

**APPLYING OF MS EXCEL 2010 FOR 2D COLOUR VISUALIZATION OF
TEMPERATURE FIELDS IN LOGS DURING THEIR DEFROSTING
PART 1. SEQUENCE OF PROCEDURES FOR THE CREATION OF 2D COLOUR
DIAGRAMS USING MS EXCEL 2010**

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ABSTRACT

A methodology for the creation of colourful 2D diagrams using MS Excel 2010, illustrating the temperature distributions in the longitudinal sections of frozen logs during different moments of their defrosting, has been suggested in this paper. For the creation of the diagrams numerical results have been used, which represent the solutions to a non-linear mathematical model of the logs' defrosting process. These numerical results are presented in files in the .txt format before their processing with the software of MS Excel 2010 aiming at the creation of the 2D colourful diagrams.

Key words: 2D visualization, temperature fields, wood defrosting, oak logs, MS Excel 2010

INTRODUCTION

A main goal during the development, optimization, and control of modern technologies for thermal treatment of wood and other materials is the scientifically based determination of the temperature in separate points in their volume at every moment of the corresponding process (Chudinov 1968, Shubin 1990, Trebula and Klement 2002, Videlov 2003, Pervan 2009).

Such a determination takes place with the help of adequate for the technological processes overly complex mathematical models (Deliiski 2003, 2011, 2013, Steinhagen 1986, 1991, Khattabi and Steinhagen 1992, 1993).

The solutions to the models are obtained in a form of large arrays of numerical data for the distribution of the temperature in the volume of the materials at every moment of the process (Deliiski 2003, 2013, Deliiski and Dzurenda 2010).

Using these arrays for technological analysis of the described by the model processes is highly straitened. The 2D visualization of the data using colour diagrams gives considerable advantages during the analysis of the data.

The toolkit of MS Excel 2010 (<http://www.gcflearnfree.org/excel2010>) allows for the creation of such color diagrams. Its application for their creation using a large array of numerical data is quite difficult and covers many various procedures.

This predetermines the relevance of this work, which is dedicated to the development of a methodology for the creation of 2D color diagrams for the visualization of temperature fields in the volume of subjected to defrosting logs, using the toolkit of MS Excel 2010.

APPROACHES FOR THE COMPILATION OF THE METHODOLOGY FOR 2D VISUALIZATION OF TEMPERATURE FIELDS IN LOGS

For the ensuring of clarity and understanding of the procedures of MS Excel 2010, which need to be followed during the creation of 2D colour diagrams their successive description further down is oriented at the visualization of temperature fields in the longitudinal section of subjected to defrosting logs with cylindrical form. As an example, during the development and implementation of the methodology the visualization of the change in temperature t is considered in 1/4 of the longitudinal section of frozen log with diameter $D = 0.4$ m and length $L = 0.8$ m, which is subjected to defrosting and to a following heating with the aim of plasticizing for the production of veneer.

For the creation of the 2D diagrams files in the .txt format are used, which contain extensive numerical results with thousands of numbers from the calculated change in t in the knots of the calculation mesh situated on 1/4 of the longitudinal section of the log (due to the presence of mirror symmetry to the other 3/4 of the longitudinal section of the log) using a mathematical model (Deliiski 2013). The spatial axes x and z of the calculation mesh are oriented so that they coincide accordingly with the radius and length of the log. The calculation mesh is built with a step on the spatial axes r and z equal to 10 mm.

This means that the spatial coordinates of the knots on the calculation mesh on the axes x change from 0 to 200 mm every 10 mm, and on the axis z – from 0 to 400 mm also every 10 mm (Fig. 1).

For the creation of the 2D diagrams text file is used, which contains results from the calculated using the model results from the distribution of t in log with initial temperature $t_0 = -40$ °C at various moments of its defrosting at the processing medium temperature $t_m = 80$ °C.

