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I-PAN

INNOVATIVE POPLAR LOW DENSITY STRUCTURAL PANEL

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D5.2 – Times and VOC´s reductions report

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Document information

Abstract

This deliverable concerns the times and VOC's reduction report from the analysis of data from pilot palnt. In view of reduction of the VOC emissions the project target is also reached, even if it is more a matter of the used material. A transfer of the technology to other kinds of wood (especially conifers) must be made to prove the results, but just from the theoretical side the VOC emissions from the belt dryer with it´s low temperature drying process (max. 110°C) should be much lower than from the state-of the art technology for drying OSB-strands, the drum dryer with it´s high temperature drying process (up to 500°C possible).

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LIST OF ABBREVIATIONS AND DEFINITIONS

DoW	Description of Work
EC	European Commission
BD	Belt Dryer
HE	Heat exchanger
CA	Circulation air
OSB	Oriented strand board
r.H.	relative Humidity
kg	Kilogram
kWh	Kilo watt hour
ct	Cent
VSD	Various speed drive
VOC	Volatile organic compound
mm	Milimeter
m^2	square meter
mbar	Milibar
Pa	Pascal
ORC	Organic rankine cycle
m	Meter
mg	Miligramm
h	Hour
%	Percent
°C	Centigrade

1 INTRODUCTION

In general, this report follows directly the results fo the deliverable D 5.1 "Innovation oriented towards costs reduction in the drying process" as optimized costs fort the drying process direct correlates with optimized times. Additionally, the exact control of the product moisture at the outlet and by this avoid of overdrying is an important item. The report shows also the problems we was faced off during the optimizing phase. The reduction of the emitted VOC´s is the second focus of this report.

2 INFLUENCE FACTORS TOWARDS TIMES AND VOC EMISSIONS

Analogue to the cost reduction, the factors material distribution on top of the dryer belt, hot air generating and distribution as well as the air guiding system has a direct influence to the times of the drying process. The VOC emissions, generated from the dryer, depends on the used kind of wood as well as on the temperature level inside the dryer tunnel.

2.1 INFLUENCE FACTORS TOWARDS TIMES IN DETAIL

The direct influence factors of the times for the drying process are in detail
- material distribution and material turning
- hot air generation
- hot air distribution inside the dryer tunnel
- ventilation of the product layer
- control of the target moisture

All this factors alone and in combination with the other ones influences the efficiency of the drying process and by that also the times of the process. Additionally, all of them have also a direct influence to the dust release to the environment.

2.1.1 INFLUENCE OF THE MATERIAL DISTRIBUTION TO THE DRYING TIME

The material distribution is in first view realized by the feeding system of the dryer, consisting of the double screw system (figure 1), driven by electric gear motors (figure 2) and the screw through of them. Without an equal product layer (figure 4) no sufficient drying result can be reached. The material is fed into the feeding duct and falls by means of gravity into the screws. The first one distributes the material all over the belt width and produces an equal product layer, whose height is adjustable by spindle lifting gears. The height of the product layer depends on the material properties, for OSB-strands the layer has to be adjusted as high as possible (240 mm) as the pressure loss is very low because of low bulk weight and geometry of the strands. At the end of screw no. 1 are turning over paddles fixed, which throws the material too much for the adjusted layer height to screw number 2. The screw through under screw number 2 is closed, so that the material is conveyed to the other side again. The here fixed turning over paddles throws the material into the material flow again and re-guides it to the process. In second view, the adjustment and data exchange between the dryer internal feeding screws and the previous conveyors determines also the quality of the product layer. Too less material from the outside means no full product layer all over the belt width, too much material leads to blockages and overfilling of the screws. Both has negative influence to the drying times, dust emissions and also costs.

In the beginning of the project, no adequate product layer could be processed (figure 3). The reason was a wrong position of the screw through underneath the screws itself, which caused ongoing blockages there and by this an unequal product layer. After changing of the screw through position into a higher one (figure 5) to allow the material to expand after distribution, the product layer was as equal as required (figure 4).

