APPLYING OF MS EXCEL 2010 FOR 2D COLOUR VISUALIZATION OF TEMPERATURE FIELDS IN LOGS DURING THEIR DEFROSTING PART 2. 2D VISUALIZATIONS OF THE TEMPERATURE FIELDS IN OAK LOG IN DIFFERENT MOMENTS OF THEIR DEFROSTING

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ABSTRACT

In the first and at the beginning of the second part of this work the methodology for creation of 2D colourful diagrams has been described as thematically-oriented sequence of the used procedures of MS Excel 2010. In this part of the work the methodology has been applied for the preparation of 2D colourful diagrams of temperature distribution in the longitudinal sections of a frozen oak log during its defrosting. The methodology can be used for the preparation of various 2D diagrams for the change of temperature, moisture, and other fields in the volume of different materials in the cases when the diagrams are created using extensive numerical results from models, adequately describing the studied processes.

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

INTRODUCTION

This paper aims to suggest a methodology for the creation with the help of the complex toolkit of MS Excel 2010 of 2D colourful diagrams of temperature fields in the volume of subjected to defrosting cylindrical wood materials using files in the .txt format with large arrays of numerical results obtained from the solution of mathematical models for these fields.

In the first part of the paper (Deliiski et al. 2013) the suggested methodology has been described as thematically oriented sequence of the used necessary procedures of MS Excel 2010. In this second part of the paper the methodology has been filled with more procedures and has been applied for the creation of 2D colourful diagrams of the temperature fields in subjected to defrosting oak log.

LABELLING OF THE 2D DIAGRAMS

For the labelling of the axis of the 2D diagram for the moment $\tau = 0$ h at an activated section “Chart Tools” of the Excel menu one selects the heading “Layout”, clicks on the button “Axis Titles” and selects “Primary Horizontal Axis Title” and “Title Below Axis” in the opened pop up windows (Fig. 1). The opened small window is marked below the diagram and in it the label “Radius *R*, mm” is input with desired font and size for the letters. In our case font Times New Roman and size 14 have been used and the letter *R* is given in italics.

After that at an activated section “Chart Tools” one selects the heading “Layout”, clicks on the button “Axis Titles” and selects “Primary Vertical Axis Title” and “Rotated Title” in the opened windows (Fig. 2). The opened small window is marked and in it the

label “Length *L*/2, mm” is input. The results of these two operations are shown on Fig. 3.

Analogously, for the setting of the title of the diagram at an activated section “Chart Tools” one selects the heading “Layout”, clicks on the button “Chart Title” and selects “Centred Overlay Title” in the opened window. The opened small window is marked above the diagram and in it the label “Time $\tau = 0$ h” (Fig. 4).

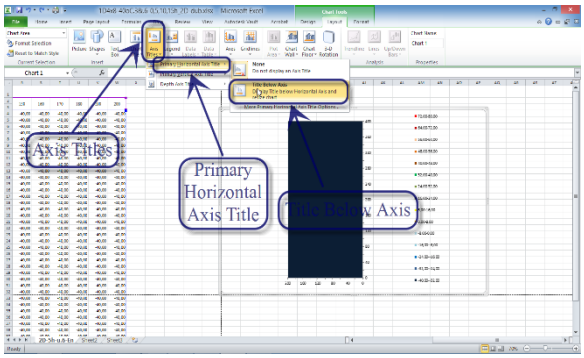

Figure 1:

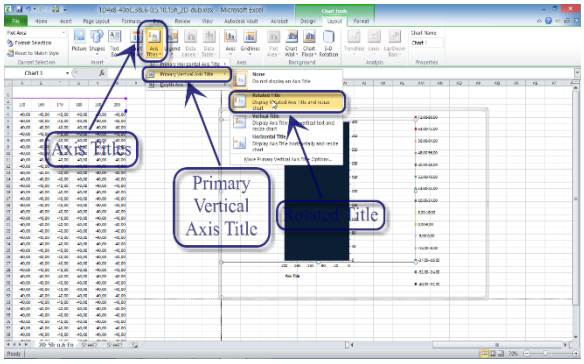

Figure 2:

