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DETERMINATION OF THE CONVERSION FACTOR OF STACKED WOOD IN SOLID CONTENT AT SPRUCE PULPWOOD AND FIREWOOD WITH THE LENGTH OF TWO AND THREE METERS

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Abstract: *The purpose of the present paper is the determination of the conversion factor of stacked wood in solid content and the conversion factor of solid content in stacked wood for spruce pulpwood and firewood with the length of two and three meters. The conversion factor of stacked wood in solid content has been determined by four methods described in writings in the field for cordwood. The values of the conversion factor of stacked wood in solid content depend on the following: length of wood pieces, form defects, wood pieces diameter and arrangement of wood pieces. The results obtained reveal values of the conversion factors of stacked wood in solid content generally lower than in the case of cordwood.*

Key words: *spruce, pulpwood, firewood, conversion factor.*

1. Introduction

At present, the unit of measurement used for wood converted to cordwood or to lengths of two or three meters is the cubic meter. In practice there is a need to move from the net wood pile volume, expressed in cubic meters, to the gross wood pile volume, expressed in stere. This transformation from cubic meters into stere and the other way round is made by two transformation factors which experimentally determine the so-called conversion factor of stacked wood in solid content and conversion factor of solid content in stacked wood. Research conducted by Decei and Anca (1968) led to the determination of conversion factors for wood assortments converted to lengths of one meter. The values determined then are used in silviculture to this day. As the size of the conversion factor of stacked wood in solid content and, implicitly, the size of the conversion factor of solid content in stacked wood depends on the length of wood pieces, is the determination of these lengths for spruce pulpwood and firewood assortments converted to lengths of two and three meters.

2. Research Venue

The research was conducted in four County Forest Administrations and four Forest Districts according to Table 1 on the site of felling areas. In the Forest District of

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Research Venue Table 1

Species	County Forest Administration	Forest District	Management Unit	Felling Area
Spruce	Sibiu	Miercurea Sibiului	U.P. V Pode	148
	Braşov	Teliu	U.P. I Buzăiel	671
	Prahova	Măneciu	U.P. II Orăţii	Depozitul Orăţii
	Argeş	Vidraru	U.P. VI Tulburea	436

Fig. 1. *Location of work points for common hornbeam and spruce*

Măneciu the research took place in the Orăţii log yard. The map of the work points is presented in Figure 1.

3. Research Method

In order to determine the conversion factor of stacked wood in solid content and the conversion factor of solid content in stacked wood, the wood has been arranged in piles with the lengths of two or three meters, the average width and height of one meter and an overheight of 10 centimetres which would compensate the loss produced by compression [3].

The conversion factor of stacked wood in solid content has been determined for each pile with the following formula:

$$f_c = \left(\frac{V_r}{V_a} \right). \quad (1)$$

where:

- V_a - represents the gross pile volume, expressed in stere, and is the result of the multiplication of the three dimensions *width* x *height* x *length* (Figure 2a).
- V_r - net pile volume, expressed in cubic meters determined by the xylometring of wood pieces (Figure 2b).

In order to be xylometered wood pieces with lengths of two or three meters have been severed at lengths of 1 meter.

The volume of the initial piece was the result of adding the volumes of the pieces with lengths of 1 meter obtained by cutting to which the wood volume lost by severing was added.

In silviculture there is a need for a fast method of determining the conversion factor of stacked wood in solid content each pile being characterized by its own conversion factor. In the case of cordwood

