International Journal of Physical Sciences Vol. 7(10), pp. 1689 - 1693, 2 March, 2012
Available online at http://www.academicjournals.org/IJPS
DOI: 10.5897/IJPS12.104
ISSN 1992-1950 ©2012 Academic Journals

Full Length Research Paper

Relationship between drying time and surface roughness in Siberian pine (*Pinus sibirica*) wood

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Accepted 03 February, 2012

Siberian pine wood imported from Russian Federation has a wide indoor and outdoor application in Turkey. The factors which affect drying times and consequently drying costs, control system quality and drying schedules of this wood are well known; however, the effect of surface quality on drying times of Siberian pine wood is not known. In this study, the effect of surface quality on drying times and final moisture contents of Siberian pine boards in different surface quality classes such as sawn, planed and planed + sanded were determined. The lowest final moisture contents were found in the planed boards while the highest ones were observed in the planed + sanded boards. Smooth surfaces decreased drying times but additional sanding process had negative effect on drying time because sand dust filled the board surface, retarding drying.

Key words: Drying time, surface roughness, Siberian pine.

INTRODUCTION

Timber drying is one of the most important processes in manufacturing sawn timber products. Drying process influences deformations, surface checking, discoloration and hence, quality of products and costs of manufacturing. Research in this field is of great importance to the wood industry since the industrial drying process always needs to be improved as market demands increase and new wood products are being developed (Rosenkilde, 2002).

Ideal drying occurs within the shortest drying time and involves using the most economical method. In ideal drying, defects and losses can also be decreased. In recent years, drying time has become the most important factor in drying industry because it affects drying costs. Drying time is directly affected by the factors which affect drying process control. The most important factor is drying temperature. When drying temperature increases, drying time decreases. This fact has forced researchers to find out alternative methods for wood drying. Drying methods applied over 100°C were developed in the beginning of the 1940s (Czepek, 1940; Fischer and Czepek, 1941; Keylwerth, 1949; Egner, 1951; Kollmann, 1952). Drying in pure hot steam, one of the methods applied with very high temperatures, has gained importance in recent years. In this method, drying time is shortened compared to conventional drying methods. In drying of some tree species, these decreases can be up to 80% (Gart and Ripen, 2003; Kantay, 2007).

In drying process, wood properties such as dimensions affect drying time. The increase of evaporation for unit of volume shortens drying time. As the thickness of lumber increases, surface proportion decreases and drying time increases. But the length of lumber is an important factor in drying time, as fast drying occurs in lumber of lengthwise direction. Therefore, shorter lumber dries faster than longer ones.

The effect of physical and anatomical properties of wood on drying time has been known for a long time (Kantay, 1993); however, the effect of surface roughness, one of the appearance properties of lumber on drying time, has not been considered. But it is known that the effect of air movement parallel to lumber surface is not much in rough surfaces. As the results of drying time and

