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Reliability of One Dimensional Model of Moisture Diffusion in Wood *

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Abstract. A model of the moisture diffusion in wood under isothermal conditions taking into consideration coating of the surface of a specimen is presented in a 2-D-in-space formulation. A reliability of a corresponding 1-D model is investigated for a simulation of moisture movement in 2-D medium. This paper presents a technique to determine the width as well as the degree of edges coating of the specimen making the 1-D model relevant for 2-D medium. This technique bases on the computer simulation of 2-D moisture diffusion to estimate the reliability of the corresponding 1-D model. In the technique, approximate coefficients of the diffusion and surface emission may be employed if accurate values of these coefficients are unknown.

Key words: wood drying, diffusion, surface emission, modelling, simulation.

1. Introduction

Wood drying is a highly energy intensive process of some industrial significance. It is a process whereby the moisture moves from an area of higher moisture content to an area of lower moisture content within the medium. When the surface moisture evaporates from the sides or ends, moisture moves from interior toward these locations. This process continues until the wood reaches its equilibrium moisture content with the ambient air climate (Skaar, 1988; Siau, 1984).

Mathematical modelling is gaining an increasing acceptance within the timber drying industry and the use of mathematical simulators, which describe the complex heat and mass transfer phenomena at a fundamental level, can provide important information which could be used in both the design and optimisation of the kiln (Rosen, 1987; Siau, 1984; Turner and Mujumdar, 1997).

From a mathematical point of view, the moisture transport process can be treated as a diffusion problem based on the Fick's second law. A model of the wood drying, under

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isothermal conditions, can be expressed through the diffusion equation with initial and boundary conditions. The initial condition expresses an initial moisture concentration in the specimen, and the boundary condition describes the surface evaporation. Moisture diffusion models have been successfully used to predict wood drying process (Perré and Turner, 1999; Söderström and Salin, 1993; Turner and Mujumdar, 1997).

Moisture movement models were successfully used also to solve the inverse coefficient problem (Chen *et al.*, 1996; Dincer and Dost, 1996; Rosenkilde and Arfvidson, 1997; Simpson and Liu, 1997). In this case, it is assumed that the type of governing equations is known. The diffusion and surface emission coefficients need to be recovered by using the data of physical experiments as a known solution of the problem. The inverse solutions are known to be sensitive to changes in input data resulting from measurement and modelling errors (Özisik, 1993; Hensel, 1991; Tikhonov and Arsenin, 1977). Hence, they may not be unique. Nevertheless, the determination of the parameters for diffusion processes in various species of wood is the problem of today (Hukka, 1999; Liu and Simpson, 1999; Weres *et al.*, 2000; Yeung and Lam, 1996).

In practice, objects to be dried are usually of three-dimensional shape. Nevertheless, in the literature on moisture movement in wood, one-dimensional-in-space (1-D) moisture transfer models have been widely used. 1-D model of moisture diffusion accurately describes the process only in an extremely long and wide plate (thickness is much smaller than length and width). Respectively, 2-D model accurately describes the mass transfer in infinite rectangular rod. However, 1-D analysis can be successfully used to predict the diffusion process for a relatively short and narrow specimen if four of six surfaces are heavily coated in order to reduce the transfer of diffusing substance from those four surfaces.

The advantage of 1-D model is an efficiency of the problem solution. In addition, 1-D model contains less parameters which usually strongly depend on variables to be found. The multidimensional inverse methods are especially complex and use of them is problematic in practice. Because of this it is important to estimate the factors making 1-D model admissible to predict the diffusion process accurately.

Recently, a concept of a level of reliability of 1-D model has been proposed (Baronas and Ivanauskas, 2002). 2-D computer simulation was used to adjust the geometry of the specimen as well as the degree of edges coating to ensure relative error less than required one resulting from the model reducing from 2-D to 1-D.

However, this technique can not be applied when the diffusion and surface emission coefficients are not determined precisely. The technique requires predetermination of these coefficients. While solving the inverse coefficients problem, at least one of these coefficients is to be determined. Because of this an application of the technique is limited. This paper extends the technique to be used in the case of the inverse coefficients problem also.