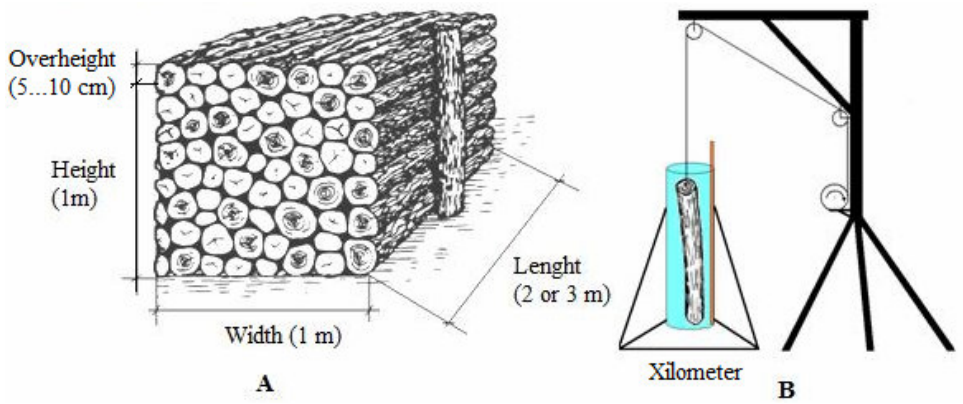

Fig. 2. *Determination of gross pile volume* (*A*) *and net pile volume* (*B*)

our country uses the method of diagonals (Figure 3).

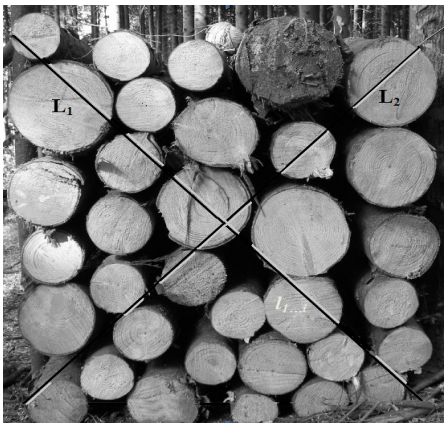

Fig. 3. *Determination of the conversion factor of stacked wood in solid content by the method of diagonals*

The conversion factor of stacked wood in solid content by the method of diagonals is calculated with the following formula:

$$f_c = \frac{\sum l_i}{L_1 + L_2}. \qquad (2)$$

where:

- $\sum l_i$ - the sum of segments from the diagonals occupied by wood pieces;

- $L_1 + L_2$ - the sum of the length of diagonals.

Where there was possibility of mechanically stacking wood, stacks with lengths of 8 meters have been created making possible the determination of the verification conversion factor according to STAS 2340-80 also by the method of diagonals. This time the length of a single diagonal has been measured as well as the segments occupied by wood pieces on this diagonal.

4. Results and Discussion

In order to determine the conversion factor of stacked wood in solid content the quantities of wood from Table 2 have been measured.

The following Tables 3-6 present the values of the conversion factors of stacked wood in solid content and of the conversion factor of solid content in stacked wood for pulpwood and firewood converted to lengths of two and three meters determined in the following way:

1 - by the ratio of volumes considering the overheight;

2 - by the ratio of volumes without considering the overheight;

3 - the verification conversion factor by the method of diagonals;

4 - by the method of diagonals.

Table 2

Quantity of wood measured for the determination on the conversion factors

Forest District	Wood assortment							
	Pulpwood 2 m		Pulpwood 3 m		Firewood 2 m		Firewood 3 m	
	V_a, [m^3 (st)]	V_r, [m^3]	V_a, [m^3 (st)]	V_r, [m^3]	V_a, [m^3 (st)]	V_r, [m^3]	V_a, [m^3 (st)]	V_r, [m^3]
SPRUCE								
Miercurea Sibiului	4.200	3.227	3.150	2.158	2.290	1.648	3.783	2.459
Teliu	2.184	1.449	3.523	2.217	-	-	-	-
Măneciu	2.352	1.647	3.245	2.224	2.117	1.482	3.404	2.349
Vidraru	2.161	1.533	3.339	2.375	-	-	-	-

The conversion factor of solid content in stacked wood (f_a) has been determined according to the conversion factor of stacked wood in solid content (f_c) determined by the ratio of volumes considering the overheight.

Unlike cordwood, firewood and pulpwood converted to 2 and 3 meters is formed only of round pieces. Thus, the values of the conversion factors of stacked wood in solid content depend mainly on the occurrence of form defects, of curvatures, forking, knots, burls or swellings. The probability that these defects will occur grows with the length of wood pieces. The values of stacked wood in solid content are lower as the length of wood pieces grows as it can be noticed from the next tables.