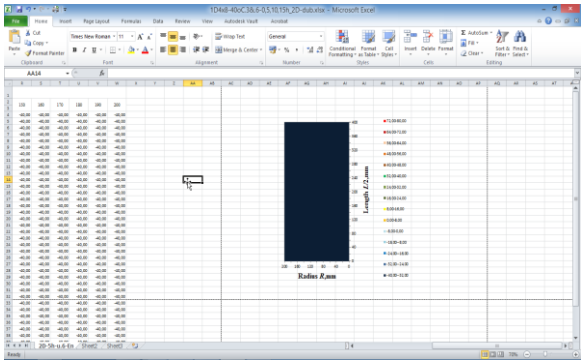

Figure 3:

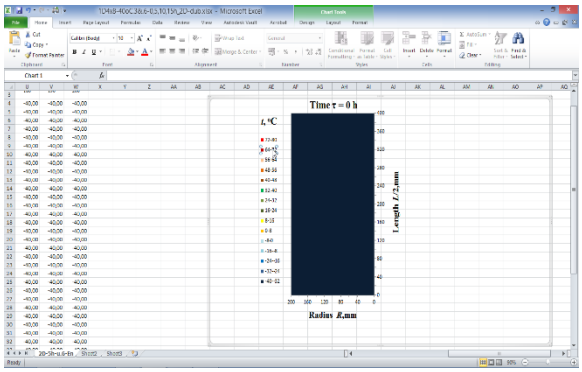

Figure 4:

By dragging the temperature legend it is situated on the left side of the diagram. In order to put a caption above the temperature legend at an activated section “Chart Tools” one needs to select the title “Layout” and to press the button “Horizontal Axis Titles”. In the pop up window the title “Primary Horizontal Axis Title” needs to be selected, and in the following window – the title “Title Below Axis” needs to also be selected. In the pop up window the temperature legend is inscribed with “*t*, °C” using font Times New Roman with size 16 and the letter *t* is given in italics. The inscription is then dragged and positioned above the scale (Fig. 4 – upper left).

INPUTTING OF DESIRED COLORS OF THE TEMPERATURE LEGEND OF THE DIAGRAMS

Desired colours are input for the separate temperature intervals of the colour legend for the temperature. For this purpose with the left button of the mouse one needs to mark the upper most interval from 72 °C to 80 °C of the legend. After that one goes to the section “Home” and clicks on the icon for colour of an area and in the pop up window selects colour Red (Fig. 5). Following this one needs to continuously mark the next intervals of the colour legend of the diagram, when after each marking one goes to the section “Home”, clicks on the icon for colour and in the pop up window selects the desired

colour for the corresponding interval. In the given case the following colours have been chosen:

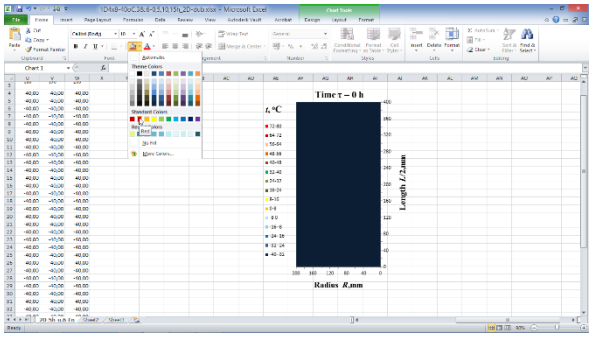

Figure 5:

▪ for the interval from 64 to 72 ºC – Dark Red;

▪ for the interval from 56 to 64 ºC – Orange, Accent 6, Lighter 40 %;

▪ for the interval from 48 to 56 ºC – Orange, Accent 6, Darker 25 %;

▪ for the interval from 40 to 48 ºC – Orange, Accent 6, Darker 50 %;

▪ for the interval from 32 to 40 ºC – Green;

▪ for the interval from 24 to 32 ºC – Olive Green, Accent 3, Darker 25 %;