The methodology encompasses procedures for the creation of 4 diagrams on which the calculated distribution of t will be portrayed in the longitudinal section of the log at 4 moments of its defrosting, equally distanced from the beginning of the heating of the log in hot water or saturated water steam. Such processing medium ensures an equality between t_m and the surface temperature of subjected to defrosting log. The temperature fields in the longitudinal section of the log will be visualized by building of 2D color diagrams, each portraying the distribution of t in the section at the desired moments ($\tau = 0$ h, $\tau = 5$ h, $\tau = 10$ h and $\tau = 15$ h) of the defrosting. Fig. 1 presents a table with the calculated with the model distribution of t in the knots of the calculation mesh in the longitudinal section of a oak log with given dimensions above and wood moisture content $u = 0,6$ kg.kg⁻¹ at each 5 h of its defrosting process.

I N P U T D A T A

2D DEFROSTING OF OAK LOG

Kq= 1 M= 21 N= 0 KD= 41 Ky=670. Kvw=1.22 Kwpr=1.63 U=0.200 Ufsp=0.29 D=2.4 L= 9.0
 tw0=-40.0 t0=-40.0 t1= 80.0 t2= 80.0 t3= 80.0 t4= 80.0 dtm= 0.01 tk= 0.0 dTAU= 200
 T1=1800. T2= 1. T3= 1. dt3= 0. dtm3= 0. T4=1800. T5= 900. TAUk= 0 INT=18000
 ds= 0.08 S1= 1.0 R0i=120. Ai= 0.0000022 dFa=0.05 Kk= 2 tcs= 25.0 dtwc= 0.1 Ts= 0
 Pw= 30 Vw=14.39 Va=47.95 tbi= 0. Sim=0.200 Xp=1.00 L-log=0.80 D-log= 0.40 dx= 0.1000

R E S U L T S

Time TAU, h Coordinate x of the characteristic points on the radius, mm
 Coordinates: 0 20 40 60 80 100 120 140 160 180 200
 y, mm oC oC oC oC oC oC oC oC oC oC

5 h

t= 0 mm	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00
t= 20 mm	80.00	78.81	76.25	72.81	69.13	65.71	63.04	61.25	60.23	59.74	59.60
t= 40 mm	80.00	77.67	72.64	65.83	58.40	51.53	46.10	42.47	40.38	39.37	39.10
t= 60 mm	80.00	76.64	69.34	59.35	48.34	38.01	29.76	24.38	21.36	19.63	19.10
t= 80 mm	80.00	75.74	66.46	53.66	39.35	25.63	14.42	7.39	4.72	2.46	1.52
t= 100 mm	80.00	75.01	64.10	48.95	31.77	14.66	-1.15	-4.72	-6.86	-8.55	-9.08
t= 120 mm	80.00	74.45	62.29	45.34	25.90	6.44	-5.51	-10.44	-13.44	-15.12	-15.64
t= 140 mm	80.00	74.05	61.00	42.78	21.91	-1.28	-8.85	-14.41	-17.89	-19.82	-20.45
t= 160 mm	80.00	73.78	60.14	41.10	19.62	-1.73	-10.97	-17.12	-21.00	-23.19	-23.91
t= 180 mm	80.00	73.61	59.61	40.01	18.03	-1.91	-12.45	-18.98	-23.16	-25.55	-26.35
t= 200 mm	80.00	73.51	59.29	39.37	16.99	-2.60	-13.50	-20.23	-24.64	-27.19	-28.04
t= 220 mm	80.00	73.46	59.13	39.02	16.37	-3.25	-14.15	-21.05	-25.64	-28.31	-29.20
t= 240 mm	80.00	73.43	59.04	38.66	16.03	-3.57	-14.54	-21.58	-26.31	-29.06	-29.99
t= 260 mm	80.00	73.42	59.00	38.79	15.94	-3.75	-14.77	-21.92	-26.74	-29.56	-30.50
t= 280 mm	80.00	73.41	58.99	38.76	15.86	-3.85	-14.91	-22.13	-27.01	-29.87	-30.84
t= 300 mm	80.00	73.41	58.98	38.75	15.81	-3.92	-14.99	-22.26	-27.18	-30.07	-31.05
t= 320 mm	80.00	73.41	58.99	38.75	15.81	-3.94	-15.03	-22.33	-27.28	-30.20	-31.18
t= 340 mm	80.00	73.42	58.99	38.77	15.84	-3.92	-15.05	-22.37	-27.34	-30.27	-31.25
t= 360 mm	80.00	73.42	59.00	38.78	15.89	-3.87	-15.05	-22.39	-27.39	-30.31	-31.30
t= 380 mm	80.00	73.42	59.00	38.80	15.93	-3.83	-15.05	-22.60	-27.39	-30.33	-31.32
t= 400 mm	80.00	73.42	59.01	38.80	15.94	-3.82	-15.05	-22.60	-27.60	-30.34	-31.33

