

Colour alterations in hydrothermally recycled particleboards

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The need for wood recycling

- FOREST AREA REDUCTION
 - INCREASE OF WOOD PRICE
 - INCREASE OF WOOD WASTE
-

The need for wood recycling

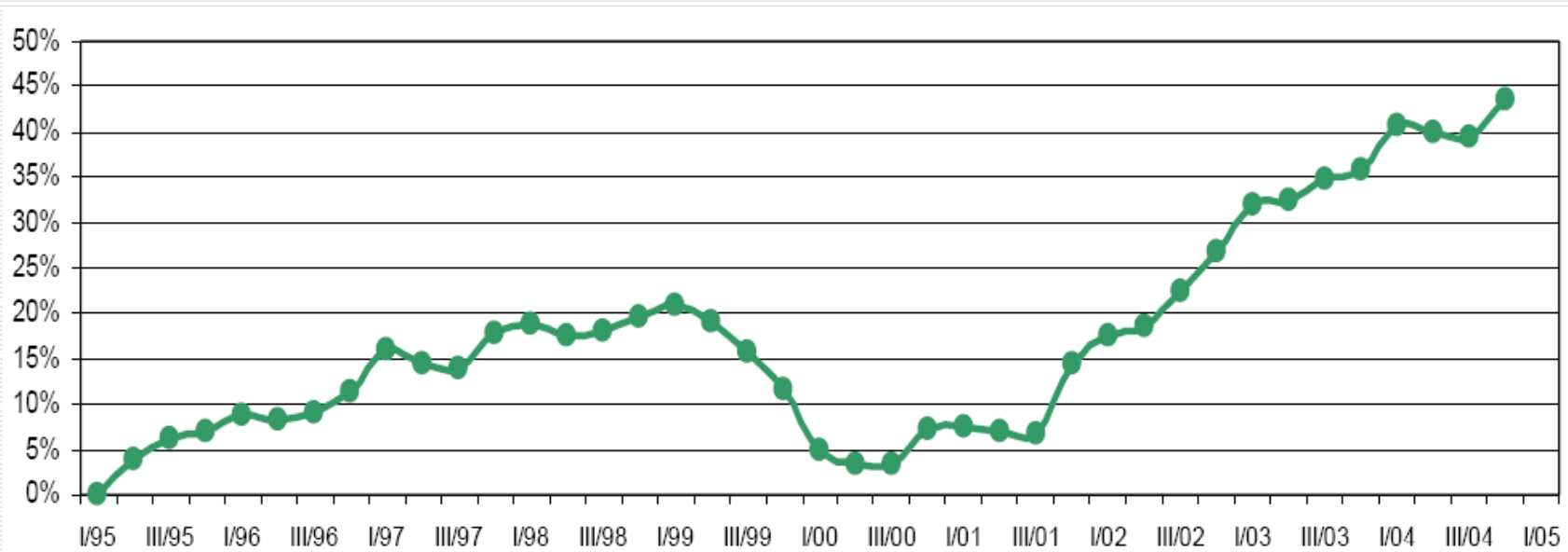
- FOREST AREA REDUCTION
- INCREASE OF WOOD PRICE
- INCREASE OF WOOD WASTE

	Area (1 000 ha)			Annual change (1 000 ha)		Annual change rate (%)	
	1990	2000	2005	1990-2000	2000-2005	1990-2000	2000-2005
Europe excluding Russian Federation	180 370	188 823	192 604	845	756	0.46	0.40
Russian Federation	808 950	809 268	808 790	32	-96	0	-0.01
Total Europe	989 320	998 091	1 001 394	877	661	0.09	0.07
World	4 077 291	3 988 610	3 952 025	-8 868	-7 317	-0.22	-0.18

Extent and change of Forest Area (FAO, 2007)

The need for wood recycling

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Wood price change (1995-2005) (Van Riet, 2006)

The need for wood recycling

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World production of Particleboards and MDF

	MDF (m ³)	PARTICLE- BOARDS (m ³)	WOOD BASED PANELS (m ³)
1966	-	10.956.500	51.099.282
1976	-	34.802.700	95.766.965
1986	-	48.273.040	120.133.227
1996	9.305.300	67.054.856	147.574.156
2003	33.035.419	92.081.498	218.922.289
2006	50.506.093	106.290.120	260.058.048

(FAOSTAT, 2008)

Recovery methods from used particleboards and MDF

1970

Ø SANDBERG

Ø PFLEIDERER

Ø HESCH

Ø W.K.I.

