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I-PAN

INNOVATIVE POPLAR LOW DENSITY STRUCTURAL PANEL

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D8.3 /1- SET UP OF THE PREPILOT PLANT AND FUNCTIONING REPORT

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Document information

Abstract

The IPAN project is drawing to a successful conclusion in technical, environmental and economic terms. The techniques applied will enable the partners to open new lines of business and to improve existing plants in terms of efficiency and environmental impact.
The implementation of the components comprising the prototype line on the IBL line has confirmed, in the experimental stages, the project targets as well as the introduction of a new type of sustainable board produced with "greener" and more environmental friendly techniques will enable the partners to take part in the 'go green' conversion of current wood based panel manufacturing processes.

Keywords

Nozzles, distribution, blender, optical system, forming, LSB

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* Abbreviations of editor/contributor name

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LIST OF ABBREVIATIONS AND DEFINITIONS

DM	Deliverables Manager
DoW	Description of Work
EC	European Commission
PM	Project Manager
PMQP	Project Management and Quality Plan
PMB	Project Management Board
PR	Peer reviewer
TMB	Technical Management Board
QM	Quality Manager
WP	Work Package
OSB	Oriented strand board

INTRODUCTION

IBL is an industrial facility for the manufacture of OSB panels where it has been possible for the partners to experiment innovative solutions to make improvements to the OSB panel production process due to the fact that IBL is a partner in the IPAN project.

Parts of equipment and machinery have been implemented within the existing plant to verify correct operation in terms of efficiency, affordability and environmental impact.

Some parts have been designed from scratch without adding the relative cost to the project, whereas some other parts were studied for further adaptation.

The combination of the OSB production plant and the modifications effected, and the choices made in terms of the resins used and the control software/hardware, have all enabled the IPAN project group to make their own choices and propose innovative OSB/LSB lines.

A lot of areas have been improved on in the existing line to obtain economic advantages on the market and to give the IPAN project partners the possibility of having a real plant that possesses some industrial research options aimed at motivating potential sales in the near future.

The techniques applied and the solutions adopted will be optimised to achieve an economical and flexible system and which, above all, is environmental friendly.

The introduction of specific solutions within the project, for example the correct angle of the strander blades or the algorithms used for processing the images of the strands as they travel through the process, and others, are the strong points of the project which, after a couple of service visits to the IBL line, have led us to believe that the prototype line will be converted into a real production line in the very near future.

On completion of all the necessary activities, the I-PAN partners set up the construction of some parts of the pre-pilot plant at the IBL premises in Monferrato Coniolo (AL), Italy installing the parts required on a production line. Such a demonstrator is a pre-industrial scale pilot plant designed and constructed on the basis of present technologies already available from partners enhanced with innovative I-PAN features. It includes data management, with a simulated integration with logistics companies. These components of the pilot line also take into account all rules and recommendations in terms of safety to ensure compliance with national and EU legislation.

IBL provided the plant to demonstrate the I-PAN process and outputs for the installation of the components for the pilot line on its own production line; STELA provided and set up the dryer system prototype they had designed; IDP provided and set up the belt conveyor and control system designed and set up the technologies for surface treatments as the final step within the mat forming process; CHIMAR participated by producing and providing the quantity innovative resin required to run the demo-trial and by assisting in the application of the resin during the demo-trial. The best performing resin system identified was chosen for the demo-trial. CHIMAR prepared a cost analysis for the best performing resin selected and UNIMI and ECS have designed a new system to monitor strand thickness and deviation from the orientation established during the mat forming process.

1 THE PILOT LINE

IBL has designed its own production line specifically for the production of OSB panels. Innovative solutions have been experimented on this OSB panel production line by IMAL, IBL, UNIMI, ECSC, IDP, CHIMAR and CIAOTECH each in relation to its own field of business, to improve the process and to produce a board from poplar wood only, utilizing the top part of the poplar tree and the poplar waste of the process as well which was previously destined for other uses.

