Title: Liquid water uptake and successive drying of Accoya™ wood

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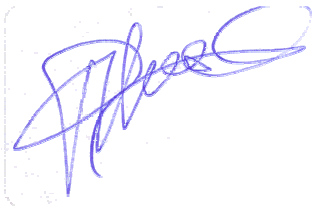

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Entries: Water uptake, drying, desorption, Accoya™ wood, Radiata Pine, KOMO certification, BRL 0605

Summary

Titan Wood B.V. appointed SHR Timber Research to determine the rate and quantity of liquid water uptake and successive drying of Accoya™ wood according to SKH Publication 97-04. The technology behind Accoya™ wood is based on wood acetylation. In this investigation, Accoya™ wood and the untreated original wood species, Radiata Pine, were tested as part of the research scheme for KOMO certification BRL 0605 “Modified Timber”.

On the basis of the results, it can be concluded that the rate and quantity of (liquid) water uptake of Accoya™ wood is reduced compared to that of (untreated) Radiata Pine. Furthermore, it can be concluded that during the successive drying phase, the drying rate of Accoya™ wood is reduced as well compared to that of (untreated) Radiata Pine.

Contents

1 Assignment

Titan Wood B.V. appointed SHR Timber Research to determine the rate and quantity of liquid water uptake and successive drying of Accoya™ wood. The technology behind Accoya™ wood is based on wood acetylation, a chemical modification process that improves the dimensional stability, UV-stability and durability of wood. The process modifies the wood without the addition of toxic chemicals. Accoya™ wood's durability and dimensional stability can be determined after the acetylation process has taken place by analysing the wood's acetyl content.

In co-operation with a Dutch certification body, SKH, and research institute, SHR Timber Research, Titan Wood has established a research scheme to independently prove the quality of Accoya™ wood. This scheme consists of:

1. KOMO certificate BRL 0605 "Modified Timber". Here the emphasis is on the uniformity and reproducibility of the production process, as well as on Titan Wood's quality system.
2. Fulfilment of the (material) requirements as listed for in use of certified Dutch joinery (SKH Publication 97-04). Emphasis is on material properties, such as durability, dimensional stability and paintability.

In this research, the rate and quantity of liquid water uptake and successive drying for Accoya™ wood and for the untreated (original) wood species, Radiata Pine, were tested as part of the research scheme described above.

2 Execution of the test

2.1 Identification and description of the samples

Sampling was performed according to SKH Publication 97-04 by Titan Wood. Accoya™ wood samples were taken from 2 batches produced in Titan Wood's pilot plant (14 and 13 samples per batch respectively), originating from different boards. In total, 27 samples of Accoya™ wood and 15 samples of (untreated) Radiata Pine were tested, each with a dimension of 20 x 20 x 400 mm. The codes of the samples and the correlating batch numbers can be found in appendix 1.

2.2 Procedure

The rate and quantity of (liquid) water uptake was determined according to SKH Publication 97-04. The samples were placed with the cross cut side into water, and were successively weighed after 1 and 24 hours, and after 2, 5, 7, 14 and 21 days. Then the samples were placed in a climate chamber (65% relative humidity, 23 °C) and successively weighed after 1 and 24 hours, and after 2, 3, 7 and 14 days to determine the drying rate.

3 Results and discussion

The average (liquid) water uptake of Accoya™ wood (per batch) and untreated Radiata Pine are shown in table 1. In table 2 the results of the drying phase are shown. In figure 1, the results are graphically presented. All individual values can be found in appendix 2.

The results show a reduction in the rate and quantity of (liquid) water uptake for the Accoya™ wood compared to the untreated Radiata Pine. Furthermore, it can be seen that the drying rate of Accoya™ wood is reduced compared to untreated Radiata Pine. There is a low variation in the results for the different acetylation batches compared to the overall variation.

Table 1. The average (liquid) water uptake of Accoya™ wood and untreated Radiata Pine. Expressed in total amount of water uptake from the start of the test till the time interval shown.