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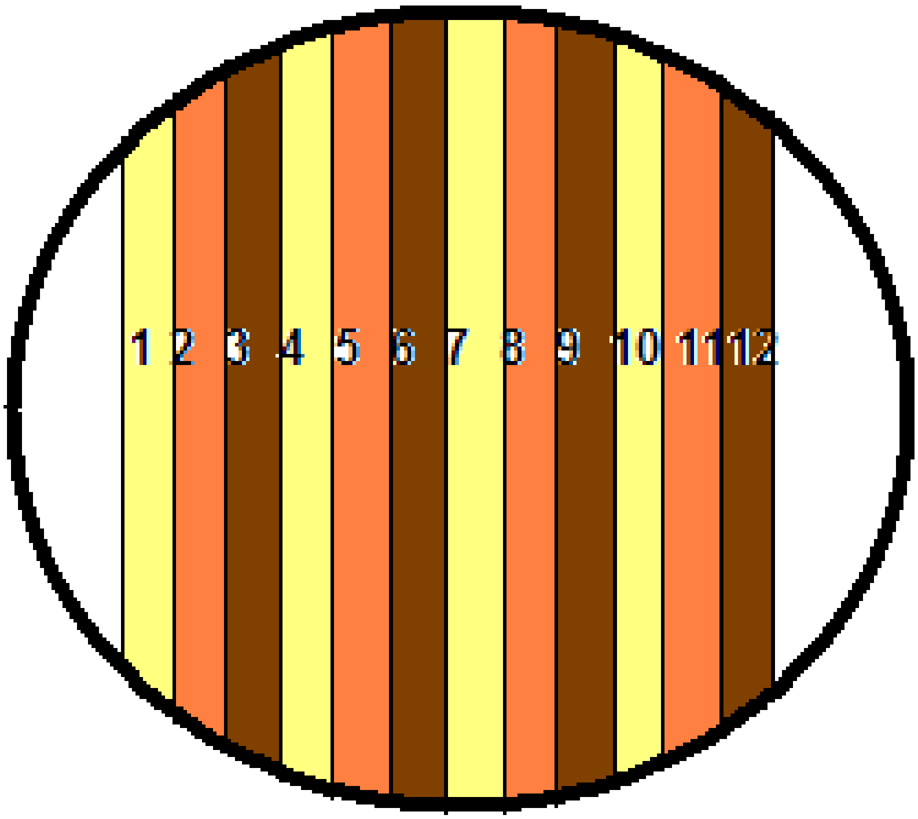

Figure 1. The locations of the lumbers, which belong to three groups, from the log. Type 1, Sawed boards (1, 4, 7 and 10), Type II, planned boards (2, 5, 8 and 11); Type III, planned + sanded boards (3, 6, 9 and 12).

quality yield are not determined in veneer drying process, air applied parallel to veneer surface and air ventilation system applied perpendicular to lumber surface have been developed (Kantay, 1983).

Effect of surface roughness (in limits of Ra_{min} = 10.465 µm; Ra_{max} = 15.065 µm surface roughness) on drying speed was not determined in drying pre-dried radial cut lamellas by means of air movement perpendicular to lamella surface in veneer roller dryer (Gungor et al., 2010).

Surface quality is an important issue in lumber manufacturing. Many factors such as properties of log, machines and saw blades affect surface quality. These are the stability of saw blade, tooth type and geometry, sharpness of saw blade and feeding and cutting speed. More smooth surfaces had been obtained by cutting with PV tooth type when compared with NV tooth type (Örs et al., 1991). According to Korkut (1999), surface roughness increases with increasing tooth set and feeding speed in sawing.

The aim of this study was to determine the effect of surface roughness on drying time of Siberian pine wood. For this purpose, some tests were done in an industrial drying kiln which has air circulation system parallel to the lumber surface and the effects of lumber surface quality on drying time and quality were determined.

MATERIALS AND METHODS

One Siberian pine (*Pinus sibirica*) log was obtained from Karaoğluları saw mill. The log was cut by flat saw method and 12 unedged boards were obtained. Three specimens groups were formed from the boards, numbered as 1, 4, 7, 10; 2, 5, 8, 11 and 3, 6, 9, 12. The board thickness of groups 1, 2 and 3 were 26, 32 and 34 mm, respectively. In this selection, it was aimed that all parameters except surface quality should be the same or similar in three groups. For this purpose, 2 edged boards (15 cm in width) from each unedged board were sawn. Therefore, 8 boards, which belong to each group, were obtained. After that Type II lumbers were planed and lowered to 26 mm thickness, Type III lumbers were planed + sanded and lowered to 26 mm thickness. Therefore, the thicknesses of all boards got to 26mm before the drying. Plane and sanding process were made only at the two wide surfaces of the lumbers, but not in their ends and edges (Figure 1).

