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CALCULATION OF THE SURFACE TEMPERATURE OF LOGS DURING THEIR FREEZING

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Abstract

A 1D mathematical model for the computation of the temperature on the cylindrical logs' surface, t_{sr}, and the non-stationary temperature distribution along the logs' radius of subjected to freezing logs has been suggested. The model includes mathematical descriptions of the thermal conductivity in the radial direction, λ_r, the effective specific heat capacity, c_e, and the density, ρ, of the non-frozen and frozen wood, and also of the heat transfer coefficient between the surrounding air environment and the radial direction of horizontally situated logs, α_r, during freezing process.

For the computation of the temperature distribution along the logs' radius and also of α_r, t_{sr}, and the wood thermal conductivity on the logs' surface, λ_{sr}, at exponentially decreasing temperature of the freezing air a software program has been prepared in FORTRAN, which has been input in the calculation environment of Visual Fortran Professional. With the help of the program, computations have been carried out for the determination of α_r, t_{sr}, λ_{sr} and 1D non-stationary temperature distribution along the radius of beech log with an initial temperature 20 ^oC and moisture content 0.6 kg.kg^{-1} during its freezing at exponentially changing air temperature from 20 ^oC to –20 ^oC with time constant 3600 s. The obtained results are numerically and graphically presented and analyzed.

Key words: *logs, freezing, surface temperature, heat transfer coefficient*

INTRODUCTION

The duration of the thermal treatment of the frozen logs aiming their plasticizing in the veneer production and also the energy consumption needed for this treatment depends on the degree of the logs' icing (Chudinov 1968, Trebula and Klement 2002, Videlov 2003, Deliiski 2004, Deliiski and Dzurenda 2010).

In the specialized literature there are very limited reports about the temperature distribution in subjected to defrosting frozen logs (Steinhagen and Lee 1988, Steinhagen 1991, Khattabi and Steinhagen 1993, Deliiski 2013b) and there is no information at all about the temperature distribution in logs during their natural or artificial freezing. That is why the modelling and the multiparameter study of the processes of freezing of logs are of considerable scientific and practical interest.

The aim of the present work is to suggest a 1D mathematical model for the calculation of the temperature on the cylindrical logs' surface, t_{sr}, and the non-stationary temperature distribution along the logs' radius of subjected to freezing logs at convective exponentially changing boundary conditions. For the achieving of this goal, as a base a model of the

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heating and cooling processes of logs is used, which has been sugested and modified earlier by the first co-author (Deliiski 2004, 2011, 2013b).

THEORETICAL BASIS FOR THE LOGS' FREEZING PROCESS

Mechanism of the 1D heat distribution in the logs during their freezing

The mechanism of the heat distribution in logs during their cooling can be described by the equation of heat conduction (also known as the equation of Fourier-Kirchhoff). When the length of the logs exceeds their diameter by at least 3 ÷ 4 times, then the calculation of the change in the temperature only along the radius of the central cross sections during the freezing of the logs (i.e. along the coordinate *r* of these sections) can be carried out with the help of the following 1D mathematical model (Deliiski 2011):

$$c_{\mathrm{e}}(T,u)\cdot\rho(T,u)\frac{\partial T(r,\tau)}{\partial\tau}=\lambda_{\mathrm{r}}(T,u)\left(\frac{\partial^2 T(r,\tau)}{\partial r^2}+\frac{1}{r}\frac{\partial T(r,\tau)}{\partial r}\right)+\frac{\partial\lambda_{\mathrm{r}}(T,u)}{\partial T}\left(\frac{\partial T(r,\tau)}{\partial r}\right)^2 \quad (1)$$

with an initial condition

$$T(r,0)=T_0 \quad (2)$$

and a boundary condition at convective heat exchange between the logs' surface and the surrounding air environment

$$\frac{\partial T(0,\tau)}{\partial r}=-\frac{\alpha_{\mathrm{r}}^{\mathrm{fr}}(\tau)}{\lambda_{\mathrm{sr}}(\tau)}\left[T_{\mathrm{sr}}^{\mathrm{fr}}(\tau)-T_{\mathrm{m}}^{\mathrm{fr}}(\tau)\right], \quad (3)$$

where c_{e} is the effective heat capacity of the log's wood, $\mathrm{J.kg^{-1}.K^{-1}}$;

r – radial coordinate: $0 \le r \le R$, m;

