[Enhancing wood durability and physical properties through innovative bio-based sustainable treatments (BioCoPol)]

COMPLEMENTARY REPORT

Title of the research project	**[Enhancing wood durability and physical properties through innovative bio-based sustainable treatments]**
Coordinator of the project	[Dr. Marion Noël]

BASIC PROJECT DATA

Project period	[31.07.2017-30.11.2017]
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URL of the project	http://[web address]

FUNDING

Total budget in EUR	[€ 728'505.-]
Public funding from WoodWisdom-Net Research Programme:	Total funding granted in EUR by source:
<u>Austria</u> Federal Ministry of Agriculture, Forestry, Environment & Water Management (BMLFUW)	[€ 182'850.-]
<u>France</u> French Environment and Energy Management Agency (ADEME)	[€ 135'030.-]
<u>Switzerland</u> The Commission for Technology and Innovation (KTI; in the Federal Department of Economic Affairs FDEA)	[€ 182'830.- = CHF 195'616.-]

PROJECT TEAM (main participants)

Name, degree, job title	Sex (M/F)	Organization	Country
P. Corbat, Director	M	Corbat Holding SA	Switzerland
E. Fredon, PhD, Assistant professor	M	Lorraine University (LERMaB)	France
P. Gérardin, PhD, Professor	M	Lorraine University (LERMaB)	France
C. Grosse, MSc., PhD candidate	F	Lorraine University / BFH AHB	France / Switzerland
C. L'Hostis, MSc., PhD candidate	M	Lorraine University (LERMaB)	France
M. Noël, PhD, Scientific collaborator	F	BFH-AHB	Switzerland
R. Schober, Director	M	Pongauer Jägerzaun	Austria
M.-F. Thévenon, PhD, Sc. collaborator	F	CIRAD (BioWooEB)	France
G. Tondi, PhD, Scientific collaborator	M	SUAS - Kuchl	Austria

DEGREES (if relevant)
Degrees earned or to be earned within this project.

Year	Degree	Sex (M/F)	Name, year of birth and year of earning M.Sc., D.Sc., etc. Degree	University	Supervisor of thesis, supervisor's organization
[2018]	[PhD]	[F]	[C. Grosse, 1990 MSc. 2015]	[Lorraine University]	[P. Gérardin, M. Noël, Lorraine University]
[2017]	[PhD]	[M]	[C. L'Hostis, 1990 M.Sc. 2014]	[Lorraine University]	[P. Gérardin, M.-F. Thévenon, Lorraine University]
[2017]	[MSc]	[F]	[A. Oberle, 1991 BSc. 2015]	[SUAS]	[G.Tondi, SUAS]
[2017]	[BSc]	[M]	[D. Bartosch, 1991]	[SUAS]	[G.Tondi, SUAS]

[2017]	[BSc]	[M]	[R. Waschak, 1957]	[SUAS]	[G.Tondi, SUAS]
[2016]	[MSc]	[M]	[P. Luckeneder, 1990 BSc. 2014]	[SUAS]	[G.Tondi, SUAS]
[2016]	[MSc]	[M]	[J. Gavino, 1992 BSc. 2014]	[SUAS]	[G.Tondi, SUAS]

PROJECT COMPLEMENTARY REPORT

A summary of the project, preferably one page only

[Because many activities were still running at the official end date of BioCoPol, as the PhD thesis of two candidates and the up-scaling of the best treatments to pilot scale, an extension was granted by several funding agencies until end of November.
These additional 3 months allowed the conception and development of an impregnation chamber to be installed and used at the BFH in Biel (CH), and to carry out several heat treatments in Corbat's industrial thermo-treatment chamber.