The following modifications have been made and installed with respect to a standard OSB board production line:

Partner	Activities	Notes
Imal	Modification to the flaker knives to adapt them to flaking poplar wood	Activity reported in the costs Items not purchased as these were made available by IBL
	Design and construction of innovative forming equipment	Cost for materials not listed in the project, only design and study
	Introduction of high-pressure resination technology – HPRS project-life2013-000307- [1]	Part of costs for materials not listed in the project, only design and study
	Design of a hardware system that is able to implement the software designed by UNIMI and ECSC for the analysis	Cost listed in the project due to the experimental nature of the activity
	Analysis of the plant, of the requirements and of the preparation of the parts to be implemented within the line as the pilot line	Activity cost listed
	Insertion of a rotary chute	Item cost listed
	Production and testing of OSB and LSB panel	Activity completed and application deposited for two patents: MO2014A000285- MO2014A000286 New, cheaper product with a lower impact with respect to plywood- patent.

partner	Activities	Notes
CHIMAR	Preparation of natural resins to verify board quality with the application of green resins	Activity cost listed
STELA	Introduced a belt dryer, adapted to the project more sustainable than those on the market	Cost for material not listed in the project, only design and study
IDP	Technical support for the conveyors and fine layer forming station	Cost for material not listed in the project, only design and study
UNIMI	Design of the software with cameras for controlling strand orientation and dimensions	Items cost listed by IMAL, part of the pilot line Activity cost listed
ECSC	Support with the development of the control software with cameras for strand dimensions and orientation	Activity cost listed
IBL	Support with the definition of the layouts and locations for the parts of the pilot line. Preparation of the supporting structures of the parts inserted and support with the LCA analysis. Research on poplar I.214 clone	Activity cost listed
CIAOTECH	Dissemination and LCA	Activity cost listed

1.1 THE PRE PILOT LINE

Generally the value of the equipment alone for an OSB production plant is over 30 M€ and hence it is difficult to reproduce it to conduct research to improve the work process unless a panel manufacturer is actually involved in the project. The IPAN project stems from the idea to innovate some aspects of the OSB panel production process within a freshly constructed productive reality – IBL – and launch a new, more ecological panel on the market [using both the trunk and the top part of the poplar tree, a part which is generally used for other purposes or burnt, and applying resins with low formaldehyde content] and introduce some novelties into the process:

- Improve the strand cutting process
- Reduce the environmental impact of the dryer and ensure that the strands do not break during the drying process or as they go through the work process in general

- Introduce innovative logic to form a layer of wood dust on the mat to produce a new type of board [LSB]
- Introduce specific algorithms to monitor/control strand dimensions, flaker knife wear and deviation with respect to ideal flake orientation when producing the mat

1.2 PROTOTYPE PARAMETERS

The parameters for the production process are always defined on field, starting from a range of standard values in relation to the work process [raw material at infeed, type of board required, technology applied [continuous or single-opening press,…]. In the case of the IPAN project, some technical solutions have been implemented within the actual IBL plant and equipment which have been configured with their own work process parameters.

The parameters for line speed, temperature, moisture content, pressure,… throughout the various steps of the process have been measured on field and agreed on and shared with IBL for a better understanding of their impact on the end product.

1.3 METHODS

As in nearly all the plants, where the partners are involved with the definition of their own production parameters, a series of tests and trials has also been implemented in conjunction with IBL on their OSB production line from poplar wood to configure the process parameters step by step.

1.4 FINE-TUNING AND WORK PROCESS TECHNIQUES

With the remote assistance link up application, [the production process is monitored step by step from Modena] and since IBL is highly skilled in the process, the fine tuning process for the parameters, which is still ongoing, has been carried out and implemented by IBL through the assistance of an IMAL technician linked up remotely.

The development of the on line technology has greatly reduced the need for technicians to travel to fine-tune the process parameters, which have been processed accordingly since these are required for the subsequent industrialization process.

2 PARTICULAR ASPECTS OF THE PILOT LINE

The control software implemented with new solutions and inserted on the IBL line has been adapted to the requirements of the existing line and likewise, the new optical systems have been connected in a safe manner to the existing ones.

We shall now analyse the various areas of the plant where design modifications have been made or equipment and/or components have been added to reach the targets set for the project.

2.1 FORMING THE LSB BOARD

As highlighted in Deliverable 7.3, the mat forming process has been adapted to produce the LSB board and modifications have been made upstream as well to achieve, through innovative technical solutions, a blending process which will not ruin the strands in any way

Fig. 1 forming of the wood dust layer for the production of the LSB panel

LSB production

Fig.2 LSB panel

2.2 STRAND CONTROL SOFTWARE

The software controlling strand breakage, dimensions and orientation as it goes into operation, should ensure a continuous feedback on the process to save natural and technical resources within the production process - Deliverables 6.2 – 6-3 -

The vision system performs real-time monitoring to analyse the blending effects on the strands. Both two-dimensional and three-dimensional setups are employed to study and prevent possible strand damage, which, in turn, can result in a better use of the resources and raw materials and to obtain a lighter and less expensive panel.