R – radius of the log, m;

T – temperature, K;

T_0 – initial temperature of the subjected to freezing logs, K;

$T_{\mathrm{m}}^{\mathrm{fr}}$ – temperature of the freezing medium, K;

$T_{\mathrm{sr}}^{\mathrm{fr}}$ – temperature on the log's surface in the radial direction during the freezing, K;

u – moisture content of the log's wood, $\mathrm{kg.kg^{-1}}$;

$\alpha_{\mathrm{r}}^{\mathrm{fr}}$ – heat transfer coefficient between the log's surface in the radial direction and the freezing medium, $\mathrm{W.m^{-2}.K^{-1}}$;

λ_{r} – thermal conductivity of the log's wood in the radial direction, $\mathrm{W.m^{-1}.K^{-1}}$;

λ_{sr} – thermal conductivity of the logs' wood on the log's surface in the radial direction, $\mathrm{W.m^{-1}.K^{-1}}$;

ρ – density of the log's wood, $\mathrm{kg.m^{-3}}$;

τ – time, s.

Mathematical description of the change in the freezing medium temperature

It is possible to have two cases for freezing of different materials in freezers. The first case is when the material is put into a working freezer with constant unchanged temperature in it, i.e. the freezing medium temperature $T_{\mathrm{m}}^{\mathrm{fr}}(\tau) = T_{\mathrm{m0}}^{\mathrm{fr}} = \mathrm{const}$.

The mathematical model (1) ÷ (3) obtains a more complicated boundary condition in the second case, when the material is put into a non-working freezer and after that the freezer is switched on. In this case, in the beginning of the freezing the temperature of the air environment in the freezer $T_{\mathrm{m}}^{\mathrm{fr}}$ decreases exponentially according to the equation

$$T_{\mathrm{m}}^{\mathrm{fr}} = T_{\mathrm{m1}}^{\mathrm{fr}} + \left(T_{\mathrm{m0}}^{\mathrm{fr}} - T_{\mathrm{m1}}^{\mathrm{fr}}\right)\exp\left(-\frac{\tau}{\tau_{\mathrm{exp}}^{\mathrm{fr}}}\right), \tag{4}$$

where $T_{\mathrm{m}}^{\mathrm{fr}}$ is the current temperature in the freezer, K;

$T_{\mathrm{m0}}^{\mathrm{fr}}$ – initial temperature in the freezer (at the moment when it is switched on), K;

$T_{\mathrm{m1}}^{\mathrm{fr}}$ – final constant temperature in the freezer, K;

τ – time, s;

$\tau_{\mathrm{exp}}^{\mathrm{fr}}$ –time constant of the exponentialy decreasing of the temperature in the freezer, K.

Mathematical description of the heat transfer coefficient between the air and the logs during their freezing

It is known that the cooling of logs in an air environment takes place through a convective heat exchange between the logs' surface and the moving environment. The freezing of wood materials at atmospheric conditions or in a freezer takes place in the conditions of free convection. For the calculation of the heat transfer coefficient given such conditions of heating or cooling of horizontally situated logs Chudinov (1968) suggests the following equation:

$$\alpha_{\mathrm{r}} = 0.997\ \sqrt[4]{\frac{\Delta T}{R}} = 0.997\ \sqrt[4]{\frac{T(0,\tau) - T_{\mathrm{m}}^{\mathrm{fr}}(\tau)}{R}}\ , \tag{5}$$

where α_{r} is the heat transfer coefficient between the air and the horizontally situated logs, i.e. the heat transfer coefficient in the radial direction of the logs, $\mathrm{W.m^{-2}.K^{-1}}$;

$T(0,\tau)$ – surface temperature ot the log during the freezing, K;

R – radius of the subjected to freezing log, m.

Videlov (2003) suggests the following analogical equation for the calculation of α_{r}:

$$\alpha_{\mathrm{r}} = 1.4\left(\frac{\Delta T}{D}\right)^{0.25} = 1.4\left(\frac{T(0,\tau) - T_{\mathrm{m}}^{\mathrm{fr}}(\tau)}{D}\right)^{0.25}, \tag{6}$$

where D is the diameter of the subjected to freezing log, m.