Ø ROFFAEL

Ø FIBRESOLVE

CRUSH

HYDROTHERMAL
TREATMENTS

2001

Hydrothermal recycling

Advantages

- reduced hygroscopicity of the recycled boards and
- reduced free formaldehyde content of the recycled boards

Disadvantages

- colour alteration of the wood
-

Aim

- colour determination of hydrothermally recycled particleboards using various recovery parameters (water impregnation, temperature, duration)
 - investigation of the effect that the percentage of the recovered particles (derived from old particleboards) has on the colour of particleboards made of fresh raw materials.
-

RESEARCH PHASES

1. Optimal groups of conditions for the recovery of wood particles from industrial particleboards
(water retention / temperature / duration)

- 1) 30%/ 150°C/ 20min
- 2) 45%/ 110°C/ 75min
- 3) 45%/ 130°C/ 20min
- 4) 45%/ 150°C/ 10min
- 5) 60%/ 110°C/ 30min
- 6) 60%/ 130°C/ 10min
- 7) 60%/ 150°C/ 8min

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3. Use of optimal recovery conditions in the production of boards

Hydrothermal Recovery



before



after

Types of produced laboratory particleboards

Board Type	Description
100	Particleboards made of 100% recovered particles
50	Particleboards made of 50% recovered and 50% fresh wood particles
0	Particleboards made of 100% fresh wood particles
0A	Recycling of type 0 boards
100A	Recycling of type 100 boards

Methods – Board production

Board density: 0,68g/cm³

Board thickness: 12mm

Board type: 3-layer

surface layers < 1,5mm

core layers > 1,5mm

Resin: urea-formaldehyde resin

12% (per dry wood weight) for the surface layers

8% (per dry wood weight) for the core layer

Hardener: ammonium chloride 2% (per dry resin weight)

Hot pressing

Temperature: 185°C,

Maximum pressure: 25Kp/cm²

Total hot pressing duration: 240s.

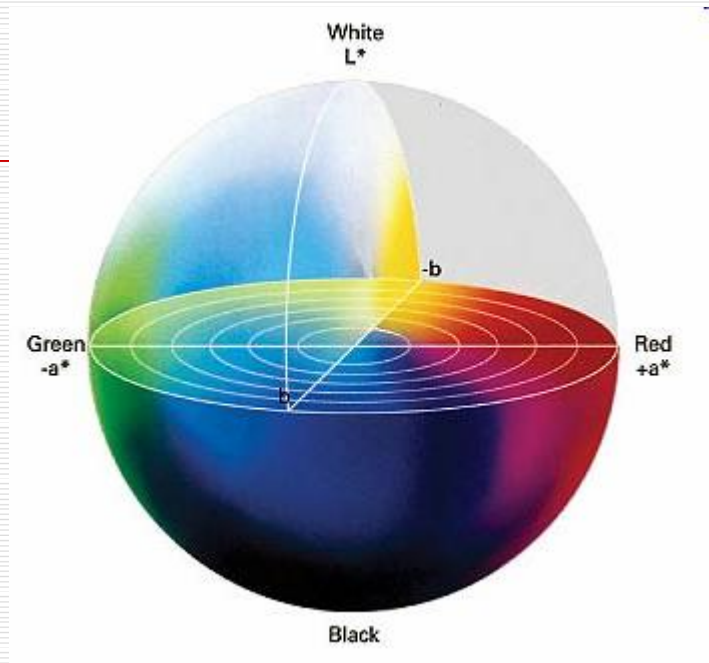
Methods

Colour determination (CIE Lab)

L* (lightness),

a* (redness)

b* (yellowness)



Total colour differences: $\Delta E^* = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$

Where ΔL^* , Δa^* and Δb^* : The changes of the colour coordinates L*, a* and b* respectively.