The process of heat conduction, which occurs during heating of solid objects, is similar in form to the process of moisture movement in these objects (Crank, 1975; Özisik, 1993). The governing Fourier equation is exactly in the form of the Fickian equation of moisture transfer, in which concentration and moisture diffusivity are replaced with temperature and thermal diffusivity, respectively. Because of this the analysis of reliability of

1-D model of the moisture diffusion can be applied to the heat conduction problems as well.

2. Moisture Movement Problem

In a two-dimensional-in-space formulation, the moisture movement, under isothermal conditions, in a symmetric piece of a porous medium (sawn board) of thickness $2a$ and width $2b$ can be expressed through the following diffusion equation

$$\frac{\partial u}{\partial t} = \frac{\partial}{\partial x}\left(D(u)\frac{\partial u}{\partial x}\right) + \frac{\partial}{\partial y}\left(D(u)\frac{\partial u}{\partial y}\right), \quad 0 < x < a, \quad 0 < y < b, \quad t > 0, \tag{1}$$

where $u = u(x, y, t)$ is moisture content, t is time, x, y are spatial coordinates, and $D(u)$ is the moisture concentration-dependent diffusion coefficient. Although the radial and tangential diffusion coefficient may be different, it was assumed that transverse diffusion function $D(u)$ is the same in both spatial directions. Moisture content u or the water of wood is expressed as the weight of water in wood divided by the weight of dry wood-substance (kg/kg).

The initial condition $(t = 0)$ is

$$u(x, y, 0) = u_0, \quad 0 \leqslant x \leqslant a, \quad 0 \leqslant y \leqslant b, \tag{2}$$

where u_0 is the initial moisture concentration in the medium. Let us assume, that edges of the specimen may be coated (isolated), e.g., painted. The boundary conditions that describe symmetry and surface evaporation $(t > 0)$ are

$$\left.\frac{\partial u}{\partial x}\right|_{x=a} = \left.\frac{\partial u}{\partial y}\right|_{y=b} = 0, \tag{3}$$

$$-D(u)\frac{\partial u}{\partial x} = S(u_e - u), \quad x = 0, \tag{4}$$

$$-D(u)\frac{\partial u}{\partial y} = (1 - \theta)S(u_e - u), \quad y = 0, \tag{5}$$

where S is the surface emission coefficient, u_e is the equilibrium moisture content, and θ is the dimensionless degree of coating of edges $(0 \leqslant \theta \leqslant 1)$. If edges of a specimen were extremely coated, then the surface coating degree equals to 1, and it equals to 0 if the surface was not coated.

In the calculations, discussed below, a corresponding model in 1-D-in-space formulation of the model was also employed. That formulation of the model can be rather easily derived from (1)–(5) by ignoring space coordinate y.

Analytical solutions of problems, described by partial differential equations of diffusion type, do not usually exist in cases of variable diffusion coefficients and complex boundary conditions (Crank, 1975). Therefore, the problem (1)–(5) was solved numerically. The finite-difference technique has been used for the discretization of the model

(Ames, 1977). We introduced a non-uniform discrete grid to increase the efficiency of calculations. Since moisture evaporates from the surface of a piece of wet wood, a bilinear increasing step of the grid was used in the space directions x and y from the surface to the center, while a constant step was used in t direction.

3. Reliability of 1-D Moisture Diffusion Model

Let us assume, that in a numerical investigation, e.g., solving the problem of inverse coefficients, we need to use 1-D formulation of the model (1)–(5). Usually physical experiments are required to solve the problem of inverse coefficients. If a specimen is relatively long like a sawn board, then we need to provide as far as possible wide specimen or to isolate the edges of a narrow specimen. Of course, the good result can be achieved also by a combination of these two ways. So, we need to find out how much wide and insulated the specimen should be to have an accurate solution of the problem. In terms of 2-D formulation of the model, when the thickness $2a$ of the specimen has been chosen, the next choice of width $2b$ and coating degree θ ir required. In the case of solving the problem of parameters identification, the diffusion D and surface emission S coefficients also need to be determined. Assuming, that the initial u_0 as well as equilibrium u_e moisture concentrations can be determined precisely before the investigation, the following parameters of the model (1)–(5) may need to be determined: b, θ, D, S.