Species	Batch		1 hour	24 hours	2 days	5 days	7 days	14 days	21 days
Accoya™ wood	LG110	water uptake [g]	1.0	4.9	6.4	9.4	11.4	14.0	17.2
		stdev	*0.2*	*0.8*	*1.1*	*1.6*	*1.8*	*2.3*	*2.8*
	LG127	water uptake [g]	0.9	4.7	6.3	9.4	11.3	14.2	17.2
		stdev	*0.3*	*1.2*	*1.7*	*2.7*	*3.1*	*3.9*	*4.9*
	average	**water uptake [g]**	**1.0**	**4.8**	**6.4**	**9.4**	**11.3**	**14.1**	**17.2**
		stdev	**0.3**	**1.0**	**1.4**	**2.1**	**2.5**	**3.1**	**3.9**
Radiata Pine	Reference	water uptake [g]	2.3	7.5	10.0	14.4	18.0	21.3	22.9
		stdev	*0.7*	*1.4*	*1.7*	*2.2*	*2.7*	*3.2*	*5.7*

Table 2. The average water desorption of Accoya™ wood and untreated Radiata Pine during the drying phase. Expressed in total amount of water evaporated from the start of the test till the time interval shown.

Species	Batch		1 hour	24 hours	2 days	3 days	7 days	14 days
Accoya™ wood	LG110	desorption [g]	0.8	8.6	11.3	12.7	16.0	17.0
		stdev	*0.2*	*2.0*	*2.6*	*2.6*	*2.5*	*2.6*
	LG127	desorption [g]	0.7	8.8	11.5	12.9	15.9	16.8
		stdev	*0.3*	*2.8*	*3.7*	*3.8*	*3.8*	*4.2*
	average	**desorption [g]**	**0.8**	**8.7**	**11.4**	**12.8**	**15.9**	**16.9**
		stdev	**0.3**	**2.4**	**3.1**	**3.2**	**3.2**	**3.4**
Radiata Pine	Reference	desorption [g]	0.8	14.8	19.4	20.3	22.0	22.7
		stdev	*0.2*	*2.4*	*3.1*	*3.3*	*3.5*	*3.8*