Another highly important factor which influences the value of the conversion factor of stacked wood in solid content is represented by the arrangement of wood pieces in piles or stacks. The manual arrangement of wood pieces can lead to a higher value of the conversion factor of stacked wood in solid content by 1 up to 3%. In silviculture it is considered that the stacking of wood pieces should be done mechanically because of the weight of wood pieces of 2 and 3 meters which is over 18 kilograms. This is the values considered acceptable for manipulating and stacking cordwood [1].

As far as the results obtained are concerned, the use of the values of the conversion factor of stacked wood in solid content obtained by the volumes ratio considering the overheight is recommended. The values obtained by the volumes ratio without considering the overheight must be considered only when, during the storage period the stacked wood compresses, the height of the stack decreasing by 5 up to 10% from the initial value.

a) For pulpwood

The conversion factors (f_c and f_a) for wood converted to 2 meters Table 3

Forest District	Mean diameter	No. of wood pieces	Pulpwood 2 m				
			f_c				f_a
			1	2	3	4	
Miercurea Sibiului	22	20	0.77	0.84	0.76	0.82	1.30
Teliu	18	29	0.66	0.73	-	0.70	1.52
Măneciu	19	27	0.70	0.77	-	0.70	1.43
Vidraru	17	34	0.71	0.78	-	0.69	1.41
Averages	19	28	0.71	0.78	0.76	0.73	1.41

The conversion factors (f_c and f_a) for wood converted to 3 meters Table 4

Forest District	Mean diameter	No. of wood pieces	Pulpwood 3 m				
			f_c				f_a
			1	2	3	4	
Miercurea Sibiului	21	20	0.69	0.75	0.78	0.75	1.45
Teliu	17	32	0.63	0.69	0.69	0.66	1.59
Măneciu	16	34	0.69	0.75	-	0.76	1.45
Vidraru	16	37	0.71	0.78	-	0.68	1.41
Averages	18	31	0.68	0.75	0.75	0.71	1.47

b) For firewood

The conversion factors (f_c and f_a) for wood converted to 2 meters Table 5

Forest District	Mean diameter	No. of wood pieces	Firewood 2 m				
			f_c				f_a
			1	2	3	4	
Miercurea Sibiului	21	23	0.72	0.79	0.78	0.87	1.39
Măneciu	16	33	0.70	0.78	-	0.75	1.43
Averages	19	28	0.71	0.79	0.78	0.81	1.41

The conversion factors (f_c and f_a) for wood converted to 3 meters Table 6

Forest District	Mean diameter	No. of wood pieces	Firewood 3 m				
			f_c				f_a
			1	2	3	4	
Miercurea Sibiului	23	19	0.65	0.71	0.74	0.76	1.54
Măneciu	16	37	0.69	0.75	-	0.75	1.45
Averages	20	28	0.67	0.73	0.74	0.76	1.49

The use of the method of diagonals for the determination of the conversion factor of stacked wood in solid content for pulpwood and firewood with lengths of 2 and 3 meters has lead to higher values of the conversion factor both in the case of the variant with the square side of 1 meter and in the case of determining the verification conversion factor. The values obtained are usually over the margin of error of 3% characteristic of the method of diagonals in the case of cordwood. One of the causes is represented by the small number of wood pieces on diagonals.

Because of the big diameters - over 15 centimeters - the requirement of a minimum of 60 pieces on each diagonal, present at the verification of the conversion factor of stacked wood in solid content in the case of cordwood could not be met. On average, each diagonal had 30 pieces of round wood. Thus, the results obtained by the method of diagonals in the case of wood with lengths of 2 and 3 meters cannot constitute at present values to be applied in practice.

5. Conclusions

The values of stacked wood in solid content are lower as the length of wood pieces grows. The probability that the form

defects will occur grows with the length of wood pieces. Another highly important factor which influences the value of the conversion factor of stacked wood in solid content is represented by the arrangement of wood pieces in piles or stacks.

The use of the values of the conversion factor of stacked wood in solid content obtained by the volumes ratio considering the overheight is recommended.

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