The calculated according to eqs. (5) and (6) values of α_{r} have been compared with each other below and have been analized.

Mathematical description of the wood thermo-physical characteristics of the logs during their freezing

The solution of the non-linear 1D mathematical model of the logs' freezing process, which is presented by the equations (1) ÷ (6), can be realized using the given in Deliiski (2011, 2013a) mathematical descriptions of the effective heat capacity of the frozen and non-frozen wood, c_e, the thermal conductivity of the wood in the radial direction, λ_r, and the density of frozen and non-frozen wood, ρ.

With the help of the mathematical description of λ_r, the current values of the thermal conductivity on the logs' surface in the radial direction $\lambda_{sr}(0,\tau)$, which participates in eq. (3), can be alo calculated during the solution of the model.

RESULTS AND DISCUSSION

The above shown mathematical description of T_m^{fr} and α_r is introduced in the earlier suggested by the first co-author non-stationary model of heating and cooling of cylindrical wood materials (Deliiski 2004, 2011, 2013b), which is presented in common form by the eqs. (1) ÷ (3). The updated model has been solved with the help of explicit schemes of the finite difference method in a way, analogously to the one used and described in (Deliiski 2003, 2013b) for the solution of a model of the heating and cooling process of prismatic and cylindrical wood materials.

For the solution of the updated model with the new description of T_m^{fr} and α_r a software program has been prepared in the calculation environment of Visual Fortran Professional.

With the help of the program as example computations have been made for the determination of the 1D change of the temperature in subjected to freezing non-frozen beech (*Fagus Silvatica* L.) log with radius $D = 0.24$ m, initial wood temperature $t_0 = 20\ ^{o}\mathrm{C}$, and wood moisture content $u = 0.6$ kg.kg^{-1} during its 50 hours freezing at $t_{m1}^{fr} = -20\ ^{o}\mathrm{C}$.

The decreasing of the freezing air medium temperature, t_m^{fr}, from the value of $t_{m0}^{fr} = t_0 = 20\ ^{o}\mathrm{C}$ to $t_{m1}^{fr} = -20\ ^{o}\mathrm{C} = \mathrm{const}$ takes place exponentially with time constant $\tau_{exp}^{fr} = 3600$ s. This decreasing of t_m^{fr} at the beginning of the freezing process of the log can be seen on the Fig. 2 for the curve of t_m.

The calculations have been done with average values of basic density of beech wood ρ_b = 560 kg·m^{-3} and fiber saturation point at 293.15 K (i.e. at 20 ^{o}C) of this wood $u_{fsp}^{293.15}$ = 0.31 kg·kg^{-1} (Nikolov and Videlov 1987).

During the computations of the log's freezing process the mathematical descriptions of the thermal conductivity, the effective heat capacity and the density of the subjected to defrosting wood have been used (Deliiski 2011). The not large difference between these thermo-physical characteristics during freezing and defrosting of the wood (Chudinov 1968) needs to be additionally studied, mathematically described, and introduced into the model.

Fig. 1 shows a table with the computed distribution of the temperature in 4 equally distant from each other nodes of the calculation mesh in the central cross-section of the beech log at every 1 h of the freezing process. The corresponding input data, which is used for the solution of the 1D model, is underlined on Fig. 1. The remaining input data, which is not underlined on this figure, relates mainly to the parameters of the equipment with which the thermal treatment of the wood materials with the aim of their freezing is carried out. Using this input data the energy parameters of the freezing process and the efficiency from the usage of the equipment can be calculated.

I N P U T   D A T A

FREEZING OF A BEECH LOG WITH DIAMETER OF 0,24 m

```
Kq=11  M= 11 N=  0 KD=  1  Ry=560.  Kwr=1.35 Kwpr=1.78  U=0.600  Ufsp293=0.31  D=2.4  L= 9.0
to= 20.0  tmo= 20.0  tmfr=-20.0 tmdfr= 20.0 t3=  0.0 t4=  0.0 dtm=.001  t01=  0.  dTAU=   80
Tfr=3600. Tdfr=3600. T3=   0. dT3= 0. dtm3= 0. T4=   0. T5=   0.  TAUproc.=360000  INT= 3600
ds=.008  Si=.10   ROi=120.  Ai=.00000022 dFa=0.05 Kk=.2  tcenter=-18.75  dtwc= 0.1  Ts=    0
Pw=.30  Vw=14.39  Va=47.95  tbi= 0.  Sim=0.200  Xp=1.00   L-log=0.00   D-log=.24   dx=.01200
```

