



Field tests of wood preservative products for treatment against mould and sapstain fungi

April, 2016

Embar - National Association of Recovery and Recycling of Packaging and Wood Wastes

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Index

1	INTRODUCTION.....	3
2	MATERIAL AND METHODS	4
2.1	Wood.....	4
2.2	Products and treatments	5
2.2.1	Products.....	5
2.2.2	Tank	6
2.2.3	Treatments	6
2.3	Storage	7
2.4	Evaluation.....	8
2.5	Validity of the test	8
3	RESULTS.....	9
3.1	Solution uptake	9
3.2	Evaluation.....	9
4	ANNEXES.....	11

1 INTRODUCTION

Users of wood pallets and sawn wood for pallets and other packaging do not accept stained wood or wood with other signs of development of mould and sapstain fungi, particularly users of packaging of foodstuff products.

Since the 1980's that traditional wood preservative products, against mould and sapstain fungi, were very effective but had high toxicity. Those products, by European impositions¹ were gradually replaced by other products, less toxic and harmful for humans and animals and more "environmentally friendly".

Tests with wood preservative products have been performed in Portugal for over 20 years, in companies working with wood for pallets and other packaging, therefore existing history and experience in this kind of field tests.

Embar – National Association of Recovery and Recycling of Packaging and Wood Wastes was contacted by some members that revealed the need to test the efficacy of new formulations of wood preservative products, used against mould and sapstain fungi. Therefore, Embar contacted all the companies with authorization to "making available on the market" this kind of products in Portugal² and also other companies that sell this kind of products around the world. In total 7 companies were contacted and invited to participate in these trials, and of these only 3³ were interested in participating.

Embar decided that for the sector of wood packaging producers the results would be more relevant if performed in industrial context, with different manufacturing conditions and eventually in different seasons.

It was decided to start with winter trials and the treatments were performed on the 10th, 11th and 14th of December of 2015. The evaluation was performed 18 weeks later (about 4 months) after the treatments, on the 31st of March of 2016, at the company MADECA – Madeiras de Caxarias, Lda., located in Salvaterra de Magos, Portugal.

In these trials the evaluation was done to determine the differences of results using different products (and concentrations), on the treatment of maritime pine wood (*Pinus pinaster*) used to manufacture pallets.

Whenever possible the methodology prescribed in *Technical Specification CEN/TS 15082:2005 "Wood preservatives - Determination of the preventive effectiveness against*

¹ Regulation (EU) no 528/2012 of the European Parliament and of the Council, of 22 May 2012, concerning the making available on the market and use of biocidal products.

² Products in the list "*Produtos biocidas tipo 8 preservadores de madeira com autorização de colocação no mercado*" (type 8 biocidal products – wood preservatives with authorized market placement), Direção Geral de Alimentação e Veterinária (DGAV) responsibility. This list is available at www.dgv.min-agricultura.pt/

³ Information about the participating companies is in ANNEX IV.

sapstain fungi and mould fungi on freshly sawn timber – Field test” was followed, being necessary to make some adjustments.

The evaluation was performed by National Laboratory for Civil Engineering (LNEC), and this report is attached in ANNEX I. In ANNEX II are presented pictures with some examples of wood after the treatments. The information regarding the team who performed this work, of Embar’s responsibility, is in ANNEX III.

2 MATERIAL AND METHODS

2.1 Wood

Maritime pine (*Pinus pinaster*) boards and stickers were used, these test specimens of freshly sawn wood, as specified in CEN/TS 15082, are susceptible to attack by sapstain and mould fungi.

Boards

The boards used, of freshly sawn wood, were visually selected to build the stacks. This wood was free of degradation by biotic agents: insect’s attack, rotting and/or sapstain and mould fungi (Figure 1). Each board had approximately the following dimensions: 1m length x 0,1 m width x 0,015 m thickness.



Figure 1 Freshly sawn wood prepared for the treatments

Stickers

The stickers used were also of maritime pine wood, but already sawn. Each sticker had the following dimensions: 600 x 30 x 20 mm (approximately). All the stickers with signs of degradation by biotic agents or dirty were not used.

Stacks

Each stack, with a total of 144 boards – 6 width and 24 height – was organized in two parts (Figure 2):

- Open stacked: 72 boards separated with stickers - 6 width and 12 height;
- Close stacked: 72 boards in contact with one another - 6 width and 12 height.