The average moisture content is usually measured at various times to predict the dynamics of drying in a physical experiment. The calculated average moisture content $\overline{u}(t)$ values at any time t were determined by numerical integration of the finite difference solutions. The relative amount of the remaining moisture content $E(t)$ in wood during drying at time t is usually called the fraction of total moisture content in specimen (Siau, 1984)

$$E(t) = (\overline{u}(t) - u_e)/(u_0 - u_e). \tag{6}$$

The time when the drying process reaches medium, i.e., $E = 0.5$, is usually called the halfdrying time. The halfdrying time (half-time technique) well characterizes the dynamics of substance diffusion (Crank, 1975; Liu and Simpson, 1996; Ouattara *et al.*, 2000). The half-time method has been successfully employed for a solution of the diffusion problem as well as for a determination of the diffusion and surface emission coefficients in various application areas (Söderström and Salin, 1993; Ouattara *et al.*, 2000; Lim and Tung, 1997).

Assuming constant values of the parameters a, u_0 and u_e of the model in 2-D formulation (1)–(5) as well as variation of the parameters b, θ, D, S, we introduce a function $T_{0.5}^{(2)}(b, \theta, D, S)$ as the halfdrying time at given half width b, coating degree θ, and coefficients D, S of internal and external moisture transfer

$$E\Big(T_{0.5}^{(2)}(b, \theta, D, S)\Big) = 0.5. \tag{7}$$

Respectively, for a case of 1-D formulation of the model, we introduce a function $T_{0.5}^{(1)}(D,S)$ of two parameters D,S only. Since 1-D model can be successfully used to predict drying time for an extremely wide plate as well as for a board with heavily coated edges, we obtain

$$T_{0.5}^{(1)}(D,S) = \lim_{b\to\infty} T_{0.5}^{(2)}(b,\theta,D,S), \quad 0 \leqslant \theta \leqslant 1, \tag{8}$$

$$T_{0.5}^{(1)}(D,S) = T_{0.5}^{(2)}(b,1,D,S), \quad b \geqslant 1. \tag{9}$$

Assuming $T_{0.5}^{(2)}$ as the true value of the halfdrying time of a two-dimensional medium and $T_{0.5}^{(1)}$ as an approximate one, we introduce the relative error $R_{0.5}$ of the halfdrying time, arising because of reducing the model from 2-D to 1-D

$$R_{0.5}(b,\theta,D,S) = \frac{T_{0.5}^{(1)}(D,S) - T_{0.5}^{(2)}(b,\theta,D,S)}{T_{0.5}^{(2)}(b,\theta,D,S)}. \tag{10}$$

Since a specimen dries faster when the surface of moisture evaporation is larger, we have $T_{0.5}^{(1)} \geqslant T_{0.5}^{(2)}$ and $R_{0.5}(b,\theta,D,S) \geqslant 0$. $R_{0.5}$ may also be called as a level of reliability of 1-D model to predict drying of a sawn board.

Using 2-D computer simulation we can estimate the reliability of the corresponding 1-D model. Calculation of the relative error $R_{0.5}$ at various values of the width as well as degree of edges coating allows to determine the characteristics of the specimen to ensure the relative error of the calculation not greater than the required one because of the reducing the model from 2-D to 1-D (Baronas and Ivanauskas, 2002).

4. Results of Calculation and Discussion

The moisture transfer model given by (1)–(5) was applied to simulate the drying of specimens from northern red oak (*Quercus rubra*). The experimental moisture content values for red oak by Simpson and Liu (1997) were used for numerical analysis. Experimental drying conditions were 43^0C at 84% relative humidity ($u_e = 0.162$). There were two air velocities: 1.5 and 5.1 m/s. The average initial moisture content u_0 was 0.825. The size of the experimental specimens was 0.102 by 0.305 by 0.029m. Since the specimens were relatively long and the ends were heavily coated, 2-D formulation model was well justified (Baronas *et al.*, 2001), $2a = 0.029$, $2b = 0.102$.