The main goal of the system designed is to study the granulometry, i.e., the particle size distribution, of the wood strands employed in the production of OSB panels. This study is important since the size of the strand is directly related to the quantity of resin necessary to produce the final panel.

It is necessary to estimate the dimensions of the strands before they enter the blending process and after they have been sprayed with resin. During the development of the project, the two dimensions that emerged as more important were length and width. Hence, the systems have been optimized accordingly to achieve good performance. In addition, some techniques based on 3D-reconstruction have been applied to provide an estimation of the variation trend in strand thickness.

We have introduced two acquisition setups and developed three methods to perform a real-time monitoring that controls the blending effects on the strands and helps estimate the optimal amount of resin.

The first acquisition method is based on a two-view acquisition setup that obtains 3-D images from free-falling strands. This setup is designed to be used before the wood strands start the blending process. In addition, a method that analyses the 3-D images and performs a granulometric analysis of the strands is proposed.

The second acquisition setup obtains the images from a top view of the conveyor belt. This setup has been designed to be used after the wood strands have gone through the blending process. Two methods have been developed to analyse the images produced using this setup. The first one uses an optimized segmentation method to perform a granulometric analysis of the strands present on the surface of the mat. The second one performs a qualitative analysis of the strands, by studying the Fourier transform of the image.

It is possible to monitor the process continually with these systems and, it is believed after approximately 10 installations, this could complete the case studies of the problems.

3 SET UP AND OPERATION OF THE PROTOTYPE LINE

As illustrated in earlier sections, some processes derive from solutions applied on field thus enabling each partner, even at this early stage, to proceed with the relative industrialization, in relation to its field of business.

The parts of the prototype line implemented within the IBL line were put into operation in steps with positive results as illustrated.

STRANDER

The conveying system towards the knives has been optimised and knife angle has been studied to achieve strand thickness within the range of the desired dimensions and to prevent breakage.

Fig.3 loading the poplar logs

Producing strands of the desired dimensions, especially thickness, to achieve better properties with the same amount of wood, has led to an improvement in existing technology and has widened the technical knowledge on blade behaviour with respect to the type of material fed into the work process [different diameters]. This knowledge has been utilized to support UNIMI and ESC with the development of the strand [flake] thickness control software and for strand orientation.

The strander produces strands [flakes] which are automatically conveyed to the dryer. This passage is critical as the strands need to be kept intact.

Fig.4 Strands after the drying process

MAT FORMING

The forming of the various mat layers [three for OSB and 5 for LSB] is essential to give the board the desired technical properties.

The forming of the layers, or rather, laying the strands [flakes] on the travelling surface, is a delicate stage as it is necessary to dose the quantity required, make sure they do not break, and make sure they are kept in the right direction when forming the mat [a mat for example, is over two metres wide]

Fig. 5 forming a mat layer

Mat compression is a known mechanical process which is used to compress the material and to render the surfaces at press infeed more compact and hence accelerate board cure times

Fig 6 Levelling and compressing the two outer layers for the OSB board

The mat is trimmed and compressed when it enters the press

Fig. 7 Example of the third layer for OSB prior to press infeed

Figure 1 previously analysed, shows the forming of the dust layer after various research, testing and studies, to produce an LSB board.

BLENDING

The high pressure resination system has been implemented and adapted to the OSB process through an innovative cone-shaped rotary chute. This new system has been implemented to improve the distribution of the resin over the strands and hence to reduce the amount of resin added to the work process.

Mechanical structure of the cone-shaped rotary chute to improve the performance of the blending process.

Fig.8 cone-shaped rotary chute

Another view of the chute constructed within the scope of the IPAN project and which is being tested on the IBL line.

Fig.9 another view of the cone-shaped rotary chute

FORMALDEHYDE

After the system was put into operation, Chimar, IMAL and IBL have experimented production with the new resin composition developed by Chimar, on both OSB and LSB panels, achieving good results. There is only one minor negative aspect which regards the colour of the board. Poplar wood is a lighter shade and so the colour of the finished OSB panel is much lighter; the panel produced with the resin developed by CHIMAR is slightly darker and this could lead to some reject issues with consumers once the process has been industrialized.