The stacks were built immediately before each treatment, and after treatment they were coded, belted and stored (see section 2.3).



Figure 2 Stacks marked and belted after treatment

Samples for uptake calculation

Measurement and recording of the nominal dimensions of 20 boards from each stack, 10 from open stacked and 10 from the close stacked, before and after treatment, to determine mean surface area and solution uptake.

2.2 Products and treatments

2.2.1 Products

The products and concentrations tested are the ones presented in Table 1.

Table 1 List of tested products and concentrations tested

Product	Concentration (%)
<i>Antiblu Select 3787</i>	-
<i>Corpol Madera Verde</i>	2% and 4%
<i>Corpol Madera Verde Evolution</i>	3% and 4%
<i>F2530/2</i>	1% and 2% (w/w)
<i>Celbrite FS1</i>	10% and 15% (w/w)

Note: More information in ANNEX IV

Solutions preparation

The solutions were prepared in the treatment tank, with the introduction of 1000 litres of water and the amount of product calculated to achieve the concentrations established for these tests (Table 1). The solutions were mixed with a circulation pump inside the treatment tank.

When there were tests of more than one concentration of the same product, first was used the smaller concentration, and after it was added more product to increase the

concentration. In these cases it was assumed that there were non-significant losses of solution after treating one stack.

2.2.2 Tank

The treatment tank used⁴ had a forced immersion system and the following approximate dimensions:

- 2,3 m of length;
- 1,1 m of width;
- 0,7 m of height (the tank has 0,8 m of height, but the mechanism used to immerse the wood approximately 0,10 m in the bottom).

The amount of solution prepared, enough to guarantee the complete immersion of the wood, was of 0,43 m of height, inside the treatment tank, corresponding to 1000 litres of solution.

2.2.3 Treatments

The treatment was performed by immersion of the stacks in the treatment tank referred in 2.2.2. Considering by the height of solution in the tank the two parts of the stack (open and close) were treated separately:

- Open stacked – 1 minute immersion – division in two piles placed side by side, since in this case the 12 layers height exceeded the solution height, due to the stickers (Figure 3);
- Close stacked – 5 minute immersion (Figure 4).

After immersion the stacks were left to drain some of the excess of treatment solution. To further increase and quicken the removal of the excess of the solution not absorbed by the wood, the stacks were placed in the tank with a slight inclination (Figure 3).

There were nine treatments performed, one for each of the solutions referred in Table 1 (different product and concentrations), and one untreated stack.

⁴ Embar would like to thank *Arch Timber Protection, Ltd.* for the use of their test treatment tank.



Figure 3 Open stacked (with stickers) prepared for treatment



Figure 4 Close stacked prepared for treatment

Samples of the treatment solutions

Samples were collected (about 250 ml) of each treatment solution, before and after treatment, and were kept by Embar.

2.3 Storage

The 10 stacks were stored at the company facilities (Figure 5), in a location chosen for not presenting extreme conditions.

The meteorological conditions of the time between the treatments and storage were atypical, with higher temperatures than in previous winters. The winter climate of 2015/16 was characterized mainly with lower temperatures between 5-8 °C and higher temperatures between 10-14 °C, with frequent and intense rainy periods, and a month of February with the highest precipitation in the last previous years in Portugal.



Figure 5 Stacks in the storage location

2.4 Evaluation

The boards of each stack were separated in five groups – level of microorganism attack – as presented in Table 2.

Table 2 Grading system used

Rating	Description of coverage	Definition
0	0 %	Clean
1	< 10 %	Slight
2	10 % ≤ coverage < 25%	Medium
3	25 % ≤ coverage < 50%	Heavy
4	≥ 50%	Severe

Source: CEN/TS 15082

In each board only sapwood was evaluated, and in both sides of each board.

2.5 Validity of the test

Following the suggested in CEN/TS 15082 the results will be considered valid if the average classification of the untreated stack are equal or higher than the ones presented in Table 3.

Table 3 Validity requirements – Average results of the untreated stack

Treatment	Boards (close stacked)	Boards (open stacked)
Untreated	3,5	2,5

Source: CEN/TS 15082

3 RESULTS

3.1 Solution uptake

As already mentioned 20 boards of each one of the treated stacks were measured and weighted before and after treatment. The average results of the solution uptake for each solution are presented in Table 4.