10 h

t= 0 mm	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00
t= 20 mm	80.00	79.60	78.72	77.42	75.84	74.12	72.43	70.90	69.69	68.89	68.61
t= 40 mm	80.00	79.22	77.46	74.88	71.73	68.28	64.87	61.78	59.30	57.68	57.10
t= 60 mm	80.00	78.85	76.25	72.43	67.74	62.60	57.46	52.79	49.01	46.52	45.62
t= 80 mm	80.00	78.50	75.11	70.12	63.96	57.18	50.34	44.07	38.95	35.55	34.32
t= 100 mm	80.00	78.18	74.06	67.99	60.47	52.13	43.65	35.78	29.28	24.88	23.26
t= 120 mm	80.00	77.89	73.13	66.09	57.33	47.55	37.52	28.08	20.12	14.60	12.65
t= 140 mm	80.00	77.65	72.33	64.44	54.59	43.53	32.08	21.12	11.59	4.55	2.80
t= 160 mm	80.00	77.44	71.65	63.05	52.28	40.13	27.45	15.05	3.44	-2.45	-3.26
t= 180 mm	80.00	77.27	71.09	61.92	50.41	37.38	23.70	10.38	-1.83	-4.64	-5.63
t= 200 mm	80.00	77.14	70.66	61.03	48.94	35.26	20.89	6.54	-3.23	-6.32	-7.40
t= 220 mm	80.00	77.04	70.33	60.36	47.85	33.69	18.86	4.79	-4.22	-7.57	-8.71
t= 240 mm	80.00	76.97	70.09	59.87	47.07	32.57	17.35	3.37	-4.95	-8.50	-9.66
t= 260 mm	80.00	76.91	69.91	59.53	46.52	31.83	16.28	1.64	-5.72	-9.16	-10.35
t= 280 mm	80.00	76.87	69.79	59.29	46.15	31.36	15.68	-0.38	-6.17	-9.62	-10.83
t= 300 mm	80.00	76.85	69.71	59.13	45.91	31.05	15.40	-1.09	-6.40	-9.93	-11.17
t= 320 mm	80.00	76.83	69.65	59.02	45.74	30.85	15.23	-1.14	-6.56	-10.14	-11.41
t= 340 mm	80.00	76.82	69.63	58.96	45.64	30.72	15.12	-1.18	-6.66	-10.29	-11.56
t= 360 mm	80.00	76.82	69.61	58.92	45.58	30.65	15.05	-1.20	-6.72	-10.38	-11.66
t= 380 mm	80.00	76.81	69.60	58.89	45.54	30.60	15.01	-1.22	-6.76	-10.43	-11.72
t= 400 mm	80.00	76.81	69.59	58.89	45.53	30.59	15.00	-1.24	-6.77	-10.45	-11.73

