NOTES AND CORRESPONDENCE

This section of the journal is available for wood scientists and technologists to publish technical notes and accounts of work in progress, as well as to discuss matters of education and professional development. In general, such material should be limited to no more than six double-spaced typewritten pages. Where applicable, contributions should appear in the approved style for technical articles in *Wood and Fiber*.

Readers are invited to submit discussions of articles that appear in *Wood and Fiber* for publication in this section. Any individual who wishes to discuss an article should submit his comments (in duplicate) soon after publication of the article. The paper being reviewed should be identified by title, author, and date of publication.

No discussion will be published unless the author of the original article has been provided with a copy of the discussion and has had an opportunity to submit a reply to the Editor, to be published with the discussion. Discussions and replies should not exceed the length suggested above. Where pertinent, references to the literature should be included.

It is anticipated that discussion and replies in *Wood and Fiber* can add, for both authors and readers, a dimension not normally found in technical journals.

COMMENTS ON "THE STATE OF MOISTURE TRANSPORT RATE CALCULATIONS IN WOOD DRYING"

As stated by R. N. Meroney (*Wood and Fiber*, **1**(1): 64–74), the present technique for drying wood has been determined by tedious empirical trial and error studies. The author indicates that drying schedules for new conditions and other wood species should be found analytically, using data about moisture movement in wood and about moisture transfer from wood to air. The author seems to assume that moisture movement within wood is sufficiently known. He recommends investigations about moisture and heat transfer. They will certainly be necessary for developing drying schedules analytically, but perhaps further studies about moisture movement within wood are as important and more difficult.

Former studies of wood moisture diffusion (about a third of which are mentioned by Meroney) show considerable discrepancies. The averages of diffusion coefficients as measured by different capable researchers for one and the same wood species under equal conditions differ as much as 1 to 10. I feel that these discrepancies need clarification too. Otherwise the wood drying situation in the year 2000 may still be principally the same as today: wood is dried by empirically found schedules, whereas a tremendous amount of theoretical drying research has been done in vain.

HANS KUBLER

University of Wisconsin
Madison

FURTHER COMMENTS ON "THE STATE OF MOISTURE TRANSPORT RATE CALCULATIONS IN WOOD DRYING"

Meroney (1969) recently gave two drying rate regimes for wood. These were the constant rate period and the falling rate period. He also indicated that the critical moisture content separating the two processes was close to 35%.

The falling rate period, or normal drying process, has been analytically derived

(Crank 1956) and obtained by non-linear numerical methods (Fosberg 1969a) as

$$E = E_0 e^{-\lambda t} \qquad (1)$$

where $E \equiv (m - m_e)/(m_0 - m_e)$, E_0 is usually taken to be 1, m is the integral average moisture content, m_e is the boundary moisture content (usually the equilibrium value at the surface), and m_0 is the initial moisture content. Equation (1) has been shown to hold over the range from 0 moisture content to complete saturation of the wood, both fibers and void volume (Fosberg 1969b).

Thus, if equation (1) is differentiated with respect to time, the mass loss rate is

$$dm/dt = -\lambda e^{-\lambda t} (m_0 - m_e) \qquad (2)$$

In order for the mass loss rate to be constant below total saturation, the boundary condition imposed on the wood must be increased logarithmically over time.

Nissan and Hansen (1961) attribute the constant rate drying to mass loss taking place from a free surface. In order to achieve this condition, both the fibers and the voids must be saturated throughout the wood, since drying will take place at the surface. The moisture content required to achieve this saturation can be determined from Stamm (1938). The critical moisture content for softwoods is then close to 200%. Above this moisture content, free water will exist on the surface of the wood, while below this critical value, the outer layers and surface will be considerably dryer and even though a large quantity of free water exists in the interior, the moisture loss rate will be controlled by diffusion of vapor through the outer layers. Thus, the critical moisture content separating the constant rate period from the falling rate period should be around 200% rather than 35%.

Meroney also states that the drying process can be expressed as

$$\ln E = -Nt/a$$

(his equation 9) in the falling rate period. However, Crank (1956) and Fosberg (1969a) have shown that the relationship should be

$$\ln E = -Nt/a^2$$

where N is a function of the Fourier number and the diffusivity.

MICHAEL A. FOSBERG
Rocky Mountain Forest and Range Experiment Station,[1] *Forest Service, U. S. Department of Agriculture, Fort Collins, Colorado 80521*

REFERENCES

CRANK, J. 1956. The mathematics of diffusion. Clarendon Press, Oxford. 347 p.

FOSBERG, M. A. 1969a. Drying rates of dead forest fuels. Submitted to Forest Science.