Table 4 Average solutions uptake

Product and concentration	Average solution uptake (l/m ³)	
	Open stacked	Close stacked
<i>Antiblu Select 3787</i>	6,5	16,2
<i>Corpol Madera Verde (2%)</i>	4,5	8,7
<i>Corpol Madera Verde (4%)</i>	7,8	16,4
<i>Corpol Madera Verde Evolution (3%)</i>	7,0	23,1
<i>Corpol Madera Verde Evolution (4%)</i>	7,2	8,2
<i>F2530/2 (1%, w/w)</i>	7,7	5,4
<i>F2530/2 (2%, w/w)</i>	8,3	8,7
<i>Celbrite FS1 - F2415/3 (10%, w/w)</i>	9,4	13,0
<i>Celbrite FS1 - F2415/3 (15%, w/w)</i>	7,4	11,6

On the evaluation date, approximately 4 months after treatment, the same boards were weighed to determine the water content, considering the initial weight, final weight and estimation of the water free weight (results in Table 5).

Table 5 Test specimens average water content – initial and final

Solution	Initial water content (%)	Final water content (%)	
		Open	Closed
<i>Antiblu</i>	101	16	101
<i>Corpol MaderaVerde (2%)</i>	88	19	83
<i>Corpol MaderaVerde (4%)</i>	80	18	74
<i>Corpol MaderaVerde Evolution (3%)</i>	94	16	65
<i>Corpol MaderaVerde Evolution (4%)</i>	104	18	90
<i>F2530/2 (1%, p/p)</i>	93	17	70
<i>F2530/2 (2%, p/p)</i>	79	18	75
<i>Celbrite FS1 - F2415/3 (10%, p/p)</i>	75	16	70
<i>Celbrite FS1 - F2415/3 (15%, p/p)</i>	91	16	80

3.2 Evaluation

Evaluation was performed 18 weeks after the treatments (approximately 4 months). The boards were graded, except the top and bottom layers of each stack (in total there were graded 132 boards/stack). Results of the average grading for each solution are presented in Table 6.

Table 6 Average grading (and standard deviation) of the test specimens, for each tested solution (18 weeks after treatment)

Solution	Stacking method	Average grading
<i>Antiblu Select 3787</i>	Open	1,33 (0,62)
	Closed	3,18 (0,98)
<i>Corpol Madera Verde (2%)</i>	Open	0,94 (0,60)
	Closed	2,06 (1,21)
<i>Corpol Madera Verde (4%)</i>	Open	1,06 (0,46)
	Closed	1,24 (1,23)
<i>Corpol Madera Verde Evolution (3%)</i>	Open	0,83 (0,51)
	Closed	2,26 (1,15)
<i>Corpol Madera Verde Evolution (4%)</i>	Open	1,27 (0,92)
	Closed	1,73 (1,10)
<i>F2530/2 (1%, p/p)</i>	Open	1,30 (0,72)
	Closed	2,91 (1,17)
<i>F2530/2 (2%, p/p)</i>	Open	1,62 (1,24)
	Closed	2,50 (1,06)
<i>Celbrite FS1 - F2415/3 (10%, p/p)</i>	Open	1,95 (1,35)
	Closed	3,03 (1,05)
<i>Celbrite FS1 -F2415/3 (15%, p/p)</i>	Open	2,08 (1,24)
	Closed	3,68 (0,61)
<i>Untreated</i>	Open	3,95 (0,21)
	Closed	4,00 (0,00)

As previously mentioned there is a copy of the full test report of National Laboratory for Civil Engineering (LNEC) in ANNEX I.

4 ANNEXES

ANNEX I – LNEC Test Report



LABORATÓRIO NACIONAL DE ENGENHARIA CIVIL

LNEC-EM Testing and Metrology

UPB - Biodegradation Prevention Laboratory

TEST REPORT

Report no. 004UPB2016

Pp. 1/8

File no. 0302/1301/3547

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Diretor do Departamento de Estruturas

MONITORING OF A FIELD TEST OF ANTI-SAPSTAIN FORMULATIONS

1 | Identification

Client: Embar - Associação Nacional de Recuperação e Reciclagem de Embalagens e Resíduos de Madeira
Date of monitoring: 2016-03-31
Field test started: 2015-12-10

2 | Introduction

The field test of anti-sapstain formulations for freshly sawn maritime pine (*Pinus pinaster* Ait.) was ongoing at a sawmill (Madeca) located in Salvaterra de Magos. LNEC was not involved in the treatment phase of the trial that took place on the 10th of December of 2015.