15 h

t= 0 mm	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00
t= 20 mm	80.00	79.79	79.32	78.63	77.76	76.79	75.79	74.87	74.11	73.60	73.42
t= 40 mm	80.00	79.59	78.66	77.27	75.53	73.59	71.59	69.74	68.21	67.18	66.80
t= 60 mm	80.00	79.39	78.00	75.94	73.35	70.44	67.45	64.66	62.34	60.78	60.21
t= 80 mm	80.00	79.20	77.38	74.66	71.25	67.39	63.42	59.68	56.37	54.47	53.72
t= 100 mm	80.00	79.02	76.78	73.45	69.24	64.48	59.54	54.87	50.96	48.31	47.34
t= 120 mm	80.00	78.85	76.23	72.31	67.36	61.72	55.86	50.27	45.56	42.34	41.16
t= 140 mm	80.00	78.70	75.72	71.27	65.62	59.17	52.41	45.93	40.41	36.60	35.20
t= 160 mm	80.00	78.56	75.27	70.32	64.04	56.84	49.25	41.80	35.36	31.12	29.47
t= 180 mm	80.00	78.43	74.06	69.49	62.65	54.77	46.40	38.21	31.04	25.92	23.99
t= 200 mm	80.00	78.33	74.51	68.77	61.44	52.96	43.89	34.92	26.90	21.01	18.73
t= 220 mm	80.00	78.24	74.22	68.16	60.41	51.42	41.75	32.06	23.20	16.40	13.61
t= 240 mm	80.00	78.17	73.98	67.66	59.57	50.16	39.99	29.69	20.02	12.10	8.42
t= 260 mm	80.00	78.11	73.78	67.26	58.90	49.16	38.60	27.83	17.48	8.35	2.78
t= 280 mm	80.00	78.06	73.63	66.95	58.37	48.39	37.55	26.45	15.69	5.66	-1.66
t= 300 mm	80.00	78.03	73.51	66.71	57.98	47.82	36.78	25.51	14.38	4.18	-1.84
t= 320 mm	80.00	78.00	73.43	66.53	57.69	47.41	36.25	24.86	13.91	3.72	-1.86
t= 340 mm	80.00	77.99	73.37	66.41	57.49	47.12	35.88	24.45	13.49	3.48	-1.90

Figure 1: The change in t in the knots of the calculation mesh, situated in the longitudinal section of a oak log with $D = 0.4$ m, $L = 0.8$ m, $t_0 = -40$ °C and $u = 0.6$ kg.kg⁻¹ during each 5 h of its defrosting

INITIALIZATION OF THE EXCEL WORKSHEETS AND COPYING OF THE TEXT FILES WITH NUMERICAL DATA FOR THE CREATION OF THE 2D DIAGRAMS

For the initialization of the Excel worksheets after starting MS Excel 2010 in the lower left corner of the opened window in the worksheet enter the name "2D_0h_u.6-En". In the cell L1 on the first line of the worksheet enter the word "Radius" and in the cell A26 on the first column (in the A column) of the worksheet enter the word "Length"(Fig. 2).

On the second line on the opened worksheet, beginning with field C and ending with field W, i.e. from cell C3 to cell W3, enter the coordinates for the knots in the calculation mesh along the radius of the log, equal correspondingly from 0 to 200 (mm) with an interval of 10 (mm). In the second column B of the worksheet, beginning with cell B4 and ending in cell B43, enter the coordinates of the knots in the calculation mesh along the length of the log, equal correspondingly from 0 to 400 (mm) with an interval of 10 (mm) (see Fig. 2).

By clicking on the icon of the text file in which the calculated results with the distribution of the temperature field on 1/4 of the longitudinal section of the subjected to defrosting log are saved, the file is opened (Fig. 3). By dragging the cursor of the mouse on the monitor the results are obtained, which relate to the distribution of t at the initial moment of the heating of frozen log (i.e. at $\tau = 0$ h), when all knots of the calculation mesh according to the input data have one and the same temperature equal to -40 °C. These results are marked and saved in a new text file, while in the last text file all explanatory texts are deleted, and only numerical records with the values of t of a subjected to defrosting log are left.