In the mathematical model (1)–(5), it was assumed that the diffusion coefficient is constant above the fiber saturation point (FSP, 0.3 for red oak) and it is equal to the coefficient at the FSP value (Hunter, 1995). The transverse diffusion function D_{SL} below FSP for red oak was represented by

$$D_{\mathsf{SL}}(u) = A\mathrm{e}^{(B/T+Cu)}, \tag{11}$$

where T is the temperature in Kelvin, A, B and C are experimentally determined coefficients (Simpson, 1993). Values of the coefficients A, B, C in (4), (11) and S in (5) were found in (Simpson and Liu, 1997) for both air velocities. Accepting $D(u) = D_{\mathsf{SL}}(u)$, good agreement between the finite difference solution of the drying problem and experimental data was obtained for both air velocities (Baronas *et al.*, 2001).

In solving the problem of inverse coefficients, the diffusion or surface emission coefficient, or even both of them are to be determined, i.e., at least one of the coefficients D, S is unknown precisely. The influence of the width as well as edges coating degree on the relative error $R_{0.5}$ of the halfdrying time has been investigated earlier (Baronas and Ivanauskas, 2002). Because of this, here we investigated the influence of the diffusion as well as surface emission coefficient on the relative error $R_{0.5}$.

Let k_{D} be a dimensionless factor of the magnification of the transverse diffusivity, k_{S} be a dimensionless magnification factor of the surface emissivity, and k_{a} be a dimensionless ratio of the width to thickness of the specimen

$$D(u) = k_{\mathsf{D}} D_{\mathsf{SL}}(u), \quad S = k_{\mathsf{S}} S_{\mathsf{SL}}, \quad b = k_{\mathsf{a}} a, \tag{12}$$

where D_{SL} is the true transverse diffusivity, and S_{SL} is the surface emissivity, determined by Simpson and Liu (1997), at the concrete drying conditions.

The mathematical model (1)–(5) was solved numerically for various values of the factor k_{D}: $0.1 \leqslant k_{\mathsf{D}} \leqslant 10$ and the factor k_{S}: $0.1 \leqslant k_{\mathsf{S}} \leqslant 10$. Other parameters ($k_{\mathsf{a}}$, θ), influencing the relative error $R_{0.5}$, varied also.

The edges of the specimen have mostly significant effect to the drying dynamics when the transverse section is a square (Perré and Turner, 1999; Baronas *et al.*, 2001). Because of this the transverse section of a specimen was modelled mainly by a square with a side of $2a$, $k_{\mathsf{a}} = 1$. Edges were not coated, $\theta = 0$. However, the transverse section of a specimen was modelled also as a rectangle at two more values of the width b: $10a$ and $20a$ ($k_{\mathsf{a}} = 5$ and $k_{\mathsf{a}} = 10$, respectively). Values of the relative error $R_{0.5}$ were calculated also at the edges coating degree θ of 0.5. The results of calculations are depicted in Figs. 1 and 2.

Fig. 1 shows the relative error $R_{0.5}$ of the halfdrying time versus the factor k_{D} of magnification of the diffusion function D_{SL}. Let us remind, that D_{SL} is the diffusion function for red oak determined by Simpson and Liu (1997). Since $D(u) = k_{\mathsf{D}} D_{\mathsf{SL}}(u)$ and D_{SL} did not change in the calculation, Fig. 1 shows the relative error $R_{0.5}$ vs. the diffusion function D. As it is possible to notice in Fig. 1, the relative error $R_{0.5}$ of the halfdrying time is a monotonous decreasing function of the transverse diffusion coefficient D at different values of the width of the specimen, the edges coating degree θ, and surface emission coefficient S. Some additional calculations also approved the proposition

$$\forall u : u_e \leqslant u \leqslant u_0\colon\ D_1(u) \leqslant D_2(u) \Rightarrow R_{0.5}(b, \theta, D_1, S) \geqslant R_{0.5}(b, \theta, D_2, S), \tag{13}$$

where D_1 and D_2 are arbitrary diffusion coefficients. The statement (13) has been approved experimentally for D_1, D_2, satisfying

$$\forall u : u_e \leqslant u \leqslant u_0\colon\ 0.1 D_{\mathsf{SL}}(u) \leqslant D_1(u), D_2(u) \leqslant 10 D_{\mathsf{SL}}(u). \tag{14}$$