Hence, the target to reduce formaldehyde has been reached – this is seen in the figures and pictures in Fig. 10 – but the research on the resin applied will continue to try and make it lighter.
A maximum reduction of approximately 14°C has been achieved with the polymerization temperature in the pressing process with the new resin, with no change to board properties.
An example may be found of this, in the group of pictures seen in Fig. 10, one of the four tests conducted in the experimenting phase after the IBL line was put into operation.

After start-up and putting the line into operation with the implementation of the innovations required by the IPAN project, we conducted laboratory tests on the boards produced on the prototype line with the resin studied by CHIMAR which were successfully passed.

TEST SAMPLE 3:

GENERAL REPORT:

- IB - 1.00.0067 - PC104 (6.4 02/05/13 00) - 00068 test3 - Produced on 16/07/2015 09:26:10

IMAL s.r.l. Code: 00068 test3

Production:
Test date: 16/07/2015 09:26:
Production date: 16/07/2015 09:26:
User:
Client
Review: No

Test:
Line:
Lot:
Shift:
Class:

Comment:

	Bending strength		Tensile strength
	M. O. R.	M. O. E.	I. B.
	N/mm²	N/mm²	N/mm²
Average	6.15	536.49	0.04
Std. Dev.			

Fig. 10 set of data on the properties of the OSB panel produced with the resin developed by the partner, CHIMAR.

GRAPHIC OF BENDING STRENGTH:

Graph showing board bending strength test

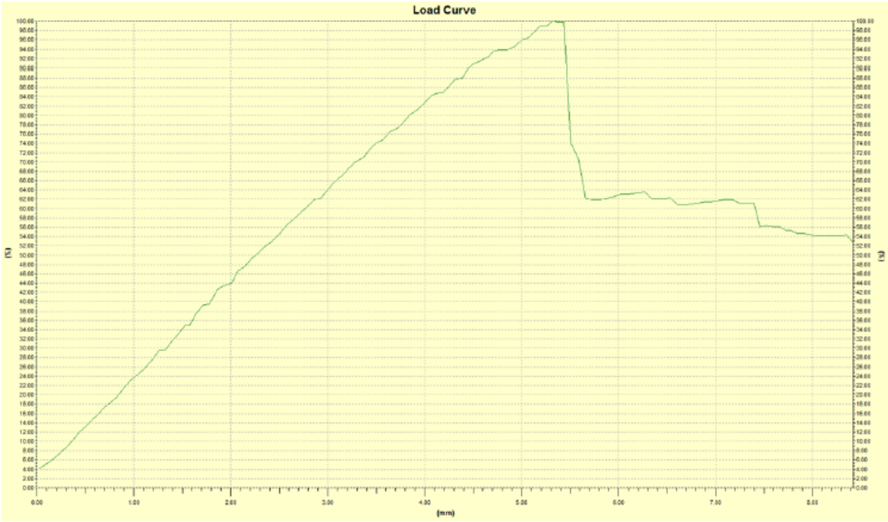

Fig. 10a: board quality diagram – bending strength- OSB panel produced

GRAPHIC OF TENSILE STRENGTH:

Graph showing board tensile strength

Fig. 10b: board quality diagram - tensile strength-OSB panel produced

Formaldehyde emission level from the laboratory tests run on the OSB panel produced with the resin developed by CHIMAR	FORMALDEHYDE EMISSIONS (EN 717-2) : 0.54 mg/m2h Fig10c: Formaldehyde emission level following laboratory tests on the OSB panel produced with the resin developed by CHIMAR

STRAND DRYING TECHNOLOGY

Stela, as defined in Deliverable 5.1, through the technological innovations has succeeded in adapting the belt dryer to the OSB production process, decreasing both dryer costs and emissions into the air - Deliverable 5.2.

The target of achieving an efficient drying via low-caloric heat has in fact been reached. Various measurements taken during the work process have made it possible to optimize the system and decrease the working temperatures with respect to other types of dryers currently utilized thanks to the intelligent application of fans, recycling of the hot air flows and monitoring of the drying process temperatures.