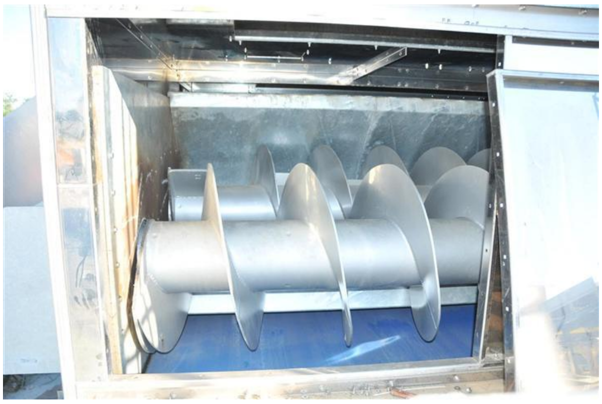

Figure 2 – feeding screws no. 1 (in front) and no. 2 (behind)

Figure 2 – drives and lifting gears of the distribution screws

Figure 3 – inadequate product layer on the dryer belt

Figure 4 – proper product layer on the dryer belt

Figure 5 –modification of the screw through position

2.1.2 INFLUENCE OF THE MATERIAL TURNING TO THE DRYING TIME

After distribution of the strands, the belt movement conveys the strands through the dryer tunnel. After approx. 1/3 rd and 2/3 rds a turning device mixes the strands and ensures an equal drying result, that means an equal moisture all over the belt width. Also the saturation of the drying air increases by the turning again, which leads to a higher water evaporation rate and so to a faster drying. As it turns out that the first design of the turning device was not working proper with OSB-strands (figure 6), a new one was developed to improve the function and ensures a high plant availability and reduces the risk of damages for following parts of the production line (figure 7).