According to the above equation, low ΔE^* values correspond to low colour differences (Oltean *et al.* 2008).

Colour coordinate values of the laboratory particleboards (2nd Phase)

Board Type (recovery parameters)		L* (Lightness)	a* (Redness)	b* (Yellowness)
1 (30%/ 150°C/ 20min)	mean	52,388	8,348	24,094
	(s)	1,17922	0,36974	0,77257
	n ^a	48	48	48
2 (45%/ 110°C/ 75min)	mean	57,293	7,041	22,525
	(s)	1,36537	0,37661	0,90875
	n	48	48	48
3 (45%/ 130°C/ 20min)	mean	58,247	6,741	22,270
	(s)	1,35182	0,39015	0,93381
	n	48	48	48
4 (45%/ 150°C/ 10min)	mean	56,399	7,076	22,725
	(s)	1,38250	0,43609	0,74042
	n	48	48	48
5 (60%/ 110°C/ 30min)	mean	60,720	6,189	20,705
	(s)	1,66620	0,50926	0,91922
	n	48	48	48
6 (60%/ 130°C/ 10min)	mean	59,250	6,480	21,349
	(s)	1,37898	0,38354	0,77742
	n	48	48	48
7 (60%/ 150°C/ 8min)	mean	56,466	7,160	22,172
	(s)	1,38767	0,35976	0,70902
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^aNumber of measurements

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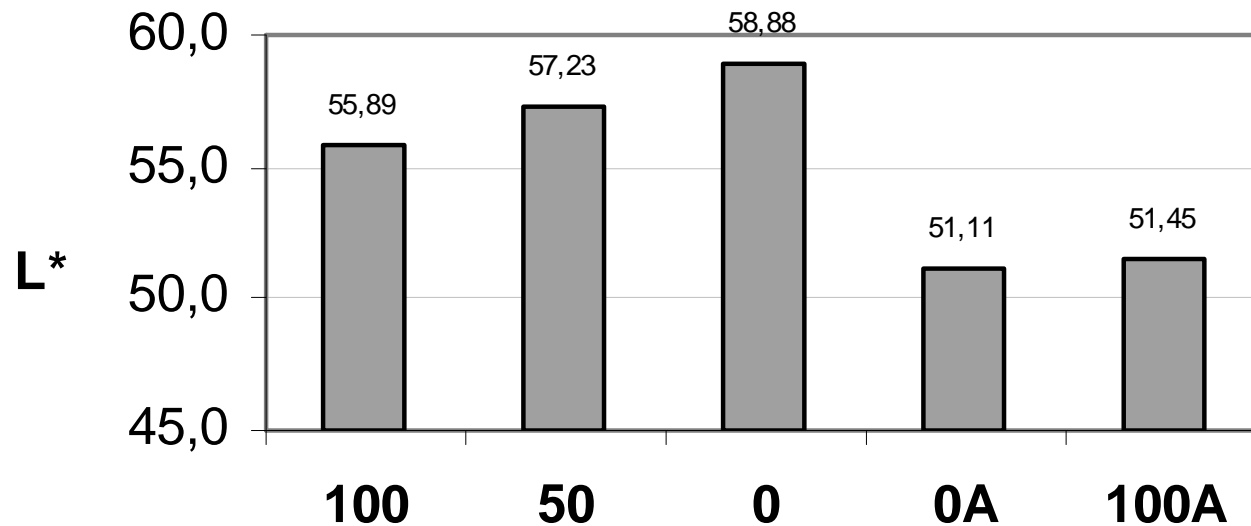
^aNumber of measurements

