effluent vapor temperature) controls the steam supply to the evaporator.

APPLICATION OF THE PROCESS

The vapor drying process was developed originally for conditioning (partially drying) material prior to treatment with a wood preservative, and it is still used largely for this purpose. Considerable success has

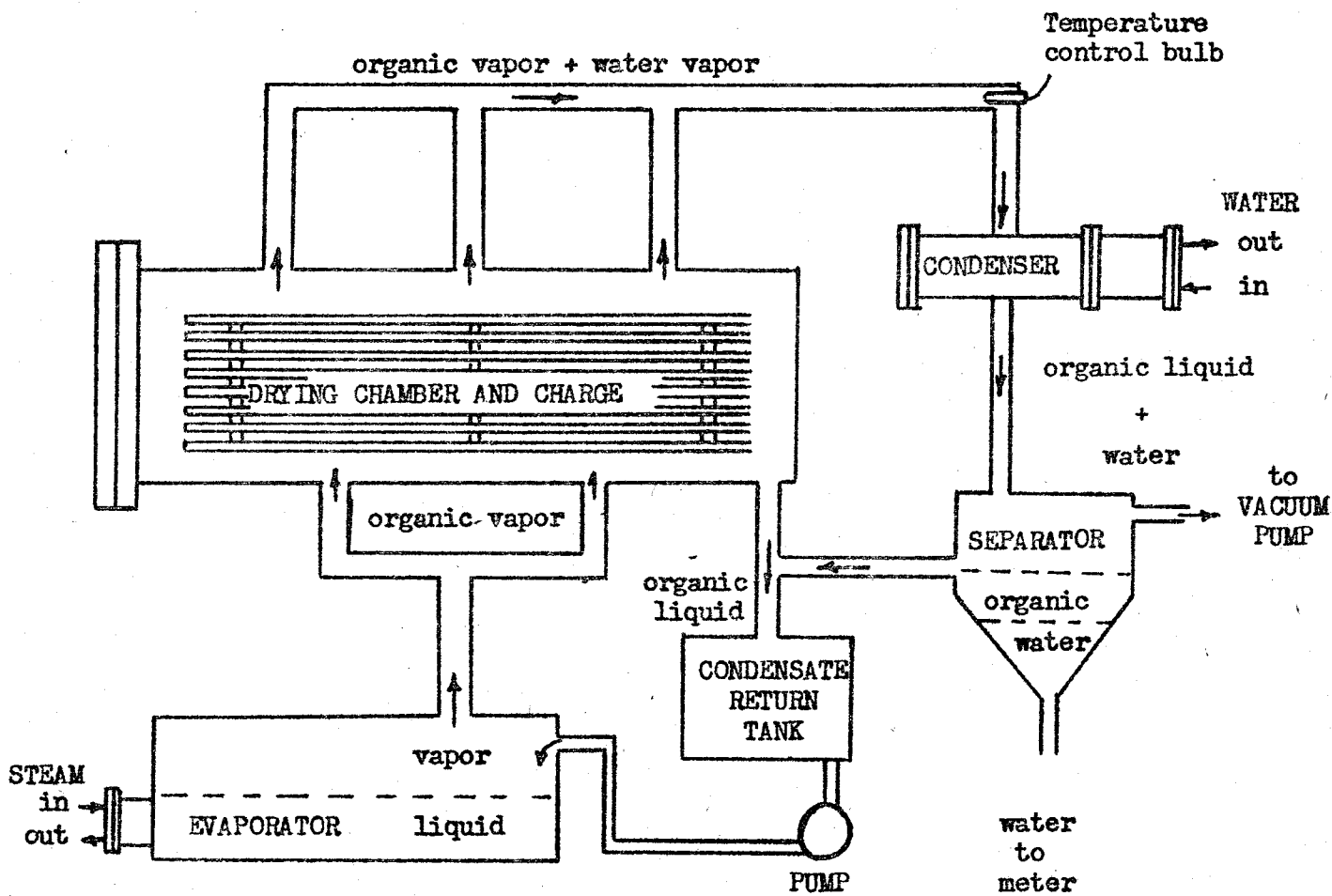


Figure 1. Flow Diagram of Vapor Drying Process

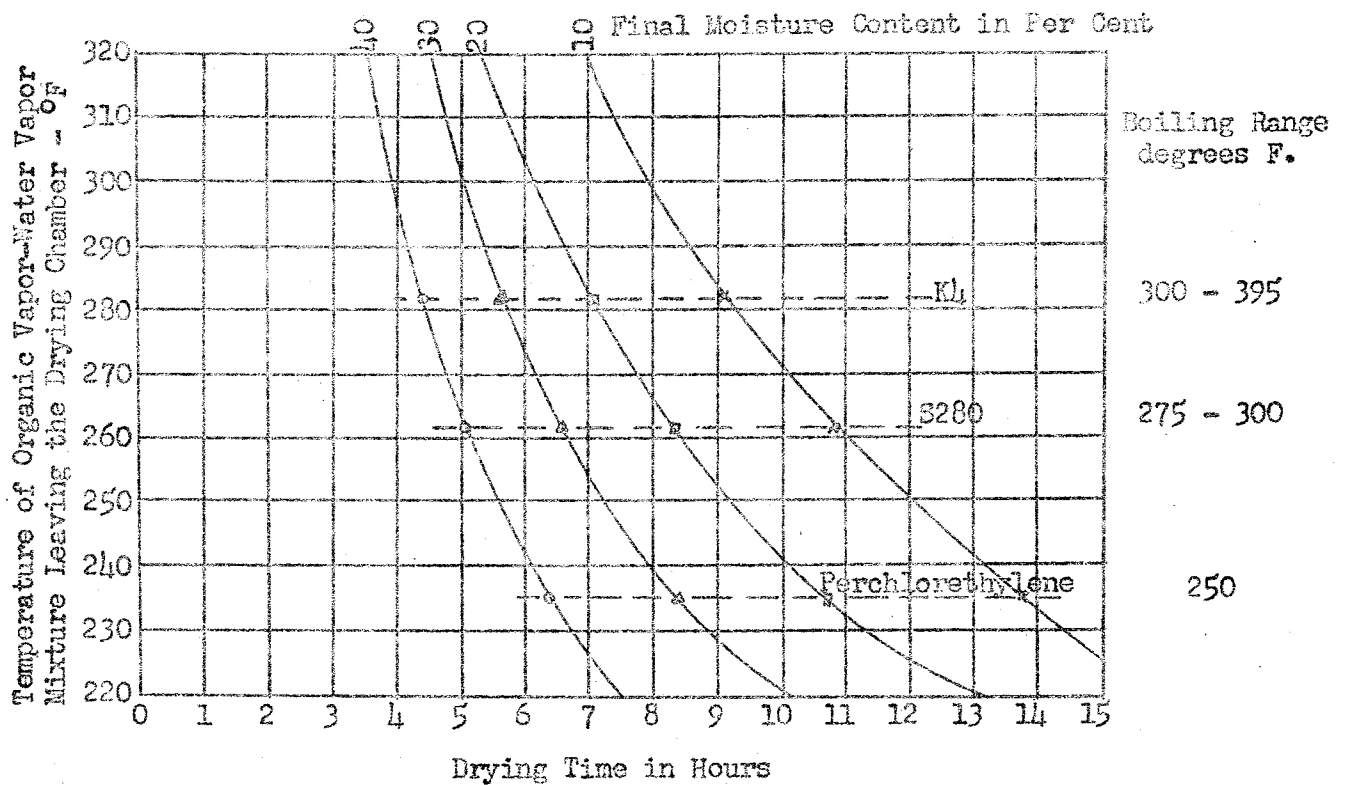


Figure 2. Relationship between temperature and time required to vapor dry 3 x 8 inch southern pine roof plank from an initial moisture content of 100 per cent with various drying agents. (Adapted from Drying Lumber by the Vapor Process by Monie S. Hudson, 1950 Proceedings of the American Wood-Preservers' Association)

been achieved in drying crossties, particularly oak and gum, which present difficult air seasoning problems, and it appears that the checking pattern attained during drying will prevent the development of large checks and splits after the ties are placed in service.

The process can be used for drying, treating, and redrying lumber that is treated with water-borne wood preservatives. Also, a solvent recovery process has been developed in which the material is dried with organic vapors, treated with a solution of a preservative in this same organic liquid, and the organic liquid is recovered, leaving the preservative in wood. This development should prove particularly useful in the preservative treatment of wood prior to lamination, where a dry nonbleeding surface is essential to a good glue board.

The drying of lumber to a specified moisture content is a field in which this process may prove commercially feasible.

VAPOR DRYING LUMBER

Organic liquids having boiling points in excess of 300° F. have been used successfully for drying 3 x 8 inch southern yellow pine lumber. The time-temperature relationship for drying this material, based on three organic liquids, is shown in Figure 2.

Unpublished data, developed through cooperation of the Taylor-Colquitt Company and the Oregon Forest Products Laboratory using experimental equipment (drying cylinder of 12½ inches I.D. by 10 feet), indicate that (1) 1-inch ponderosa pine lumber can be dried from an average initial moisture content of 150 per cent to 10 per cent in 8 hours when an alternate heating (260° F.) and vacuum cycle is used; (2) 1-inch Douglas-fir