For each formulation under test, 132 boards were packed (half open-stacked and half closed-stacked) treated and exposed to the weather without protection. This report refers to the grading conducted, 18 weeks after treatment, on the 31st March 2016 of the packs described in Table 1.

Table 1: Packs graded on the 31st March 2016 after 18 weeks of exposure

Product	Concentration
Antiblu Select 3787	'A' 1.0%+'B'0.6%
Corpol Madera Verde	2%; 4%
Corpol Madera Verde Evolución	3%; 4%
Celbrite F2415/3	10%; 15% (w/w)
F2530/2	1%; 2% (w/w)
No treatment	-

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Report no. 004UPB2016
Pp. 2/8
File no. 0302/1301/3547
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The test specimens were classified using the grading method described in CEN/TS 15082 (2005) "Wood preservatives - Determination of the preventive effectiveness against sapstain fungi and mould fungi on freshly sawn timber - Field test". The top and bottom layers were not considered in the assessment. The grading classes considered were therefore: 0 = clean (0%); 1 = slight (<10%); 2 = medium (10 -25%); 3 = heavy (25 - 50%); 4 = severe (> 50%).

2.1 Results of monitoring

The following figure 1 presents all grading values obtained and the averages results are summarized in table 2. The wood moisture content was also randomly monitored both in open and close-stacked test specimens and the average of three measures is also presented in table 2.

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UPB - Biodegradation Prevention Laboratory

Report no. 004UPB2016

Pp. 3/8

File no. 0302/1301/3547

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Table 2. Average (and standard deviation) classification rating and average wood moisture content (%) of the tests specimens of each formulation treatment and stacking method.

Products	Time of exposure	Stacking method	Average grading	Average wood moisture content (%)
Antiblu Select 3787	18 weeks	Open-stacked	1.33 (0.62)	19.8
		Close-stacked	3.18 (0.98)	75.0
Corpol Madera Verde 2%	18 weeks	Open-stacked	0.94 (0.60)	20.1
		Close-stacked	2.06 (1.21)	69.4
Corpol Madera Verde 4%	18 weeks	Open-stacked	1.06 (0.46)	19.8
		Close-stacked	1.24 (1.23)	63.1
Corpol Madera Verde Evolución 3%	18 weeks	Open-stacked	0.83 (0.51)	20.0
		Close-stacked	2.26 (1.15)	70.0
Corpol Madera Verde Evolución 4%	18 weeks	Open-stacked	1.27 (0.92)	20.1
		Close-stacked	1.73 (1.10)	73.3
Celbrite F2415/3 10% (w/w)	18 weeks	Open-stacked	1.95 (1.35)	21.4
		Close-stacked	3.03 (1.05)	73.4
Celbrite F2415/3 15% (w/w)	18 weeks	Open-stacked	2.08 (1.24)	22.9
		Close-stacked	3.68 (0.61)	75.9
F2530/2 1% (w/w)	18 weeks	Open-stacked	1.30 (0.72)	19.4
		Close-stacked	2.91 (1.17)	69.3
F2530/2 2% (w/w)	18 weeks	Open-stacked	1.62 (1.24)	19.6
		Close-stacked	2.50 (1.06)	64.8
No treatment	18 weeks	Open-stacked	3.95 (0.21)	20.8
		Close-stacked	4.00 (0.00)	78.4