▪ for the interval from 16 to 24 ºC – Olive Green, Accent 3, Darker 50 %;

▪ for the interval from 8 to 16 ºC – Yellow;

▪ for the interval from 0 to 8 ºC – Orange;

▪ for the interval from –8 to 0 ºC – Aqua, Accent 5, Lighter 60 %;

▪ for the interval from –16 to –8 ºC – Aqua, Accent 5, Lighter 40 %;

▪ for the interval from –24 to –16 ºC – Blue;

▪ for the interval from –32 to –24 ºC – Dark Blue, Accent 1, Darker 25 %;

▪ for the interval from –40 to –32 ºC – Dark Blue, Text 2, Darker 50 %.

CREATION OF THE 2D DIAGRAMS FOR DESIRED MOMENTS OF THE LOG'S DEFROSTING

After the desired colours for the temperature legend have been input one proceeds with the creation of colour zones on the 2D diagram with time coordinate $\tau = 5$ h.

Based on the already created 2D diagram for the temperature distribution in the longitudinal section of the subjected to defrosting log at the beginning of the defrosting process, i.e. at the moment $\tau = 0$ h, the 2D diagram for the moment $\tau = 5$ h of the defrosting process is yet to be created. For this purpose the created diagram for $\tau = 0$ h together with its numerical data is copied by selecting and clicking with the right button of the mouse on it and selecting "Copy" in the menu that has appeared (Fig. 6). After the diagram for $\tau = 0$ h has been copied, it is necessary for it to be situated in the second (for $\tau = 5$ h) Excel worksheet. For this purpose one needs to click with the right button of the mouse on an empty cell on the second worksheet and on the opened pop up window one needs to select the first button below the heading "Paste Options".

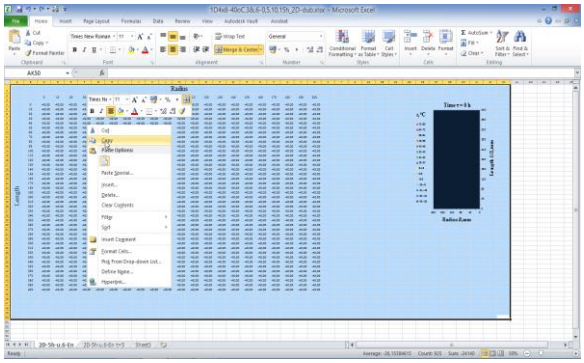

Figure 6:

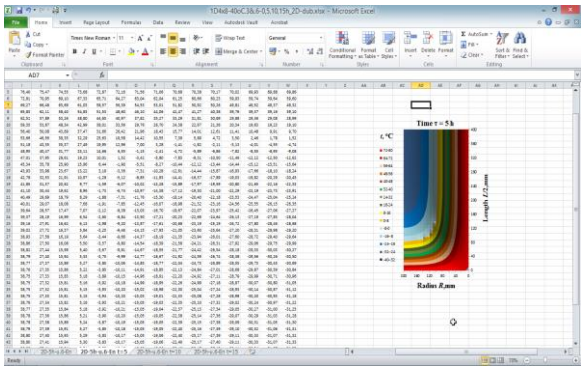

Figure 7:

After that it is necessary to input into copied 2D diagram for $\tau = 0$ h the calculated values for the distributions of the temperature in the longitudinal section of the log, which is distanced from the beginning of the defrosting process by 5 h. This happens when at an activated section "Chart Tools" with the left button of the mouse one clicks on the 2D diagram of the second Excel worksheet and from the section "Design" of the Excel menu then clicks on the button "Select Data".

The marked blinking field in the appeared pop up window shows the destination from which the array of calculated data needs to be taken for the creation of this diagram. Since it relates to the moment $\tau = 5$ h of the defrosting process, the area of the table with data needs to be marked which relates to the temperature distribution at this moment.

After marking the data with this temperature distribution the button OK needs to be pressed in the pop up window. As a result of this on the second 2D diagram the distribution of the temperature at the considered moment $\tau = 5$ h is automatically visualized (Fig. 7).