lumber can be dried from an average initial moisture content of 47 per cent to 10 per cent in 6 hours using a continuous cycle at 260° F.; (3) 2-inch Douglas-fir lumber can be dried from an average initial moisture content of 47 per cent to 12 per cent in 12 hours with a continuous cycle using a vacuum of 17 inches of mercury.

Although no difficulty was encountered in drying 1-inch Douglas-fir at 260° F., considerable honeycomb developed when 2-inch material was dried at this same temperature. The use of a vacuum of 17 inches of mercury, which reduced the temperature to 235° F., apparently eliminated this internal checking.

The shrinkage of the material during drying has been normal which, in view of the high temperatures used and an equilibrium moisture content of virtually zero, would appear to favor the development of seasoning defects. Since such defects do not develop when the proper drying cycle is employed, the theory has been advanced by Mr. H^Uudson that "the duration of stress applied to given laminae is so short, because of rapid drying, that the strength-time limit of resistance of the wood to failure is not exceeded." The expansion of the wood at these temperatures also may have a significant effect on the intensity of the stresses developed.

The present practice is to steam the charge, after drying and recovery of the organic liquid, in an attempt to relieve stresses. In some instances steaming has been successful, but more experimental work must be done with Douglas-fir to develop a satisfactory steaming cycle. A more successful approach to this problem of relieving stresses appears to be through control of the water vapor - organic vapor mixture in the drying chamber. This might be accomplished by recirculating the vapors within the chamber at a controlled temperature and pressure and, if neces-

sary, by adding water to the system in order to establish equilibrium moisture content conditions which appear to be theoretically possible at these higher temperatures. A study now is being made to determine what equilibrium moisture content conditions, if any, do exist.

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