The impregnation chamber was conceived to allow the impregnation of several railway sleepers together. The stainless steel container manufacture has been subcontracted. It is linked to the vacuum pump of the BFH autoclave and equipped with a filtering cycle.
Lactic acid (85%) was kindly provided by the company Jungbunzlauer (200 kg) and used with no further modification, except dilution in water for some variants (66%).
Beech and oak railway sleepers and beech and ash wood pieces (square-edged) were kindly provided by the company Corbat.

The impregnation observation is reported in Table 1 below:

Table 1: impregnation physical observation

Sample	Impregnation product	IY[2] [%]	IY_{LA}[3] [%]
1_Beech railway sleeper, drilled	LA[1] 85%	29.5	25.1
2_Beech railway sleeper, raw	LA 66%	58.2	38.4
3_Oak railway sleeper, drilled	LA 85%	17.2	12.4
4_Oak railway sleeper, raw	LA 85%	27.6	19.5
5_Beech, raw square edged piece	LA 66%	52.8	30.3
6_Beech, raw square edged piece	LA 66%	46.8	26.9
7_Ash, raw square edged piece	LA 66%	11.4	4.3
8_Ash, raw square edged piece	LA 66%	2.7	1.3

[1] LA = lactic acid
[2] IY = impregnation yield
[3] IY_{LA} = impregnation yield of lactic acid (dry basis)

Independently of the species considered, a significant impregnation yield is achieved for such large pieces.

So far, two railway sleepers (1 and 2) could be heat treated in the industrial equipment. The cycle was set up as similar as possible as the lab treatment (48h of dry heat at 160°C). The main difference consisted in a constant relative humidity in the chamber of 50%. No emission was noticed in the chamber from the treated wood (not different from usual thermo-treated wood cycles). Despite a homogeneous impregnation, the heat treatment revealed to be mostly inducing the reaction on wood envelop (4 to 5 cm deep), observed by the colour change. For that reason, lactic acid dilution from 85% to 66% was carried out for the impregnation of additional samples (table 1). Besides, sleepers came out of the chamber significantly cracked (to be noticed: all sleepers were initially very cracked before impregnation and treatment) but still solid. The stiffness expected and noticed might be at least partially avoided by a thermo-treatment under slightly humid conditions. This will be the next treatment to be carried out at the company Corbat, as soon as the chamber is again available. The best sleeper to be obtained in this treatment series will be exposed in ground contact at Corbat's site to evaluate durability.

The pictures below show some insight of this project important step:

Figure 1: impregnation installation at the BFH labs

Figure 2: oak sleeper soaked into lactic acid

Figure 3: sleepers before impregnation

Figure 4: sleeper before impregnation

Figure 5: impregnated sleepers before (left) and after (right) thermo-treatment]

1.3 Complementary conclusions

The most important contributions to the state-of-the-art, derived from the results and discussion.

[This final step was necessary to evaluate the extent of the remaining challenges to be overcome to get to a sustainable industrial solution. Lactic acid impregnation revealed to be easily feasible, as expected, even if the conception of an industrial scale chamber seems unavoidable when the treatment goes to industrialization, because of the product specificities. However, the thermo-treatment atmosphere (in particular the relative humidity in the chamber) confirmed to be the tricky part on large wood pieces. Railway wood sleepers are usually not machined after creosote impregnation, whereas the deformation induced by lactic acid treatment will make that compulsory. For that reason, among others (like economic viability), the impulse should be given in the next months on the adaptation of the treatment for outdoor furniture, terrasses or façades, within the frame of a nationally funded project started last August.]

1.4a Complementary capabilities generated by the project

Knowledge generated in the project / outcomes of the project, such as unpublished doctoral theses, patents and patent applications, computer programs, prototypes, new processes and practices; established new businesses; potential to create new business opportunities in the sector.

[The impregnation chamber described above, that will be used for many other developments running at the BFH.]

1.4b Complementary utilisation of results

Give a brief description of how the results of the research and development have been used and/or what is the exploitation plan or plans for transferring the results into practice.

[Additional results presented in this complementary report will be very beneficial to the new project mentioned above.]