R E S U L T S

Time h	Energy q kWh/m3	Temperature tm oC	ts oC	Temp.in charact.points on R,mm 30 oC	60 oC	90 oC	120 oC	tav Simpson oC	dtav/dtau oC/h	ALFAr Chud. W/m2.K	Videl. W/m2.K	LAMsr W/m.K	LAMc W/m.K
0	0.00	20.0	20.00	20.0	20.0	20.0	20.0	20.00	0.00	0.00	0.00	0.457	0.457
1	0.98	-5.3	13.56	16.9	19.5	19.9	20.0	18.54	-2.61	3.54	4.18	0.448	0.457
2	3.11	-14.6	6.35	10.8	16.9	18.8	19.6	15.34	-3.56	3.63	4.29	0.438	0.456
3	5.52	-18.0	1.08	5.4	13.1	16.4	18.2	11.69	-3.64	3.55	4.19	0.430	0.454
4	8.06	-19.3	-2.32	1.3	9.2	13.3	15.8	8.19	-3.21	3.44	4.06	0.480	0.451
5	9.63	-19.7	-2.72	0.0	6.1	10.1	12.7	5.80	-2.04	3.44	4.06	0.481	0.447
6	10.82	-19.9	-3.04	-0.6	4.1	7.4	9.7	3.99	-1.62	3.43	4.05	0.481	0.442
7	11.76	-20.0	-3.37	-1.0	2.7	5.3	7.2	2.55	-1.23	3.42	4.04	0.482	0.439
8	13.55	-20.0	-4.91	-1.4	1.6	3.6	5.1	1.21	-1.08	3.34	3.94	0.484	0.436
9	14.17	-20.0	-5.34	-1.9	0.6	2.3	3.5	0.24	-0.80	3.31	3.91	0.484	0.433
10	15.23	-20.0	-6.52	-3.7	0.0	1.3	2.2	-0.73	-0.88	3.25	3.83	0.486	0.431
11	15.68	-20.0	-7.27	-4.4	-0.6	0.4	1.2	-1.47	-0.58	3.20	3.78	0.487	0.430
12	17.09	-20.0	-8.04	-5.6	-0.9	-0.1	0.4	-2.28	-0.75	3.15	3.72	0.488	0.429
13	17.41	-20.0	-8.85	-6.5	-1.1	-0.6	-0.2	-2.84	-0.45	3.10	3.66	0.489	0.428
14	18.22	-20.0	-9.44	-7.3	-1.3	-0.9	-0.6	-3.46	-0.59	3.05	3.61	0.490	0.428
15	18.48	-20.0	-10.15	-8.2	-1.8	-1.0	-0.8	-3.94	-0.40	3.00	3.54	0.491	0.427
16	19.73	-20.0	-10.67	-8.8	-3.4	-1.0	-1.0	-4.52	-0.57	2.96	3.50	0.492	0.427
17	19.95	-20.0	-11.25	-9.6	-4.1	-1.1	-1.0	-4.98	-0.39	2.91	3.44	0.492	0.427
18	20.67	-20.0	-11.71	-10.1	-5.1	-1.3	-1.0	-5.47	-0.60	2.87	3.39	0.493	0.427
19	20.92	-20.0	-12.16	-10.7	-6.0	-1.7	-1.0	-5.96	-0.43	2.84	3.35	0.494	0.427
20	22.11	-20.0	-12.57	-11.2	-6.5	-2.7	-1.0	-6.44	-0.79	2.80	3.30	0.494	0.427
21	22.38	-20.0	-12.93	-11.6	-7.4	-3.6	-1.0	-6.99	-0.46	2.76	3.26	0.495	0.427
22	22.58	-20.0	-13.28	-12.1	-8.0	-4.1	-1.1	-7.40	-0.37	2.73	3.22	0.495	0.427
23	23.33	-20.0	-13.59	-12.4	-8.5	-5.1	-1.2	-7.95	-0.51	2.70	3.18	0.496	0.427
24	23.55	-20.0	-13.88	-12.8	-9.1	-5.7	-1.3	-8.40	-0.41	2.67	3.15	0.496	0.426