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Report no. 004UPB2016

Pp. 4/8

File no. 0302/1301/3547

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Antiblu Select 3787							Corpol Madera Verde 2%							Corpol Madera Verde 4%						
Open-stacked	2	2	2	3	3	1	3	1	1	3	1	1	1	1	2	1	1	1		
	1	1	2	1	1	2	1	1	1	1	2	1	2	2	2	1	1			
	3	1	1	2	3	1	1	1	2	1	1	2	1	2	1	1	1			
	1	1	1	2	1	1	1	1	1	2	1	1	1	2	1	1	1			
	1	1	1	1	1	1	1	0	0	1	1	0	1	1	1	1	1			
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
	1	1	1	1	1	1	0	1	1	0	1	1	1	1	1	2	1			
	2	2	3	2	1	1	0	1	0	1	1	1	1	1	0	1	0			
	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	1			
	1	2	1	1	1	1	1	0	0	1	1	0	1	0	1	1	1			
Closed-stacked	2	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	0		
	4	3	3	4	4	1	1	2	2	1	1	2	3	2	2	2	2	1		
	4	3	4	4	4	4	1	3	4	3	0	2	3	2	1	1	0	0		
	4	4	3	3	4	2	1	4	4	2	1	1	0	1	1	0	0	1		
	4	3	3	2	3	4	2	4	4	4	1	1	0	0	0	0	0	1		
	4	1	3	1	3	3	1	4	2	4	2	0	3	1	0	2	0	1		
	4	2	2	2	4	3	2	4	3	4	3	1	2	0	1	0	0	1		
	4	4	2	2	4	4	2	1	4	1	2	1	1	0	0	0	0	1		
	3	4	2	3	3	4	3	3	3	1	1	1	3	1	0	1	0	1		
	4	4	2	2	4	4	2	4	2	1	3	1	3	2	1	0	1	1		
Corpol Madera Verde Ev. 3%							Corpol Madera Verde Ev. 4%							No treatment						
Open-stacked	1	1	1	1	1	1	3	1	2	2	3	4	4	4	4	4	3			
	1	2	1	2	1	0	2	3	3	3	3	2	4	4	4	4	4			
	1	1	1	1	1	2	1	1	1	3	1	1	4	4	4	4	4			
	1	1	1	1	1	1	1	1	1	1	1	0	4	4	4	4	4			
	1	1	1	1	0	1	1	1	1	1	0	0	4	4	4	4	4			
	1	1	1	1	0	1	1	0	1	1	1	1	4	4	4	4	3			
	1	1	1	1	0	1	1	1	1	1	0	1	4	4	4	4	4			
	1	2	1	0	1	1	1	1	2	1	1	1	4	4	4	4	4			
	0	0	1	1	0	1	1	1	3	3	2	1	4	4	4	4	4			
	0	1	0	1	0	1	1	1	1	1	1	0	3	4	4	4	4			
Closed-stacked	1	0	0	1	0	0	0	1	0	1	1	0	4	4	4	4	4			
	3	4	1	3	3	3	2	3	3	3	4	3	4	4	4	4	4			
	1	2	2	3	1	2	2	1	1	1	3	4	4	4	4	4	4			
	1	1	2	2	4	3	3	1	2	1	1	1	4	4	4	4	4			
	2	0	1	4	3	3	2	1	1	1	0	1	4	4	4	4	4			
	1	1	1	3	1	0	2	1	2	2	1	1	4	4	4	4	4			
	1	1	2	2	1	2	3	1	1	1	0	1	4	4	4	4	4			
	2	1	3	1	2	1	1	1	1	1	1	2	4	4	4	4	4			
	3	1	2	3	2	3	2	3	1	1	1	0	4	4	4	4	4			
	3	1	3	3	4	4	4	4	4	1	1	1	2	4	4	4	4			