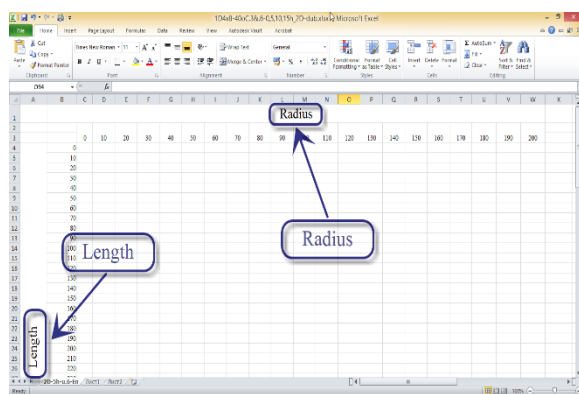


Figure 2:

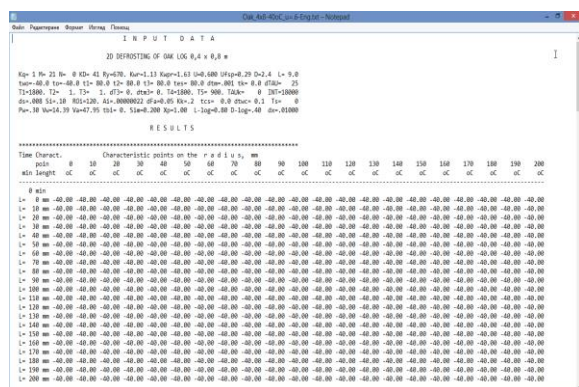


Figure 3:

The numerical data from the new text file are copied onto a newly created .docx file in MS Word 2010. In this file the decimal separator “point” in the data for t in the text

file needs to be substituted with a separator “comma”, which is recognized by MS Excel.

For a quick starting of the function “Replace” in MS Word 2010 the buttons Ctrl + H need to be pressed simultaneously. At the end the button “Replace All” needs to be pressed and then the window on the worksheet named “2D_0h_u.6-En” needs to be closed. The obtained file with decimal separator “comma” is saved as a regular text file, e.g. with the name “New text document.txt”.

The worksheet with name “2D_0h_u.6-En” is opened again and one need to click on section “Data” from the menu of Excel and with the button «From Text» the operation “Import Text File” is started. The new text file named “New text document.txt” is marked and one clicks on the button “Import” (Fig. 4).

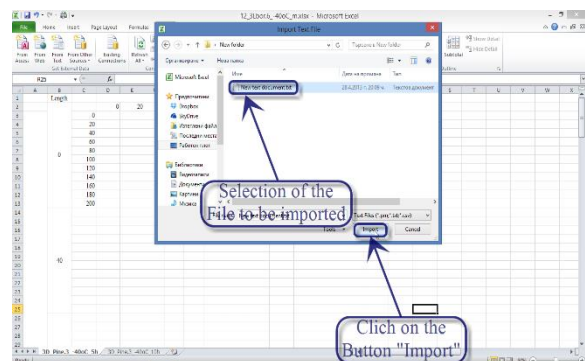


Figure 4:

Then the pop up window shown on Fig. 5 appears. On this window the type of file “Fixed width” is selected, one selects for the importing to begin from line “1” and an origin of the file is given as “866:Cyrilic (DOS)”. After this one needs to click on the “Finish” button in the lower right corner of the pop up window (Fig. 5). Then a new pop up window appears. One needs to choose on it the option that the subjected to importing data be moved onto the existing worksheet “2D_0h_u.6-En” and marks the cell on the worksheet, where the importing of the data begins (in this case cell C3). One then clicks

on “OK” in the previous window and the data, needed for the creation of the 2D diagrams are imported onto the worksheet “2D_0h_u.6-En” (Fig. 6).