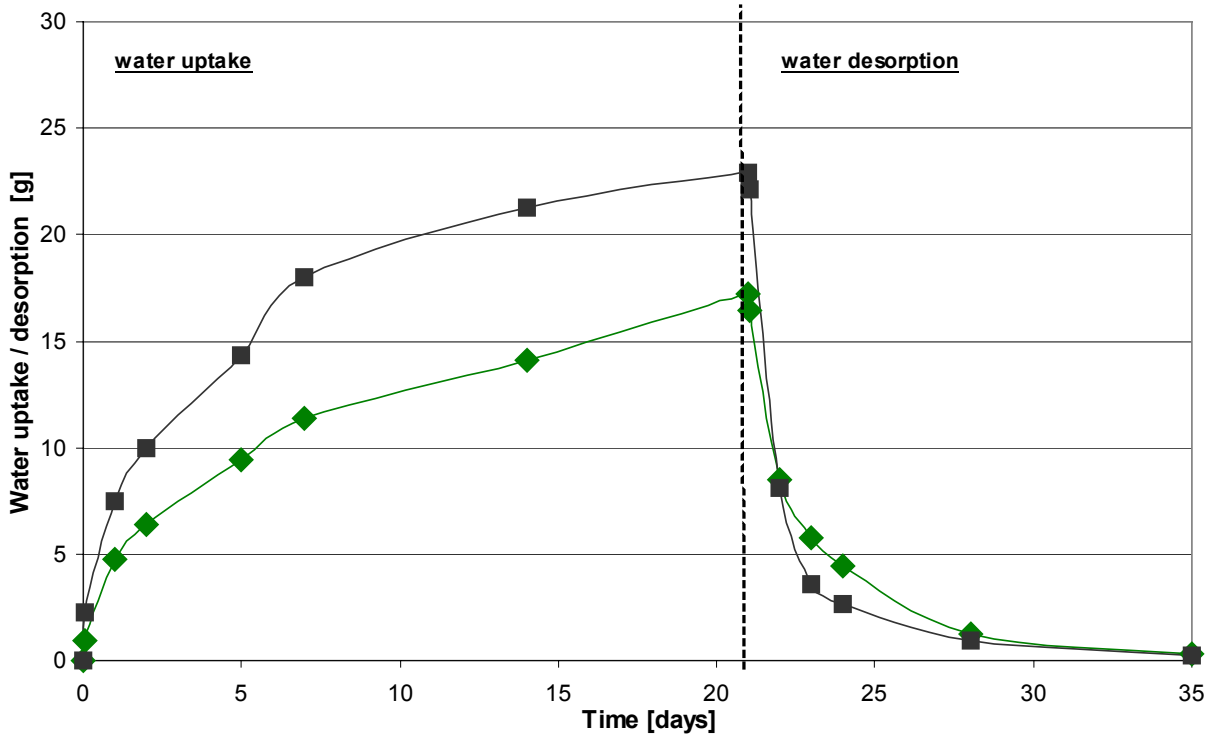

Figure 1. Rate and quantity of (liquid) water uptake over 21 days and drying rate over 14 days in a climate of 65% RH for Accoya™ wood (green line) and (untreated) Radiata Pine.

4 Conclusion

On the basis of the results, it can be concluded that the rate and quantity of (liquid) water uptake of Accoya™ wood is reduced compared to that of (untreated) Radiata Pine. Furthermore, it can be concluded that during the successive drying phase, the drying rate of Accoya™ wood is reduced as well compared to that of (untreated) Radiata Pine.

References

BRL 0605 (dated 31-01-2003). National Assessment Directive for the KOMO® Product Certificate Modified Timber. Stichting Keuringsbureau Hout SKH, Wageningen, the Netherlands.

SKH Publicatie 97-04 (Nieuw concept 13 april 2006). Beoordelingsgrondslag Houtsoorten voor toepassing in geveltimmerwerk; eisen en bepalingsmethoden. Stichting Keuringsbureau Hout SKH, Wageningen.

Appendix 1 Sampling, codes and batch numbers

Accoya™ wood Acetylated Radiata Pine			Reference Radiata Pine
	Batch LG110	Batch LG127	References
1	LG110 RP1	LG127 RP14	Reference 1
2	LG110 RP7	LG127 RP23	Reference 2
3	LG110 RP27	LG127 RP16	Reference 3
4	LG110 RP12	LG127 RP22	Reference 4
5	LG110 RP19	LG127 RP25	Reference 5
6	LG110 RP61	LG127 RP8	Reference 6
7	LG110 RP9	LG127 RP19	Reference 7
8	LG110 RP10	LG127 RP2	Reference 8
9	LG110 RP17	LG127 RP5	Reference 9
10	LG110 RP52	LG127 RP10	Reference 10
11	LG110 RP20	LG127 RP20	Reference 11
12	LG110 RP28	LG127 RP30	Reference 12
13	LG110 RP44	LG127 RP7	Reference 13
14	LG110 RP47		Reference 14
15			Reference 15

Appendix 2 Water uptake and desorption

Water uptake

Accoya™ wood Board	Water uptake [g] ↗						
	1 hour	24 hours	2 days	5 days	7 days	14 days	21 days
LG110 RP01	1.1	5.2	6.9	10.0	12.3	15.6	18.4
LG110 RP07	0.9	4.5	5.7	8.0	9.4	11.1	13.4
LG110 RP09	1.5	6.7	8.9	12.5	14.8	18.3	22.2
LG110 RP10	0.9	4.8	6.2	9.1	11.3	14.2	17.8
LG110 RP12	1.1	5.5	7.4	10.9	13.0	15.7	18.8
LG110 RP17	1.4	5.3	6.7	9.3	11.3	14.4	18.7
LG110 RP19	0.9	4.3	5.6	8.6	10.7	13.7	16.6
LG110 RP20	0.8	4.2	5.6	8.3	10.0	11.9	13.9
LG110 RP27	1.0	5.3	6.8	9.6	11.2	13.5	16.0
LG110 RP28	0.6	3.8	5.0	7.5	9.0	10.8	13.2
LG110 RP44	0.9	4.6	6.1	9.1	11.2	13.5	16.5
LG110 RP47	1.0	5.5	7.9	12.5	15.0	18.2	22.3
LG110 RP52	0.8	4.1	5.5	8.5	10.4	12.6	15.6
LG110 RP61	0.8	4.5	5.8	8.3	10.1	12.6	16.6
Avg	***1.0***	***4.9***	***6.4***	***9.4***	***11.4***	***14.0***	***17.2***
Stdev	***0.2***	***0.8***	***1.1***	***1.6***	***1.8***	***2.3***	***2.8***