25	24.76	-20.0	-14.15	-13.1	-9.5	-6.3	-1.6	-8.93	-0.64	2.64	3.11	0.496	0.426
26	25.35	-20.0	-14.39	-13.4	-10.1	-7.1	-4.0	-9.64	-1.02	2.61	3.08	0.497	0.482
27	25.82	-20.0	-14.64	-13.7	-10.7	-8.4	-6.5	-10.63	-0.95	2.58	3.04	0.497	0.486
28	26.23	-20.0	-14.92	-14.1	-11.5	-9.7	-8.3	-11.53	-0.86	2.54	3.00	0.497	0.488
29	26.60	-20.0	-15.25	-14.5	-12.3	-10.8	-9.7	-12.35	-0.78	2.50	2.95	0.498	0.490
30	26.93	-20.0	-15.59	-14.9	-13.0	-11.8	-10.8	-13.09	-0.71	2.46	2.90	0.498	0.492
31	27.23	-20.0	-15.94	-15.3	-13.7	-12.6	-11.8	-13.76	-0.64	2.41	2.84	0.499	0.493
32	27.49	-20.0	-16.27	-15.7	-14.3	-13.4	-12.7	-14.36	-0.57	2.36	2.78	0.499	0.494
33	27.72	-20.0	-16.58	-16.1	-14.8	-14.0	-13.5	-14.90	-0.51	2.30	2.72	0.500	0.495
34	27.93	-20.0	-16.87	-16.4	-15.3	-14.6	-14.1	-15.39	-0.46	2.25	2.66	0.500	0.496
35	28.12	-20.0	-17.13	-16.8	-15.8	-15.2	-14.7	-15.83	-0.42	2.20	2.60	0.500	0.497
36	28.29	-20.0	-17.38	-17.0	-16.2	-15.6	-15.2	-16.22	-0.37	2.16	2.55	0.501	0.498
37	28.44	-20.0	-17.60	-17.3	-16.5	-16.1	-15.7	-16.58	-0.34	2.11	2.49	0.501	0.498
38	28.58	-20.0	-17.81	-17.5	-16.9	-16.4	-16.1	-16.90	-0.30	2.06	2.44	0.501	0.499
39	28.70	-20.0	-17.99	-17.7	-17.1	-16.8	-16.5	-17.18	-0.27	2.02	2.38	0.502	0.500
40	28.81	-20.0	-18.16	-17.9	-17.4	-17.1	-16.8	-17.44	-0.25	1.97	2.33	0.502	0.500
41	28.91	-20.0	-18.31	-18.1	-17.6	-17.3	-17.1	-17.67	-0.22	1.93	2.28	0.502	0.500
42	29.00	-20.0	-18.45	-18.3	-17.8	-17.6	-17.4	-17.88	-0.20	1.89	2.23	0.502	0.501
43	29.08	-20.0	-18.58	-18.4	-18.0	-17.8	-17.6	-18.07	-0.18	1.85	2.19	0.502	0.501
44	29.15	-20.0	-18.69	-18.6	-18.2	-18.0	-17.9	-18.23	-0.16	1.81	2.14	0.503	0.501
45	29.21	-20.0	-18.80	-18.7	-18.4	-18.2	-18.0	-18.39	-0.15	1.77	2.10	0.503	0.502
46	29.27	-20.0	-18.89	-18.8	-18.5	-18.3	-18.2	-18.52	-0.13	1.74	2.05	0.503	0.502
47	29.32	-20.0	-18.98	-18.9	-18.6	-18.5	-18.4	-18.65	-0.12	1.70	2.01	0.503	0.502
48	29.37	-20.0	-19.06	-19.0	-18.7	-18.6	-18.5	-18.76	-0.11	1.67	1.97	0.503	0.502
49	29.41	-20.0	-19.13	-19.0	-18.8	-18.7	-18.6	-18.86	-0.10	1.64	1.93	0.503	0.502
50	29.45	-20.0	-19.20	-19.1	-18.9	-18.8	-18.8	-18.95	-0.09	1.60	1.89	0.503	0.503