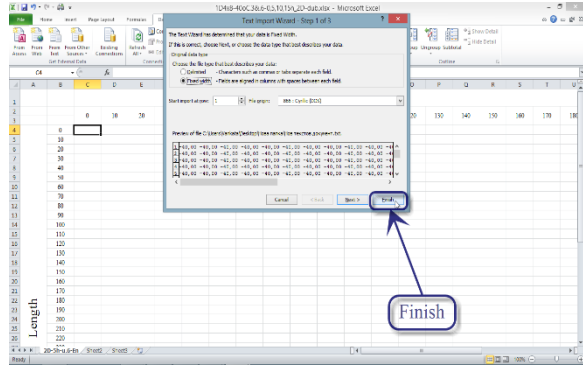


Figure 5:

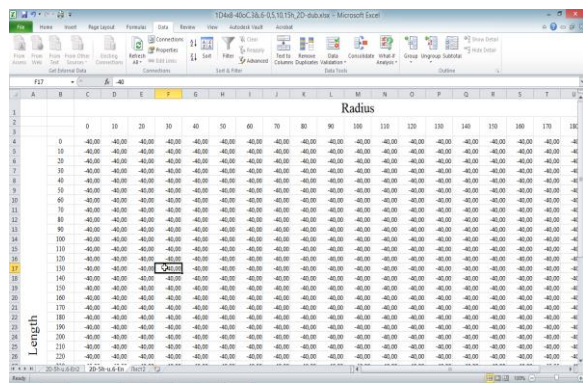


Figure 6:

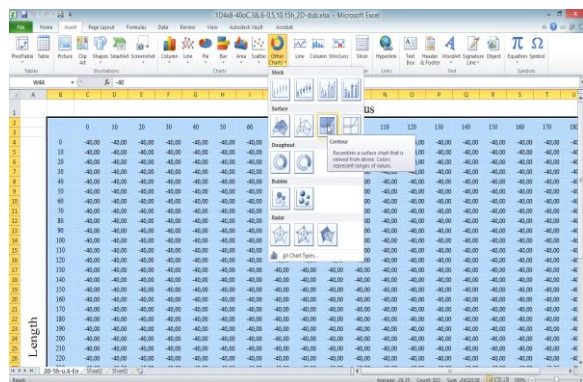


Figure 7:

With the help of the mouse all temperature data is marked on the table on worksheet “2D_0h_u.6-En”, which relate to the distribution of t in the longitudinal section at moment $\tau = 0$ h. One needs to click on the Excel menu item “Insert”, then on the subitem “Other Charts” and to select the third item on

the second row from left to right on pop up window (Fig. 7).

Then the shown on Fig. 8 window with a 2D diagram, situated on the right of the array with numerical temperature data for the longitudinal section at $\tau = 0$ h appears on the worksheet. Since the temperature in all points of this log’s section is equal to the initial wood temperature, then the entire diagram that has appeared on Fig. 8 have a uniform color.

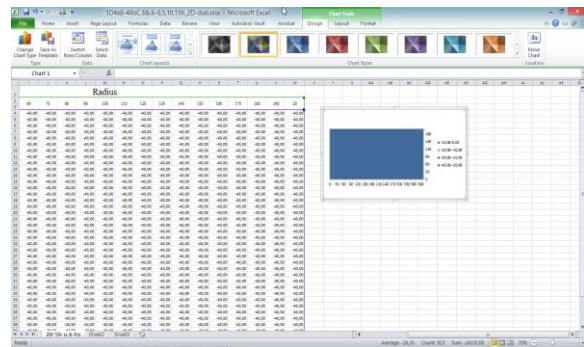


Figure 8:

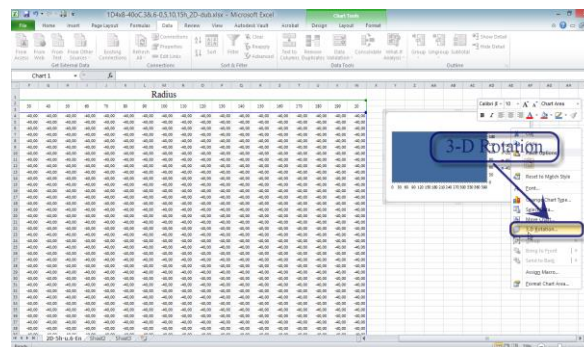


Figure 9:

GRADUATION AND POSITIONING OF THE AXES OF THE DIAGRAMS

Given an active section “Chart Tools” from the Excel menu one clicks with the right button of the mouse on the 2D diagram on Fig. 8 and as a result of that a window with heading “Format Chart Area” appears. In this window one needs to click with the left button of the mouse on the heading “3-D Rotation” (Fig. 9) and in the newly appeared window the desired settings for the positioning of the coordinate axes of the diagram and

their following graduation are done. After that with the help of the button “Close” this window closes.