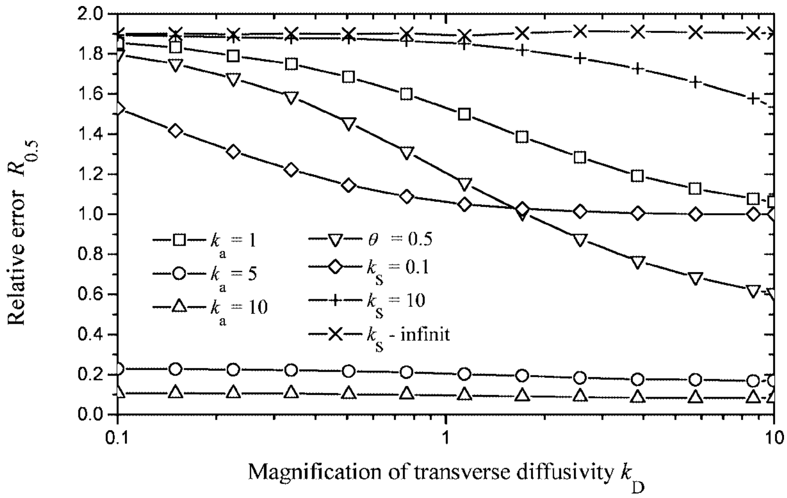

Fig. 1. Dependence of relative error $R_{0.5}$ on the factor k_D of magnification of the diffusion function D_{SL} at 5.1 m/s air velocity (Simpson and Liu, 1997). Values of $R_{0.5}$ were calculated at the following values of the width to thickness ratio k_a: 5(○), 10(△), 1 (otherwise), edges coating degree θ: 0.5 (▽) and 0 (otherwise), and the surface emissivity magnification factor k_S: 0.1 (◇), 10 (+), ∞ (×), 1(otherwise).

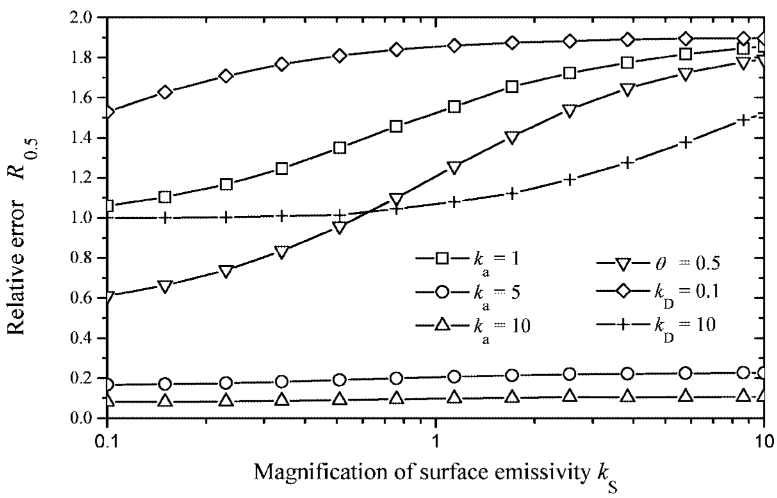

Fig. 2. Dependence of relative error $R_{0.5}$ on the factor k_S of magnification of the surface emission coefficient S_{SL} at 5.1 m/s air velocity (Simpson and Liu, 1997). Values of $R_{0.5}$ were calculated at the following values of the width to thickness ratio k_a: 5(○), 10(△), 1 (otherwise), edges coating degree θ: 0.5 (▽) and 0 (otherwise), and the transverse diffusivity magnification factor k_D: 0.1 (◇), 10 (+), 1(otherwise).

Fig. 2 shows the relative error $R_{0.5}$ of the halfdrying time versus the factor k_S of magnification of the surface emission coefficient S_{SL}, which was published in (Simpson and Liu, 1997). Since $S = k_S S_{SL}$, Fig. 2 shows $R_{0.5}$ vs. S. According to Fig. 2, $R_{0.5}$ is a monotonous increasing function of the surface emission coefficient S at different values of the width of the specimen, the edges coating degree θ, and transverse moisture diffusion coefficient D

$$S_1 \leqslant S_2 \Rightarrow R_{0.5}(b, \theta, D, S_1) \leqslant R_{0.5}(b, \theta, D, S_2), \tag{15}$$

where S_1 and S_2 are two arbitrary values of the surface moisture coefficient S, $0.1S_{\mathsf{SL}} \leqslant S_1, S_2 \leqslant 10S_{\mathsf{SL}}$, and the diffusion function D satisfies (14).