E N D

Fig. 1. Change in $T_{\mathrm{m}}^{\mathrm{fr}}$ (third column), $T_{\mathrm{sr}}^{\mathrm{fr}}$ (fourth column), α_r (fourth–eq.(5) and third–eq.(6) columns from right), in λ_{sr} and λ_c (second and first columns from right), and in t in 4 equally distant from each other points ot the central cross section of a beech log with D = 0.24 m, t_0 =20 °C, and u=0.6 kg·kg^{-1} during every 1 h of its freezing process at $t_{\mathrm{m1}}^{\mathrm{fr}}$ = –20 °C

On Fig. 2 the computed change in the freezing medium temperatures, $t_{\mathrm{m}}^{\mathrm{fr}}$ (this temperatures is shown as t_{m} on the figure), in the surface temperature of the log, $t_{\mathrm{sr}}^{\mathrm{fr}}$ (shown as t_{sr} on the figure) and also in the temperature at the central point of the log, t_{c}, during the freezing process is shown.

On Fig. 3 the computed change in the heat transfer coefficient between the log's surface in the radial direction, α_r, during the studied freezing process is shown.

On Fig. 4 the computed change in the wood thermal conductivity at the log's surface in the radial direction, λ_{sr}, and at the log's center, λ_c, during the freezing process is shown.

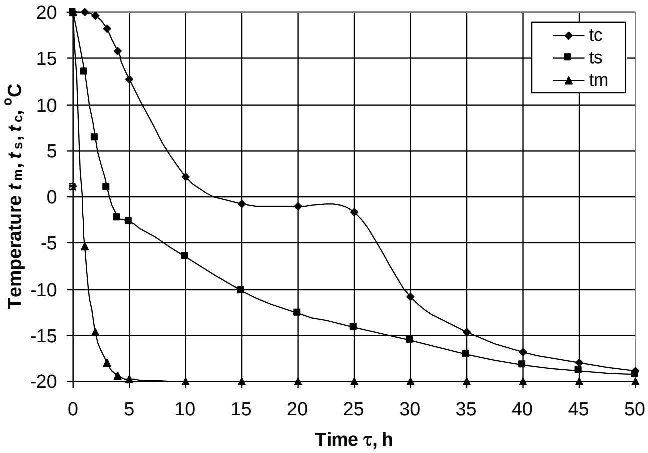

Fig. 2. Change in t_m, t_s, and t_c of beech log with D = 0.24 m, t_0 = 20 °C, and u = 0.6 kg·kg^{-1} during 50 h freezing at $t_{\mathrm{m1}}^{\mathrm{fr}}$ = –20 °C

The obtained results lead to the following conclusions:

1. On the curve of situated on the log's center characteristic point on Fig. 2 the specific almost horizontal section of retention of the temperature t_{c} for a long period of time in the range from –1 °C to –2 °C can be seen, while in this point a complete freezing of all amounts of free water in the wood occurs. It can be noted that such retention of the temperature on the logs' axis has been observed in experimental studies during the defrosting process of pine logs containing ice from the free water (Steinhagen and Lee 1988, Steinhagen 1991, Khattabi and Steinhagen 1993). Analogically, the almost horizontal sections in the change of the wood temperature on the logs' axis are absent during defrosting of the logs, which contain only frozen bound water.

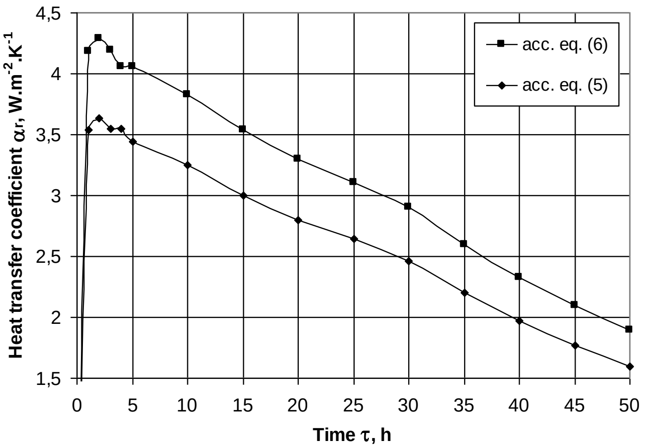

Fig. 3. Change in α_r during 50 h freezing at t_{m1}^{fr} = –20 °C of beech log with D = 0.24 m, t_0 = 20 °C, and u = 0.6 kg·kg^{-1}