In the given case the following settings have been selected: $X: = 0^\circ$, $Y: = 90^\circ$ and Perspective: $= 0,1^\circ$ (Fig. 10). In the section “Chart Tools” one needs to click with the right button of the mouse on the numbers on the vertical axis of the diagram, as a result of which a pop up window appears. One clicks on the heading “Format Axis” in this window and following a marking of the heading “Axis Options” in the next window the desired settings for the graduation of the vertical axis of the diagram are made. The setting of this temperature axis is selected in this case with a range of -40 to 80 °C with a graduation every 8 °C.

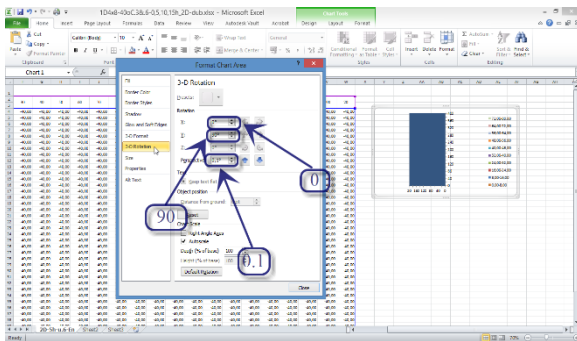


Figure 10:

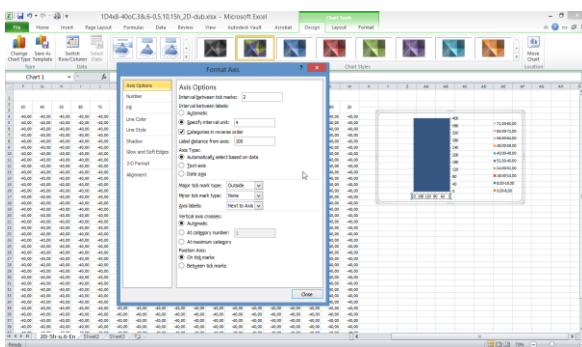


Figure 11:

In the section “Chart Tools” with the right button of the mouse one needs to click in the area close to the diagram. As a result of this a pop up window appears, on which one clicks with the left button of the mouse on the lowest heading “Format Chart Area”.

In the appeared new window, one needs to click on “Fill” and to choose the option “No fill”, as a result of which a white background needs to be chosen for the area surrounding the diagram. For the removal of the line of the diagram from the same pop up window one needs to choose “Border Colour” and from there the option “No line”.

At an activated section “Chart Tools” with the right button of the mouse one clicks on the numbers on the horizontal axis of the diagram and in the opened window clicks on “Format Axis”. In the newly opened window “Axis Options” one clicks on the command “Categories in reverse order” and with the button “Close” this window is closed. The reversing of the categories provides for a switching in the arrangement of the graduation numbers on the axis in such a way that the initial values for the graduation along both axes, x (along the radius of the log) and z (along the length of the log) to coincide (Fig. 11).

CONCLUSIONS

Results from the application of the presented above portion of the methodology are shown in the second part of this paper. With its help 2D diagrams have been created, which illustrate the temperature distribution in the volume of frozen oak log at desired moments of its defrosting.

ACKNOWLEDGEMENT

This paper was composed as a part of the solution of the joint project between University of Forestry in Sofia and TU in Zvolen “Modelling and visualization of the wood defrosting processes in the technologies for wood thermal treatment”, which is supported by the Scientific Research Sector in the University of Forestry (project 114/2011).

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