The equality of tangential-radial and heartwood-sapwood proportions was taken into account in the three groups of boards. Also in the drying piles named “slated box”, the distribution of the boards of the groups was considered, and the boards placed side by side were kept close to one another (Figure 2).

Drying process was made in a conventional kiln trademarked “EISENMANN” and has axial ventilators which provide vertical air

Figure 2. The location of boards in three groups at the pile

Figure 3. The kiln and sample boards.

Figure 4. Full automatic control system. The tooth features of the saw blade used for sawing are: Clearance angle: 17°; sharpness angle: 63°; hook angle: 10°; tooth pitch: 40 mm; tooth depth: 11.5 mm; thickness of the tooth with setting (sawing width): 3.5 mm; thickness of the blade: 1.2 mm.

circulation (Figure 3). The kiln was controlled with full automatic control unit trademarked "GANN Hydromat TKA-6" (Figure 4).

P-60 (60 sand) type sandpaper and HHS type 40^o angled planning blade were used for sanding and planning. The drying schedule which considers timber moisture flowing and includes relatively protective drying conditions was applied (Table 1a).

Before the drying process, initial moisture content of the boards was measured by GANN RTU 600, resistance type moisture meter

Table 1a. Applied drying schedule and obtained daily data for drying conditions.

Tree species: Siberian pine (*Pinus sibirica*)
Beginning of drying time: 04/03/2007
T_1 (initial temperature): 55°C
T_2 (final temperature): 75°C
Gradient: 2.4
Timber group: 3
Lumber thickness: 26 mm
Kiln number: 1
Heating time: 4 h
Final moisture: 15%
Conditioning time: 8 h

Table 1b. Contd.

Date	Time	Temperature (°C)	EMC (%)	Type 3	Type 2	Type 3	Type 1	Average (%)
				Moisture 1 (%)	Moisture 2 (%)	Moisture 3 (%)	Moisture 4 (%)	
04/03/2007	18:20	11	18	45.8	39.7	46.5	43.8	43.9
04/03/2007	24:20	53	11.4	42.6	36.7	42.4	38.4	40.1
05/03/2007	08:00	57.8	13.1	41.3	34.3	37.2	36.1	37.5
05/03/2007	13:30	64.6	10.8	36.5	30.3	33.7	30.3	32.9
05/03/2007	18:30	67.4	10.1	33.4	26.6	29.7	26.1	29.1
05/03/2007	24:00	68.40	9.80	29.9	22.3	25.7	21.8	25.00
06/03/2007	08:00	67.20	9.40	27.30	19.30	21.60	19.00	22.00
06/03/2007	13:00	69.60	8.70	25.00	16.90	19.20	16.90	19.80
Condensation	18:10	75.40	7.6	23.9	13.70	17.00	14.80	15.40
07/03/2007	Cooling							

Table 2. Final moisture for boards of three types surface quality.

Surface	Sample numbers	Range	Minimum	Maximum	Arithmetic mean	Standard error	Standard deviation	Variance
Normal cut	16	5.9	12.1	18.0	14.588	0.3707	1.4827	2.1985
Planned	16	5.6	11.3	16.9	13.750	0.4046	1.6182	2.6187
Planned + sanded	16	5.3	14.3	19.6	16.638	0.3946	1.5786	2.4918

which has compensation buttons for tree species and temperature. The hammer type electrod and its scale were used to measure the depth. All the measurements could be easily made by getting to 1/3 of the board thickness. A total of 16 moisture values were determined for every group of boards due to two measurements taken from each board.

Arithmetic mean and standard deviation of final moisture on boards existing in three groups were determined. The difference of groups in board moisture was also determined by “One way Anova” test and existing differences among groups were also searched by DUNCAN test (Table 1b).