———. 1969b. Effects of precipitation on dead fuel moisture. USDA, Forest Serv., Rocky Mountain Forest and Range Experiment Station, Research Progress Report.

MERONEY, R. N. 1969. The state of moisture transport rate calculations in wood drying. Wood and Fiber, **1**(1): 64–74.

NISSAN, A. H., AND D. HANSEN. 1961. Fundamentals of drying porous materials. TAPPI, **44**(8): 529–534.

STAMM, A. J. 1938. Calculations of the void volume in wood. I and E. C., **30**(11): 1280–1281.

[1] Maintained in cooperation with Colorado State University.

AUTHOR'S CLOSURE TO "THE STATE OF MOISTURE TRANSPORT RATE CALCULATIONS IN WOOD DRYING"[1]

The author would like to thank Mr. Fosberg and Professor Kubler for their interest and comments on the paper. The suggestion by Mr. Fosberg that the critical moisture content for softwoods is 200% was based on a relation which assumed that m_0 was the fiber saturation condition and that the critical point exists when the first decrease in total wetted surface occurs. There is some dissension concerning the exact

[1] Meroney, R. N., 1969. The state of moisture transport rate calculations in wood drying. Wood and Fiber, 1(1): 64–74.

mechanism for the inception of a falling rate period as noted in the original paper —in fact "effective" constant rate drying may occur below the fiber-saturation level itself. On the other hand, as noted by Strom, when the movement of free liquid is highly restricted, it is possible for drying to be immediately diffusion controlled, but only when the "adequate" heat and circulation are supplied (Strom 1964). Hence, the so-called critical moisture point may vary from 25% up to the initial moisture content of the wood depending upon wood type. Mr. Fosberg's suggestion that $\ln E \sim a^{-2}$ is true for the drying of cylindrical elements; however, for flat slabs the original Equation 9 of the paper, $\ln E = Nt/a$, is correct.

The author would like to reassure Professor Kubler that he never intended to discredit the study or importance of research in wood moisture diffusion. Rather, considering the complexity of the internal mechanism of drying, as so aptly indicated by Marshall (1958), the rather pragmatic engineering viewpoint was taken that one might arrive at adequate approximate solutions for industrial kiln schedules by the use of the suggested falling rate regime relations.

REFERENCES

MARSHALL, W. R., JR. 1958. Drying—its status in chemical engineering in 1958. Chemical Engineering Progress Symposium Series, No. 25, Vol. 55, 213–227.

STROM, A. J. 1964. Wood and cellulose science. Ronald Press Co., New York.

SASTRY, G. P. 1969. The reaction of formaldehyde with spruce lignins. *Holzforschung* 23(1): 15–16. Spruce Willstätter lignin and spruce Björkman lignin were condensed with formaldehyde and also with radioactive formaldehyde under different conditions. The results of formaldehyde-lignin condensations under different conditions obtained by radioactive method are in agreement with dimedone results of formaldehyde-lignin condensation. (A)

BÁLINT, G., and A. TOMEK. 1968. On the increase in stability of mine props from oak and turkey oak. *Holztechnologie* 9(4): 266–270. Optimum impregnation of oak and turkey oak for mining was studied. Effective protection was obtained from aqueous solutions of 2% modified U-salt and from 5% Celcure. Methods provided savings in time and materials. Leachable and chemically bound preservatives were studied. (RE)

FRENCH, J. R. J. 1968. An artificial egg-laying site for the common furniture beetle *Arorium punctatum* (de Geer). *J. Inst. Wood Sci.* 4(3): 34–36. A technique is described for embossing on wood samples artificial egg-laying sites for the common furniture beetle, *Arobium punctatum*. (JW)

SCHNEEWEISS, G. 1969. Influence of dimensions on the bending strength of wooden beams. *Holz als Roh- und Werkstoff* 27(1): 23–29. Shows that in addition to length (proved by the author in a previous paper), the influence of width is as important as its height or depth on the bending strength of wooden beams. Presents the theory of size effect and a computational method. (JY)

DINWOODIE, J. M. 1968. Why measure density critically? *J. Inst. Wood Sci.* 4 (3): 3–5. The author inquires whether or not the high cost of specialized techniques for measuring wood density is justified by the additional information obtained. He presents several arguments for increased accuracy. (JW)

OLOFINBOBA, M. O., and J. R. S. LAWTON. 1968. An investigation into the biology of the blue-stain organisms in *Antiaris africana*. *J. Inst. Wood Sci.* 4(3): 6–20. Blue stain of the wood *Antiaris africana* is verified to be caused by the fungus *Botryodiplodia theobromae*. Block culture and field experiments revealed the parts of the tree susceptible to the organism, the path of penetration through the xylem, and the resulting effect on cellular carbohydrates. (JW)