Colour coordinate values of the laboratory particleboards (3rd Phase)

		100	50	0	0A	100A
L* (Lightness)	mean	55,89	57,23	58,88	51,11	51,45
	max	57,04	57,97	60,76	51,77	52,48
	min	54,92	55,30	55,97	49,99	50,01
	(s)	0,5465	0,6548	1,1028	0,4754	0,4925
	n	24	24	24	24	24
a* (Redness)	mean	7,62	7,61	7,21	8,98	9,09
	max	8,36	8,56	8,30	9,93	9,81
	min	4,46	7,03	6,39	8,45	8,51
	(s)	0,7758	0,3888	0,5005	0,3929	0,3353
	n	24	24	24	24	24
b* (Yellowness)	mean	25,29	24,99	24,49	26,15	26,15
	max	26,24	25,77	26,02	27,41	27,21
	min	24,17	23,97	23,51	25,07	24,81
	(s)	0,6089	0,5238	0,5735	0,5780	0,5675
	n	24	24	24	24	24

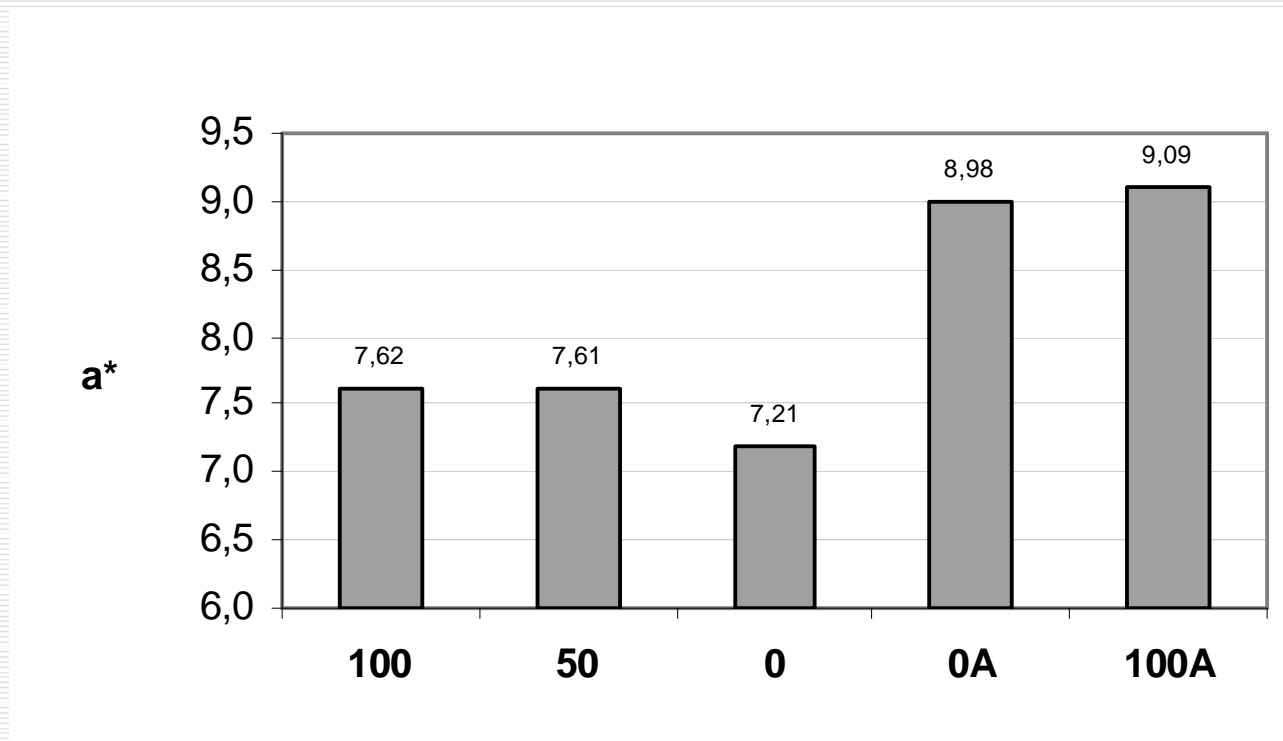
Effect of the recovered wood percentage and of the recycling on the lightness of the laboratory boards