At the same time, the process analysed by Stela and adopted in the IPAN project has decreased both the drying time as well as the presence of the VOC substances released into the environment. The new system has optimized design to enhance convection efficiency and the use of the exhaust air for different cycles. In order to avoid the high dust emissions and to save energy, the exhaust air re-circulates through special heat-exchangers at temperatures of up to 95 °C to provide the most suitable drying air conditions for water evaporation.

Recirculating the air makes the drying process (faster) with a more efficient thermal exchange with respect to state-of-the-art systems. More specifically the drying system control has a flexible control range retention time in the active zone of 6 – 30 min.

The dust content is filtered through the product layer and the belt, so that less wood dust is released into the air. Moreover, the drying system runs at low pressure (suction mode) to further reduce the amount of VOCs released into the environment. The velocity of the air through the belt is very low so that the filter (plastic belt and the product layer on it) can work in a suitable manner.

Fig. 11 belt dryer on which Stela has conducted research and made modifications within the scope of the project

HANDLING AND METERING

Imal and IDP have found innovative solutions which have permitted the elimination of the spike rolls for discharge by designing and developing special belt conveyors to attenuate the damage to the strands and minimize blade wear. The belt conveyor developed in this project has been designed for processing the slim strands obtained from the process. The belt conveyor is equipped with a control system for handling, selecting and storing the strands ready for further processing.

DUST FORMING

The new technology - fig.1 - is able to apply a layer of wood dust over raw LSB boards. Since such boards could have a relatively rough and not very homogenous surface and, certain strands could be lying in unwanted orientation and directions, the resinated wood dust will cover the surface voids. Also, an innovative pre-compression system has been fabricated so that the mat may be conveyed between the conveyor belt and press infeed without the dust being dispersed into the air.

PRESSING

As mentioned earlier, the working temperature of the press has decreased with the new resin for both the OSB panel and the LSB panel.

SOFTWARE CONTROL

After putting the production process into operation, various optical control points were installed to analyse material flow to monitor board quality and process performance to see whether these complied with the IPAN project targets. These cameras applied in the process are network connected to a computer which processes the images and through algorithms created by UNIMI and ECS, provide indications on panel quality and on the deviations with respect to the standards set

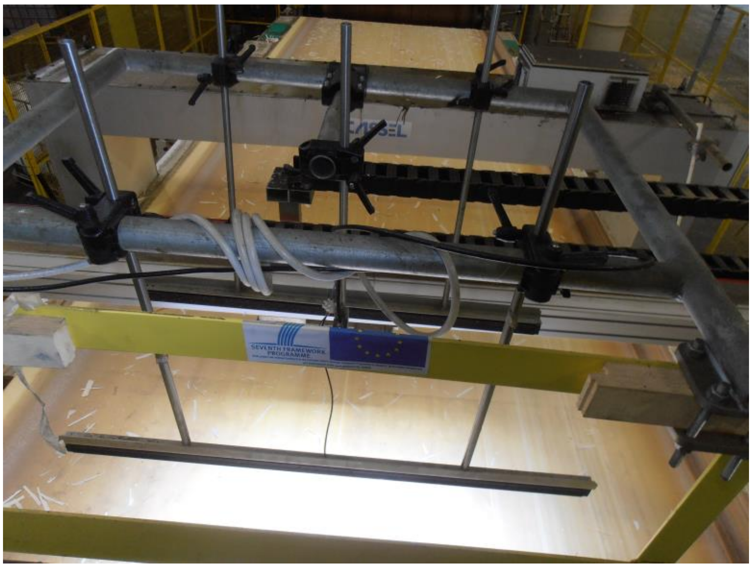

Fig. 12 example of the optical system on the last OSB layer

The optical control points located at various points along the line monitor the work process continually and then once the data have been processed, can indicate whether the values measured deviate from the historical average calculated

Fig. 13 example of the optical system on the first OSB layer

The data are processed through a series of algorithms developed by UNIMI and ESC utilizing a specific MATLAB licence for university purposes. After running the tests and the verifications, we shall proceed with the industrialization of the software so that a user-friendly package can be available on several platforms.

Fig.14 Control and processing unit in the IBL control room

4 CONCLUSIONS

The IPAN project is closed and the targets have been reached.

The techniques and solutions applied have been shared with the partners and in some cases are already in the industrialization stage.

The IPAN project has led to many new innovations, such as an innovation to the forming station equipment and new techniques for controlling the OSB process- which will be applied in future by the partners in various plants around the world.