We have not proved the properties (13) and (15) for entire domain of the function $R_{0.5}$. The range of values of the transverse diffusion coefficient as well as the surface emission coefficient was specific for wood drying (Siau, 1984; Söderström and Salin, 1993). Calculation showed that the properties (13) and (15) are valid for both air velocities: 1.5 and 5.1 m/s. The relative error $R_{0.5}$ of the halfdrying time depends on drying conditions slightly.

5. Specimen Adjustment to 1-D Model

The halfdrying time $T_{0.5}^{(2)}(b, \theta, D, S)$, obtained from the 2-D model (1)–(5), is a monotonous increasing function of half width b as well as of edges coating degree θ (Baronas and Ivanauskas, 2002). Respectively, the relative error $R_{0.5}(b, \theta, D, S)$ of the halfdrying time is a monotonous decreasing function of these two parameters: b and θ. The increasing width as well as edges coating makes a specimen more relevant for 1-D model. Because of this, it is reasonable to use 2-D simulation to estimate the reliability of the corresponding 1-D model. 1-D model is considered as an approximation of more complex 2-D one.

Using multiple 2-D simulation we calculate the relative error $R_{0.5}$ at various values of the width and degree of edges coating. Thus, we can determine the characteristics of the specimen, ensuring the relative error of the calculation not greater than the required one because of the model reducing from 2-D to 1-D (Baronas and Ivanauskas, 2002). Since physical experiments are usually necessary in solving the problem of inverse coefficients, it is important to prepare a specimen, which would be relevant to 1-D model.

We define the minimal value $K_{\theta,D,S}(r)$ of the width to thickness ratio k_{a} for which the relative error $R_{0.5}(b, \theta, D, S)$ of the halfdrying time does not exceed r at given edges coating degree θ, surface emissivity S, and moisture diffusivity D as follows:

$$K_{\theta,D,S}(r) = \min_{k_{\mathsf{a}} \geqslant 1} \{k_{\mathsf{a}}\colon\ R_{0.5}(k_{\mathsf{a}}a, \theta, D, S) \leqslant r\}. \tag{16}$$

In other words, if k_{a} is the ratio of the width $2b = 2k_{\mathsf{a}}a$ to thickness $2a$ of a specimen, such as $k_{\mathsf{a}} \geqslant K_{\theta,D,S}(r)$, then the relative error $R_{0.5}$ of the halfdrying time, calculated from 1-D model, does not exceed r due to the use of the 1-D model at given θ, D and S. Let us remind, that the thickness $2a$ of the specimen has been predetermined.

Since the relative error $R_{0.5}$ of the halfdrying time is a monotonous decreasing function of edges coating degree θ also, we define a function $\Theta_{k_{\mathsf{a}},D,S}(r)$ as the minimal value of the degree of edges coating for which relative error $R_{0.5}(b, \theta, D, S)$ does not exceed r at given geometry (thickness $2a$ and width $2k_{\mathsf{a}}a$), surface emissivity S of the specimen, and moisture diffusivity D

$$\Theta_{k_{\mathsf{a}},D,S}(r) = \min_{0 \leqslant \theta \leqslant 1} \{\theta : R_{0.5}(k_{\mathsf{a}}a, \theta, D, S) \leqslant r\}. \tag{17}$$

Thus, if θ is the degree of edges coating of a specimen, having transverse section $2a$ by $2ak$, such as $\theta \geqslant \Theta_{k_{\mathsf{a}},D,S}(r)$, then the relative error of the halfdrying time, calculated by using 1-D model, does not exceed r due to the use of the 1-D model.

So, using (16) and (17) we can choose the width as well as degree of edges coating to be sure that the error of calculations will not be greater than the required one in the case of use of the 1-D model. The kind of adjustment (width or edges coating) depends on our possibilities.

This technique of the adjustment of the width and edges coating of the specimen can not be applied when the diffusion coefficient D and surface emission coefficient S in (1)–(5) are not defined precisely. These coefficients must be predetermined before the application of the technique. However, while solving the inverse coefficients problem, at least one of these coefficients is to be determined. Because of this, an application of the technique is limited.