(3rd Phase)



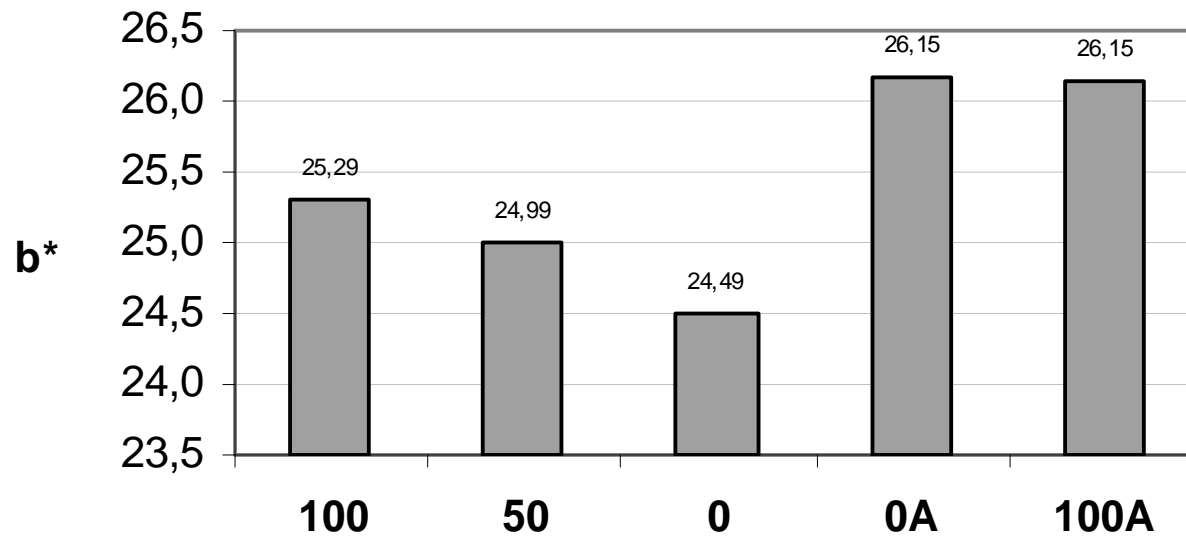
Effect of the recovered wood percentage and of the recycling on the redness of the laboratory boards

(3rd Phase)



Effect of the recovered wood percentage and of the recycling on the yellowness of the laboratory boards

(3rd Phase)



Colour differences of boards compared to control (type 0)

		0	50	100	0A
ΔE^*	mean	0,00	1,87	3,28	8,16
	n	24	24	24	24



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Not perceptible by the human eye

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ΔE^* mean	0,00	1,87	3,28	8,16
ΔE^* n	24	24	24	24



Perceptible by the human eye

Colour differences between the board types 100 and 100A

		100	100A
ΔE^*	mean	0,00	4,81
	n	24	24

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		100	100A
ΔE^*	mean	0,00	4,81
	n	24	24

Perceptible by the human eye

Conclusions (1/2)

Among the 7 hydrothermal recovery processes tested, the milder hydrothermal treatment parameters (water retention after impregnation of 60%, temperature of 110°C and duration of 30min) resulted in boards with the highest lightness as well as the lowest redness and yellowness values.

The application of the recovery parameters of 45%/ 150°C/ 10min, which was found to be the most advantageous regarding the properties of the recycled boards, caused to the boards the following colour alterations:



Conclusions (2/2)

Replacement of fresh wood particles at a rate of 50% by recovered particles did not cause to the boards colour differences perceptible by the human eye.

The recycling of particleboards made of recovered material as well as the recycling of particleboards made of fresh material resulted in perceptible by the human eye colour differences.



THANK YOU!