The remaining 2D diagrams for the moments $\tau = 10$ h and $\tau = 15$ h of the defrosting process are prepared using an analogous way to the described above with $\tau = 5$ h (Fig. 8 and Fig. 9).

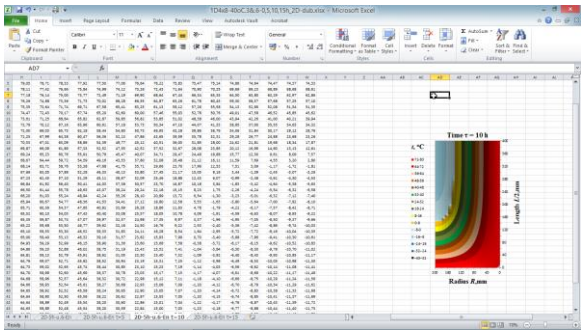

Figure 8:

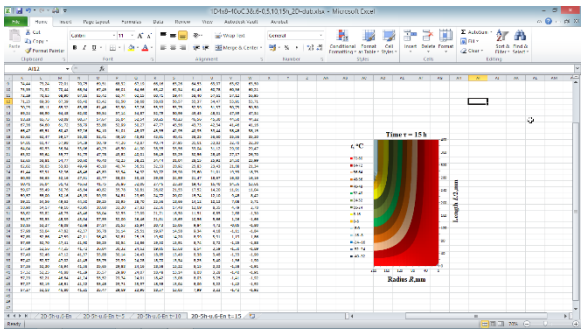

Figure 9:

CREATION OF 2D DIAGRAMS OF THE DEFROSTING PROCESS OF OAK LOG

As a result of the application of the procedures from the methodology described in part 1 (Deliiski et al. 2013) and above in part 2 of the current paper, the diagrams for the distribution of the temperature field in 1/4 of the longitudinal section a subjected to defrosting oak log with moisture content equal to $u = 0{\cdot}6$ kg.kg^{-1} in the beginning and after 5 h, 10 h, and 15 h defrosting at $t_m = 80$ °C have been created as shown on Fig. 10.

On Fig. 1 in part 1 of this paper the input data is given, which is used by the mathematical model for the calculation of the distribution of the temperature in the log during its defrosting process and consequently this distribution is used for the creation of the diagrams.

It can be clearly seen on the figures the faster increase in the temperature along the length of the log compared to along its radius. A reason for this is the 1.63 times larger coefficiend of thermal conductivity along the

fibers of the oak wood, than along its radius (Deliiski 2013).

CONCLUSIONS

Using the suggested in this work methodology for the first time with the help of the toolkit of MS Excel 2010 a 2D colour visualizations of the change in temperature fields in subjected to defrosting wood materials with cylindrical shape has been done. The toolkit of MS Excel 2010 contains significantly larger capabilities for the solution of similar problems compared to that of AutoCAD, which was used earlier for the creation of analogous monochrome visualizations (Deliiski et al. 2010).