Let us assume, that we need to use 1-D model to determine the diffusion coefficient D and surface emission coefficient S. Even if the coefficients D and S are unknown, usually these coefficients can be estimated from known values for similar species of wood or similar drying conditions.

Let us assume that the following estimation of the coefficients D and S is available:

$$\forall u\colon\ u_e \leqslant u \leqslant u_0\colon\ D(u) \geqslant D_0(u), \tag{18}$$

$$S \leqslant S_0, \tag{19}$$

where $D_0(u)$ is a known moisture diffusion function of moisture content u, and S_0 is a known constant. Particularly, D_0 may be constant, and S_0 may be infinite, i.e., $S_0 = \infty$. From (13), (15), and (16)–(19) we obtain

$$\forall r : r > 0\colon\ K_{\theta,D,S}(r) \leqslant K_{\theta,D_0,S_0}(r), \quad \Theta_{k_{\mathsf{a}},D,S}(r) \leqslant \Theta_{k_{\mathsf{a}},D_0,S_0}(r). \tag{20}$$

While adjusting the specimen, the exact expression of the diffusion coefficient D and surface emission coefficient S is not necessary. It is enough to have an estimation D_0 and S_0 of D, S satisfying the condition (18) and (19). Having known coefficients D_0 and S_0 which correlate with the unknown coefficients D and S, satisfying (18), (19), we can use D_0, S_0 to determine characteristics of a specimen being relevant to 1-D model not only at D_0, S_0 but at D, S also. In accordance with (16) and (17), we choose the geometry of the specimen and edges coating degree to ensure the relative error of the halfdrying time not greater that required one. According to (20), the relative error at true values of the coefficients of diffusion (D) and surface emission (S) are not be greater than it is at D_0

and S_0. Such a way of specimen regulation can be applied for specimens to be used in a physical experiment while solving the problem of determination of the diffusion as well as surface emission coefficient for different species of wood.

6. Conclusions

The 2-D-in-space moisture transfer model (1)–(5) taking into consideration coating of the surface of a wood specimen can be successfully used to investigate a reliability of the corresponding 1-D model. Using a computer simulation of 2-D moisture diffusion, the reliability of the corresponding 1-D model can be efficiently estimated by applying a concept of the relative error of the halfdrying time. The relative error has been introduced assuming the halfdrying time, obtained from 2-D model, as the true value. The halfdrying time, calculated from 1-D model, was considered as an approximation of the true halfdrying time.

The relative error of the halfdrying time of wood is a monotonous decreasing function of the transverse diffusion coefficient at different width of the specimen, the edges coating degree, and surface emission coefficient. The relative error of the halfdrying time of wood is a monotonous increasing function of the surface emissivity at the different width and edges coating degree of the specimen, as well as the transverse moisture diffusion coefficient.

The proposed error estimation procedure can be used to adjust the width of the specimen (e.g., long sawn board) as well as the degree of edges coating to ensure relative error less than required one resulting from the reducing the model from 2-D to 1-D. In the adjustment an approximation of the coefficients of diffusion and surface emission can be employed if the accurate values of the coefficients are unknown. This is helpful in solving the inverse coefficients problem for different species of wood when the diffusion and surface emission coefficients need to be recovered by using the data of physical experiments as a known solution of 1-D problem.

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Drėgmės difuzijos medienoje vienmačio modelio patikimumas

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Straipsnyje pateikiamas drėgmės sklidimo medienoje izoterminėmis sąlygomis dvimatėje erdvėje matematinis modelis, kuriame yra atsižvelgiama į kūno paviršiaus izoliavimą. Darbe yra išnagrinėtos atitinkamo vienmačio modelio patikimumo sąlygos drėgmės sklidimui dvimačiame kūne modeliuoti. Straipsnyje yra pateiktas santykinai ilgo bandinio minimalaus jo pločio ir briaunų izoliavimo lygmens parinkimo metodas, įgalinantis vartoti vienmatį modelį, kad numatyti drėgmės kiekį bandinyje pakankamai tiksliai. Pateiktasis metodas gali būti taikomas kai tikslios modelio parametrų reikšmės nėra žinomos.