Accoya™ wood Board	Water uptake [g] ↗						
	1 hour	24 hours	2 days	5 days	7 days	14 days	21 days
LG127 RP02	1.0	5.0	6.4	8.7	10.5	13.1	16.6
LG127 RP05	1.1	5.2	6.8	9.8	11.7	14.5	18.3
LG127 RP07	0.5	2.6	3.7	5.9	7.3	9.1	10.8
LG127 RP08	0.6	3.7	4.9	7.3	9.0	11.7	13.7
LG127 RP10	0.6	3.4	4.6	6.8	8.2	10.1	12.6
LG127 RP14	0.7	4.0	5.1	7.2	8.7	11.5	14.1
LG127 RP16	1.2	5.6	7.3	11.0	13.3	16.5	20.5
LG127 RP19	0.8	5.4	7.7	12.0	14.4	17.9	22.0
LG127 RP20	1.8	7.1	9.6	14.5	17.5	22.5	28.3
LG127 RP22	1.1	4.8	6.3	9.3	11.0	13.7	16.3
LG127 RP23	0.9	6.1	8.7	13.3	15.4	19.2	22.6
LG127 RP25	0.8	3.3	4.6	7.0	8.5	10.6	12.7
LG127 RP30	1.0	4.5	6.4	9.7	11.5	13.8	15.9
Avg	***0.9***	***4.7***	***6.3***	***9.4***	***11.3***	***14.2***	***17.2***
Stdev	***0.3***	***1.2***	***1.7***	***2.7***	***3.1***	***3.9***	***4.9***

Radiata Pine Board	Water uptake [g] ↗						
	1 hour	24 hours	2 days	5 days	7 days	14 days	21 days
Reference 1	2.6	7.7	10.5	15.9	19.7	25.4	29.1
Reference 2	0.5	3.3	4.8	7.6	9.7	11.8	13.0
Reference 3	3.0	8.0	10.4	15.1	18.6	23.9	27.4
Reference 4	2.1	7.4	9.7	14.2	18.2	21.3	23.1
Reference 5	2.0	7.1	9.4	13.9	17.5	20.0	21.5
Reference 6	3.5	8.8	11.2	15.5	19.0	23.2	25.4
Reference 7	3.3	9.8	12.4	17.0	21.3	23.1	23.6
Reference 8	2.3	8.1	10.8	15.1	18.3	21.1	21.3
Reference 9	2.2	8.8	12.0	16.9	21.7	24.4	17.4
Reference 10	2.0	6.8	9.2	13.3	16.3	19.1	32.2
Reference 11	2.0	6.9	9.4	13.9	17.1	20.8	14.6
Reference 12	2.3	8.3	10.8	15.0	18.8	21.7	32.5
Reference 13	2.5	7.1	9.8	14.4	18.2	22.3	19.7
Reference 14	2.2	7.0	9.3	13.7	17.3	20.9	22.0
Reference 15	1.9	7.3	9.7	14.1	17.8	20.5	21.2
Avg	***2.3***	***7.5***	***10.0***	***14.4***	***18.0***	***21.3***	***22.9***
Stdev	***0.7***	***1.4***	***1.7***	***2.2***	***2.7***	***3.2***	***5.7***