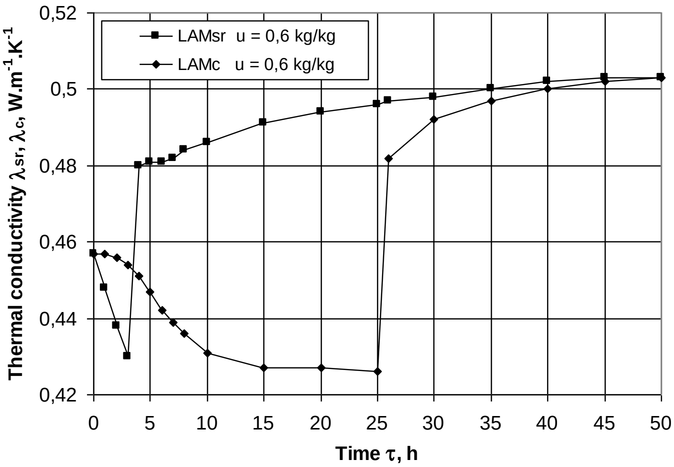

Fig. 4. Change in λ_{sr} and λ_c during 50 h freezing at t_{m1}^{fr} = –20 °C of beech log with D = 0.24 m, t_0 = 20 °C, and u = 0.6 kg·kg^{-1}

2. With the increase of the duration of the freezing process the coefficient α_r decreases (Fig. 3) because of the decreasing of the differece ΔT between the processing medium temperature and the log's surface temperature (see eqs. (5) and (6)). The character of the change in α_r during the freezing process is one and the same for the values, which have been calculated according to eq. (5) and eq. (6).

It can be noted that equation (6) produces about 18% larger values of α_r, than equation (5).

3. The character of the change in the wood thermal conductivity on the log's surface, λ_{sr}, and in the log's center, λ_c , is very complex (Fig. 4). The current values of λ_{sr} and of λ_c depend not only on the wood moisture content and on the current temperature at the log's surfase and log's central point respectively, but also on the momentous aggregate condition

of the free water in these points.The larger values of λ_{sr} and λ_c on Fig. 4 related to the frozen free water at the log's surface or at the log's central point, and the lower values of λ_{sr} and λ_c related to the logs' points with non-frozen free water in them at respective moments.

The comparison of the values of λ_{sr} and of λ_c on Fig. 4 with the values of the radial thermal conductivity of frozen beech wood given on Fig. 5 in (Deliiski 2013a) at correspondig wood temperatures shows that they are both equal. This proves the high precision of the wood thermal conductivity calculation in the presented model in this work.

CONCLUSIONS

The present paper describes the suggested by the authors 1D mathematical model for the calculation of the temperature on the logs' surface, t_{sr}, and the non-stationary temperature distribution along the logs' radius of subjected to freezing logs at convective exponentially changing boundary conditions. As a base, a model of the heating and cooling processes of logs is used, which has been created and modified earlier by the first co-author. The mechanism of the heat distribution along the radius of the logs during their freezing is described by the 1D partial differential equation of heat conduction.

For the numerical solution of the model with the help of an explicit form of the finite-difference method a software program has been prepared in FORTRAN, which has been input in the calculation environment of Visual Fortran Professional. Using this program, as an example, computations have been carried out for the determination of the surface temperature and of the 1D change in the temperature along the radius of a beech log with diameter 0.24 m, initial temperature 20 ^{o}C, and moisture content 0.6 $kg \cdot kg^{-1}$ during its 50 hours freezing at an exponentially decreasing air temperature from 20 ^{o}C to –20 ^{o}C with time constant 3600 s.

The obtained results show the complex character of the change in the temperature on the logs' surface and along the logs' radius, and also of the heat transfer coefficient between the logs' surface and the freezing air environment. Also, the change in the wood thermal conductivity on the logs' surface and in the separate points along the logs' radius, especially strong depending on the aggregate condition of the water in each point at every moment of the freezing process, has a very complex character.

The created model, after its update with new experimentally obtained more precise data about the heat transfer coefficient, can be used for a science-based calculation of the duration of the logs' freezing process at different initial and boundary conditions.

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