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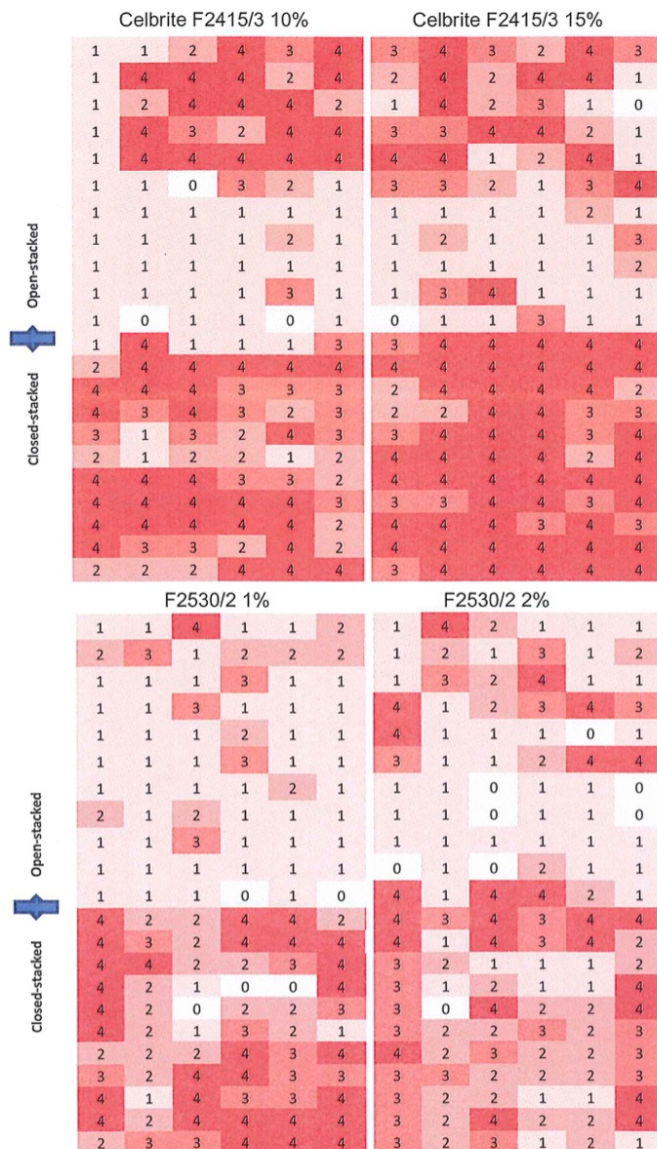


Fig. 1 – Grading of the test specimens for each formulation monitored.