RESULTS

Initial moisture contents of Types 1 (sawed surfaces), 2 (planned surface) and 3 (planned and sanded surfaces) boards were measured as 50.2, 49.4 and 45.8%, respectively. Drying process continued for 48 hours. Final moisture contents were measured after drying process and found to be 14.59, 13.75 and 16.64% for Types 1, 2 and 3 boards, respectively. The results show that the fastest drying occurs in planned surfaces according to the arithmetic means of final moistures. Also drying speed of sawed surfaces and planned +sanded surfaces was found to be less than planned surfaces. Arithmetic means, standard deviations and variances are shown for final moisture content of planned, normally cut and planned + sanded in Table 2.

One way ANOVA test was used to analyze and obtain

Table 3. One way ANOVA test results.

Group	Sum of squares	df	Mean square	F	Significance
Between groups	70.622	2	35.3108	14.4934	0.000
Within groups	109.635	45	2.4363		
Total	180.257	47			

Table 4. Duncan test results.

Group	N	Subset for alpha = 0.05	
Operation type		1	2
Planning (type 2)	16	13.750	
Normal cut (type 1)	16	14.588	
Planning + sanding (type 3)	16		16.638
Significant		0.136	1

differences in arithmetic means for final moisture in the groups. Test results are shown in Table 3. One way ANOVA test showed that significant difference exists between the groups in 5% level of significance. Duncan test was applied to determine the group or groups, bringing out these differences. Duncan test results are shown in Table 4.

Duncan test results show that final moistures for planned + sanded boards are different from the two other groups. Also, no significant difference of final moisture was obtained between normally cut and planned surfaces.

Conclusion

Drying speed increases with increasing lumber surface quality, but additional sanding process to increase surface quality is not necessary. Additional sanding process had negative effect on drying time because sand dust filled the board surface and drying was retarded.

Final moistures of the planned boards were found not only 6% less than sawed boards but also 21% less than planned + sanded boards. Additional sanding process after the planning had negatively effect on drying time.

REFERENCES

Czepek R (1940). Report on wood drying experiments in Elektrowaermeinstitut in food, wood releases the Technical Committee on issues at the VDI, Heft Nr. 28, s. 76/87.

Egner K (1951). For drying of wood at temperatures above 100 oC. Wood raw workpiece, Bd. 9, H. 3, 85-95.

Fischer W, Czepek R (1941). The hot drying of softwood in an electrically heated drying chamber. Releases of the Technical Committee on Wood questions the VDI wood conference, 32: 10.

Gart WF, Riepen M (2003). Superheated steam drying. 4th Int. Seminar for Holzindüstrie St. Gallen / Switzerland.

Gungor NM, Kantay R, Korkut S (2010). Effect of surface roughness on drying speed of drying lamellas in veneer roller dryer. Afr. J. Biotechnol. 9(25):3840-3846.

Kantay R (1983). Studies on drying properties of alnut, Quercus and Fagus veneers, Faculty of Forestry Publication, İstanbul University, Bahcekoy/Istanbul. P. 269.

Kantay R (1993). Drying and Steaming of Lumber, Education and Culture Foundation, Publication, Istanbul. p.6

Kantay R (2007). Lumber drying in pure heat steam and thermal treatment, Wood Machinery Technology and Research Journal, March-April 2007/02, EFS Publication Group. , p. 27

Keylwerth R (1949). Fundamentals of high temperature drying. Holz-Zentralblatt Jg. 75(76): 953.

Kollmann F (1952). Studies on the drying of pine lumber with erhöchten temperatures. Svenska Trafekn. Avd. Medd. 23: 3-10.

Korkut S (1999). Researches on curing surface quality in lumber production, M.Sc.Thesis, Istanbul University Institute of Natural Sciences.

Ors Y, Kalaycıoglu H, Colakoglu G (1991). Effect of blade teeth geometry on lumber surface quality, Turk. J. Agric. Forestry 15: 777-784.

Rosenkilde A (2002). Moisture content profiles and surface phenomena during drying of wood. Trätek - Swedish Institute for Wood Technology Research, Doctoral Thesis.