Desorption

Accoya™ wood Board	Vapour release [g] ↘					
	1 hour	24 hours	2 days	3 days	7 days	14 days
LG110 RP01	-0.8	-8.9	-11.8	-13.2	-16.9	-18.2
LG110 RP07	-0.6	-6.5	-8.6	-9.7	-12.7	-13.0
LG110 RP09	-1.2	-12.5	-16.4	-17.9	-21.0	-22.3
LG110 RP10	-0.9	-8.8	-11.5	-12.8	-16.4	-17.6
LG110 RP12	-0.9	-9.7	-12.8	-14.3	-17.7	-18.6
LG110 RP17	-0.9	-9.9	-13.0	-14.4	-17.6	-18.5
LG110 RP19	-0.8	-8.1	-10.7	-12.1	-15.6	-16.5
LG110 RP20	-0.6	-5.9	-7.9	-9.1	-12.8	-14.1
LG110 RP27	-0.8	-8.4	-11.0	-12.3	-14.9	-15.6
LG110 RP28	-0.4	-6.0	-8.0	-9.4	-13.1	-14.1
LG110 RP44	-0.9	-8.5	-11.2	-12.4	-15.6	-16.3
LG110 RP47	-1.0	-11.9	-15.6	-17.1	-20.1	-21.2
LG110 RP52	-0.7	-7.2	-9.5	-10.9	-14.5	-15.5
LG110 RP61	-0.5	-7.9	-10.5	-11.9	-15.5	-16.5
Avg	***-0.8***	***-8.6***	***-11.3***	***-12.7***	***-16.0***	***-17.0***
Stdev	***0.2***	***2.0***	***2.6***	***2.6***	***2.5***	***2.6***

Accoya™ wood Board	Vapour release [g] ↘					
	1 hour	24 hours	2 days	3 days	7 days	14 days
LG127 RP02	-0.7	-8.1	-10.7	-12.0	-15.3	-16.2
LG127 RP05	-0.8	-9.9	-13.1	-14.4	-17.2	-18.0
LG127 RP07	-0.3	-5.7	-7.6	-8.8	-12.0	-12.5
LG127 RP08	-0.5	-6.8	-9.0	-10.1	-13.2	-13.7
LG127 RP10	-0.4	-5.3	-7.1	-8.1	-11.3	-12.4
LG127 RP14	-0.5	-6.8	-9.1	-10.3	-13.3	-13.7
LG127 RP16	-1.1	-9.2	-12.2	-13.5	-17.0	-18.9
LG127 RP19	-1.1	-11.0	-14.5	-16.0	-19.8	-21.1
LG127 RP20	-1.3	-15.5	-20.3	-21.8	-24.4	-26.2
LG127 RP22	-0.8	-8.9	-11.7	-13.0	-15.6	-16.1
LG127 RP23	-1.1	-11.6	-15.2	-16.9	-20.3	-21.5
LG127 RP25	-0.4	-6.2	-8.2	-9.4	-12.1	-12.6
LG127 RP30	-0.7	-8.9	-11.7	-12.9	-14.9	-15.6
Avg	***-0.7***	***-8.8***	***-11.5***	***-12.9***	***-15.9***	***-16.8***
Stdev	***0.3***	***2.8***	***3.7***	***3.8***	***3.8***	***4.2***

Radiata Pine Board	Vapour release [g] ↘					
	1 hour	24 hours	2 days	3 days	7 days	14 days
Reference 1	-1.0	-18.7	-24.5	-25.8	-28.0	-29.2
Reference 2	-0.6	-8.4	-11.1	-11.7	-13.0	-13.0
Reference 3	-1.0	-17.3	-22.7	-24.2	-26.2	-27.2
Reference 4	-0.9	-15.1	-19.7	-20.6	-22.1	-22.9
Reference 5	-0.8	-13.9	-18.1	-18.8	-20.3	-20.9
Reference 6	-0.9	-16.1	-21.1	-22.4	-24.5	-25.4
Reference 7	-1.0	-15.9	-20.7	-21.4	-22.8	-23.7
Reference 8	-0.9	-14.4	-18.7	-19.2	-20.5	-21.2
Reference 9	-1.1	-16.8	-21.8	-22.5	-24.0	-24.9
Reference 10	-0.9	-13.1	-17.0	-17.6	-18.9	-19.3
Reference 11	-0.7	-14.2	-18.6	-19.8	-21.9	-22.6
Reference 12	-0.6	-15.0	-19.5	-20.2	-21.7	-22.3
Reference 13	-0.6	-16.4	-21.4	-22.7	-24.7	-25.5
Reference 14	-0.6	-14.0	-18.4	-19.5	-21.4	-22.1
Reference 15	-0.6	-13.3	-17.3	-18.3	-20.1	-20.6
Avg	***-0.8***	***-14.8***	***-19.4***	***-20.3***	***-22.0***	***-22.7***
Stdev	***0.2***	***2.4***	***3.1***	***3.3***	***3.5***	***3.8***