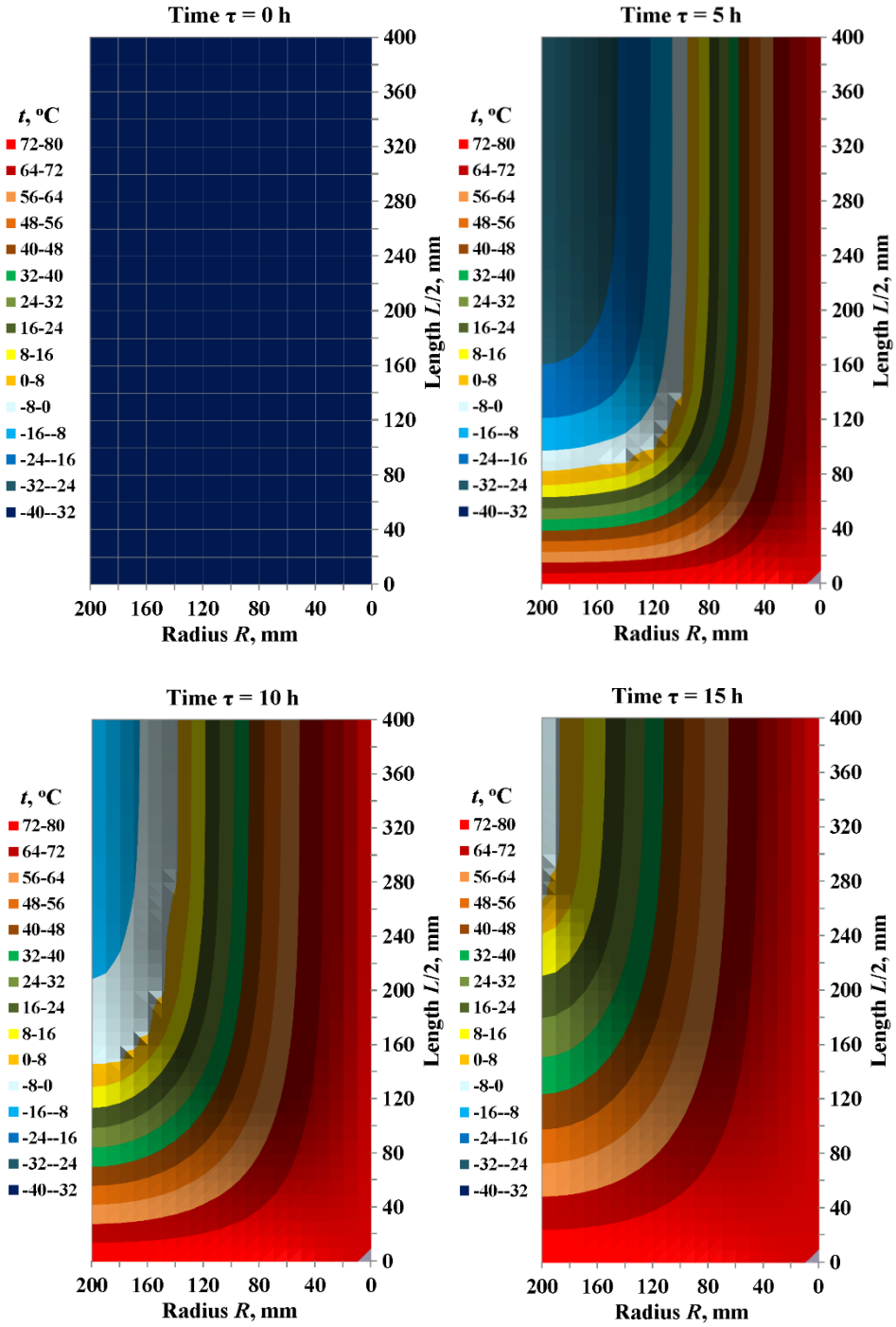

Figure 10: 2D distribution of the temperature in 1/4 of the longitudinal section of oak log with D = 0.4 m, L = 0.8 m, t_0 = −40 °C, and u = 0.6 kg·kg^{-1} in the beginning (τ = 0 h) and after 5 h, 10 h, and 15 h defrosting at t_m = 80 °C

The colour visualizations allow for the tracking and analyzing of the movement on the border of melting of the ice in the logs during their thermal treatment, as well as the change in the temperature of radial and longitudinal direction of the fibers, which are of special interest for the practice (Chudinov 1968, Shubin 1990, Shteinhagen 1986, 1991, Trebula and Klement 2002, Videlov 2003, Pervan 2009, Deliiski 2013, Deliiski and Dzurenda 2010). With the help of these visualizations it is easy to determine the moment of reaching of the zone of optimal for the various wood species temperatures in the volume of the logs, guaranteeing the needed degree for plasticizing for the obtaining of high quality veneer.

The methodology can be used for the creation of various 2D diagrams for the change in temperature, moisture content, magnetic and many other fields in the volume of different materials using large arrays of numerical data obtained from the solution of models, adequately describing the studied processes. The diagrams strongly support the analysis of the ongoing non-stationary processes in the logs and also the formation of the scientifically based control of these processes.

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