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Pp. 6/8

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Antibu Select 3787



Corpol Madera Verde 2%



Corpol Madera Verde 4%



Corpol Madera Verde Ev. 3%



Corpol Madera Verde Ev. 4%



No treatment



Celbrite F2415 10%



Celbrite F2415 15%



F2530 1%



F2530 2%

Fig. 3 – Aspect of the open-stacked boards of the formulations graded

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TEST REPORT

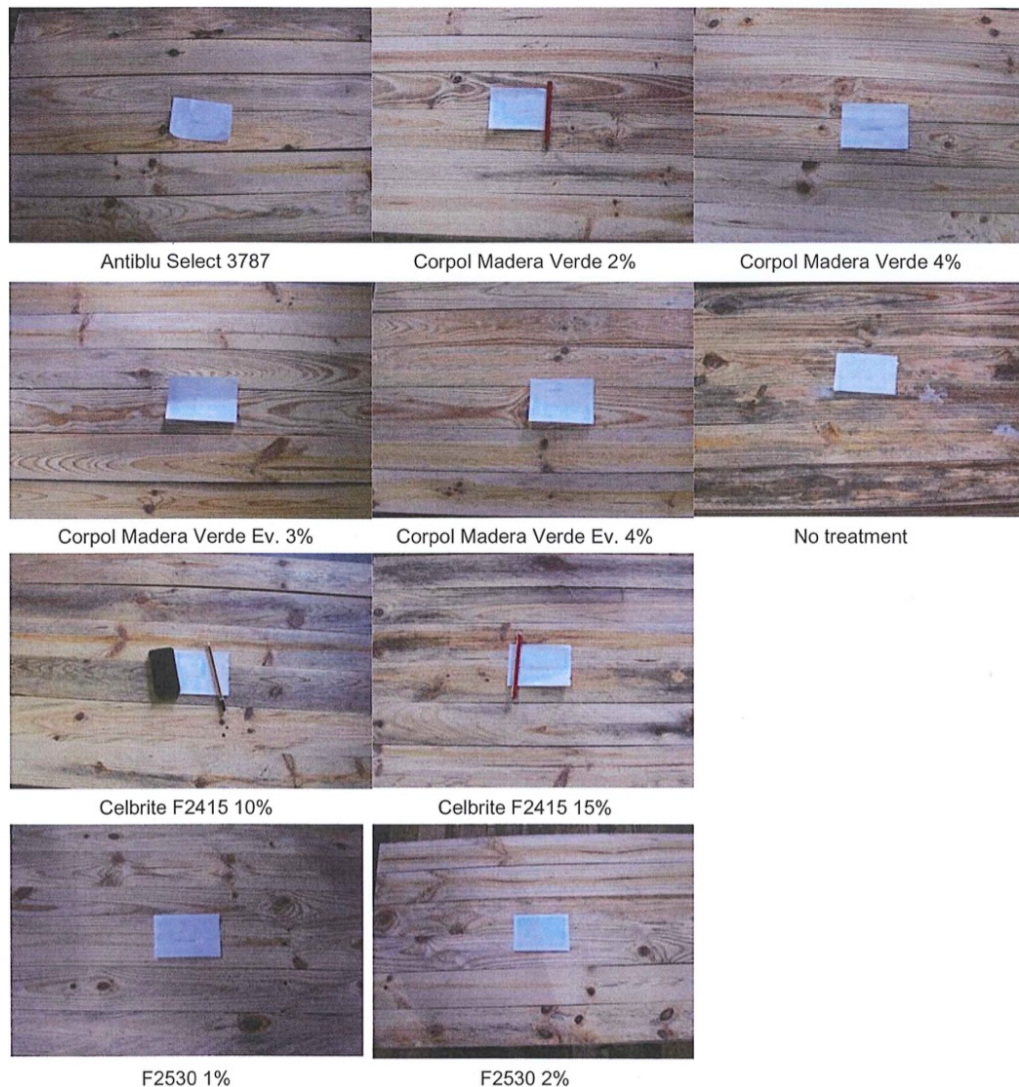


Fig. 4 – Aspect of the close-stacked boards of the formulations graded

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LNEC-2042



LABORATÓRIO NACIONAL DE ENGENHARIA CIVIL

LNEC-EM Testing and Metrology

UPB - Biodegradation Prevention Laboratory

TEST REPORT

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Signature

José Manuel Catarino
Diretor do Departamento de Estruturas

Colaboração

Sónia Duarte, Marta Duarte

Lisbon, LNEC, 18th April of 2016

O TÉCNICO RESPONSÁVEL

Lina Nunes

O COORDENADOR DA UPB

Lina Nunes

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ANNEX II - Pictures

Visual examples of wood after the treatments, in addition to the evaluation performed by LNEC.



Figure 6 Samples of the untreated wood – close stacked – Grading: 4



Figure 7 Samples of the untreated wood – open stacked - Grading: 3,95



Figure 8 Samples of wood treated with the solution Antiblu Select 3787, close stacked – Grading: 3,18



Figura 1 Samples of wood treated with the solution Antiblu Select 3787, open stacked – Grading: 1,33



Figure 9 Samples of wood treated with the solution Corpol Madera Verde (4%), close stacked – Grading: 1,24



Figure 10 Samples of wood treated with the solution Corpol Madera Verde (4%), open stacked – Grading: 1,06



Figure 11 Samples of wood treated with the solution Celbrite FS1 (10%), close stacked – Grading: 3,03



Figure 12 Samples of wood treated with the solution Celbrite FS1 (10%) open stacked – Grading: 1,95



Figure 13 Samples of wood treated with the solution Celbrite FS1 (15%), close stacked – Grading: 3,68



Figure 14 Samples of wood treated with the solution Celbrite FS1 (15%), open stacked – Grading: 2,08



Figura 2 Samples of wood treated with the solution F 2530/2 (2%), closed stacked – Grading: 2,50



Figura 3 Samples of wood treated with the solution F 2530/2 (2%), open stacked – Grading: 1,62



Figura 4 Samples of wood treated with the solution F 2530/2 (1%), close stacked – Grading: 2,91



Figura 5 Samples of wood treated with the solution F 2530/2 (1%), open stacked – Grading: 1,30

ANNEX III

Filipa Pico – EMBAR (and coordination)

José António Santos – Consultant

Evaluation

Lina Nunes, Sónia Duarte and Marta Duarte – National Laboratory for Civil Engineering (LNEC) - <http://www.lnec.pt/en/>

Observers

Representatives from the companies testing products.

Incompatibility declaration

The responsible for the treatments, assembling the stack and accompanying all the interventions, Filipa Pico and José Santos, declare they do not have any incompatibility in what concerns impartiality towards the different products, not having any commercial relationship, of dependence or any other with the companies testing their products and/or their representatives.

ANNEX IV

Table 7 List of tested products and companies

Product	Company
<i>Antiblu Select 3787</i>	Arch Timber Protection, Ltd.
<i>Corpol Madera Verde</i>	Quimunsa, S.A.
<i>Corpol Madera Verde Evolution</i>	Quimunsa, S.A.
<i>F2530/2</i>	Osmose / Koppers
<i>Celbrite FS1 - F2415/3</i>	Osmose / Koppers