Figure 6 –first design of the turning device

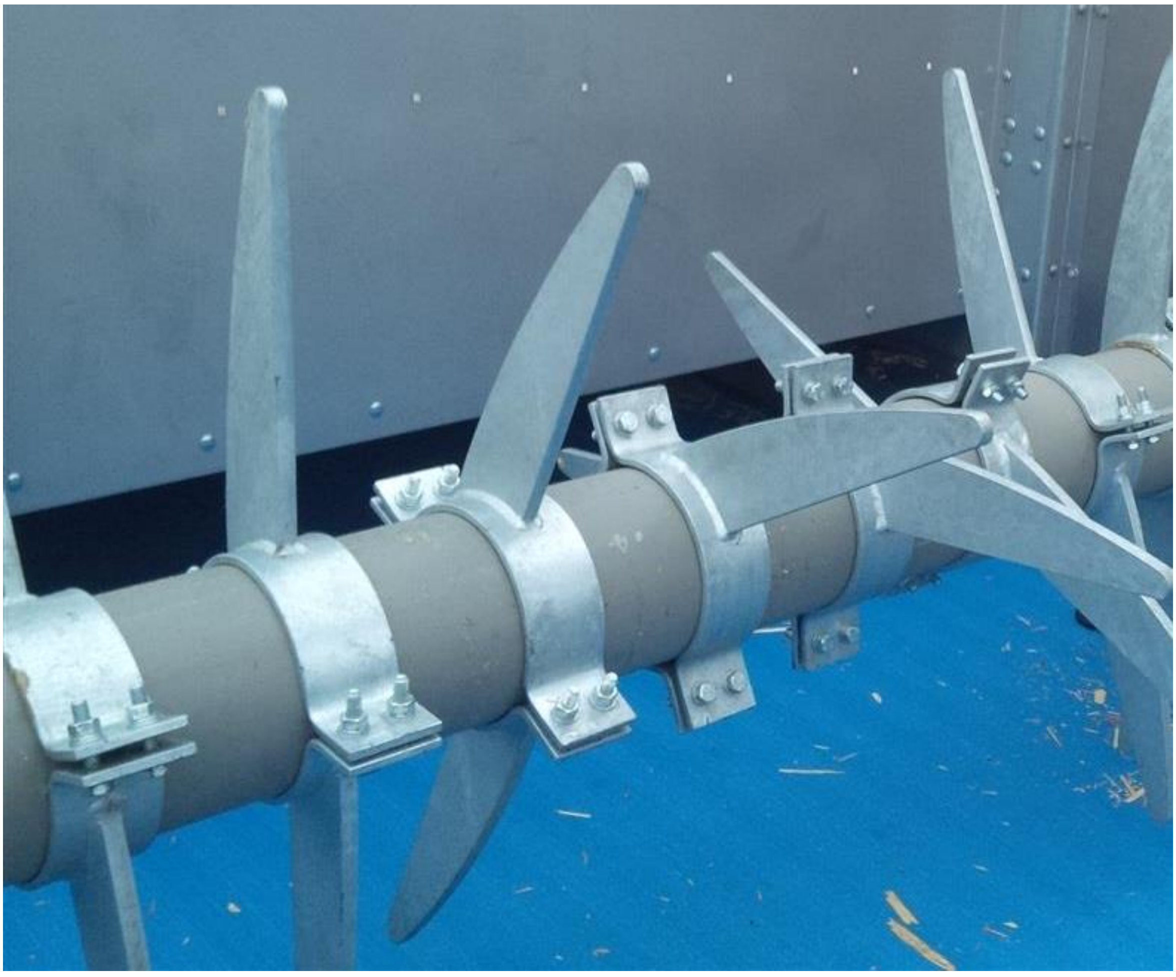

Figure 7 –turning device designed for OSB-strands

2.1.3 INFLUENCE OF THE HOT AIR GENERATION TO THE DRYING TIME

The next item influencing the times of the drying process is the hot air generation by means of the hot water heat exchangers. The working principle of the HE is that hot water flows through the inner tubes and heats up the on the tubes welded fins. By the big surface of the fins (approx. 1.260 m² per HE in the exhaust area, figure 8, and approx. 1.490 m² per HE in the circulation area, figure 9) the fresh air sucked through the HE gets heated up, the water flow gets cooled down and back to the ORC-process circle.
As the layer of OSB-strands produces just a very little pressure drop of approx. 2 – 4 mbar (200 – 400 Pa), depending on the layer height and the moisture content, the hot air generation must take place as equal as possible all over the dryer surface. For this, Stela installed 13 pc of HE exchangers (11 copper-aluminium in the exhaust air area and 2 stainless steel in the circulation area) all over the dryer length, that means averagely one HE every 3,35 m. The HE has a dimension of approx. 5.000 x 1.350 mm to provide an equal hot air-flow all over the dyer width.

Figure 8 – installed heat exchangers in the exhaust air area

Figure 9 – installed heat exchangers in the circulation air area

After some month of operation it was recognized that the HE does not complete reach the requirements. Because of this, a second row of HE (figure 10) with an additional heat exchanging surface of approx.. 600 m² each was installed to take more thermal energy out of the hot water circuit and by this increase the drying temperature. This leads to a faster drying and so to reduced production times.

Figure 10 – additional installed heat exchangers with piping

2.1.4 INFLUENCE OF THE HOT AIR DISTRIBUTION TO THE DRYING TIME

The hot air distribution inside of the dryer tunnel is the next very important item to ensure the shortest possible drying time. It is depending from the compression ration inside the dryer, which is depending again from the product layer on the belt and the airflow through the product layer and belt. Only if these requirements are fulfilled, the full drying surface will be equal ventilated with hot air, and this leads again to the best drying result and so to the shortest possible drying time.

2.1.5 INFLUENCE OF THE PRODUCT VENTILATION TO THE DRYING TIME

By the ventilation of the product layer the moisture is removed convectively. For the airflow, the optimum between big enough for proper moisture transport and low enough for keeping the filter function of the product layer and dryer belt has to be found. As the requirements changes with decreasing moisture over the drying process, all exhaust air fans are controlled by VSD´s so that a single adjustment of the fan speed and by this of the airflow is possible.

2.1.6 INFLUENCE OF THE TARGET MOISTURE TO THE DRYING TIME

The lower the final moisture of the product, the longer the required drying time is an easy to understand fact. Unfortunately the required retention time inside the dryer tunnel changes with differing input moistures. Reasons for this are the different times of the year (time of felling of the trees, in summer the moisture is higher than in winter), different storage time of the logs before stranding, the weather during the storage time (more sunny means lower moisture, more rainy means higher moisture) and of course also the derivation of the logs. To control the output moisture, a moisture control sensor was installed by company IMAL (figures 11 and 12). It is installed at the through of the discharge screw, as the dry material has to cover the sensor permanent to allow a proper measurement. According to the shown value, the retention time can be adjusted by the VSD driven belt drive. As the system reacts slow because of the dimension, the possibilities are limited. So in the next step a measurement of the input moisture and use of the generated data for adjustment of the retention time should be the logical consequence.

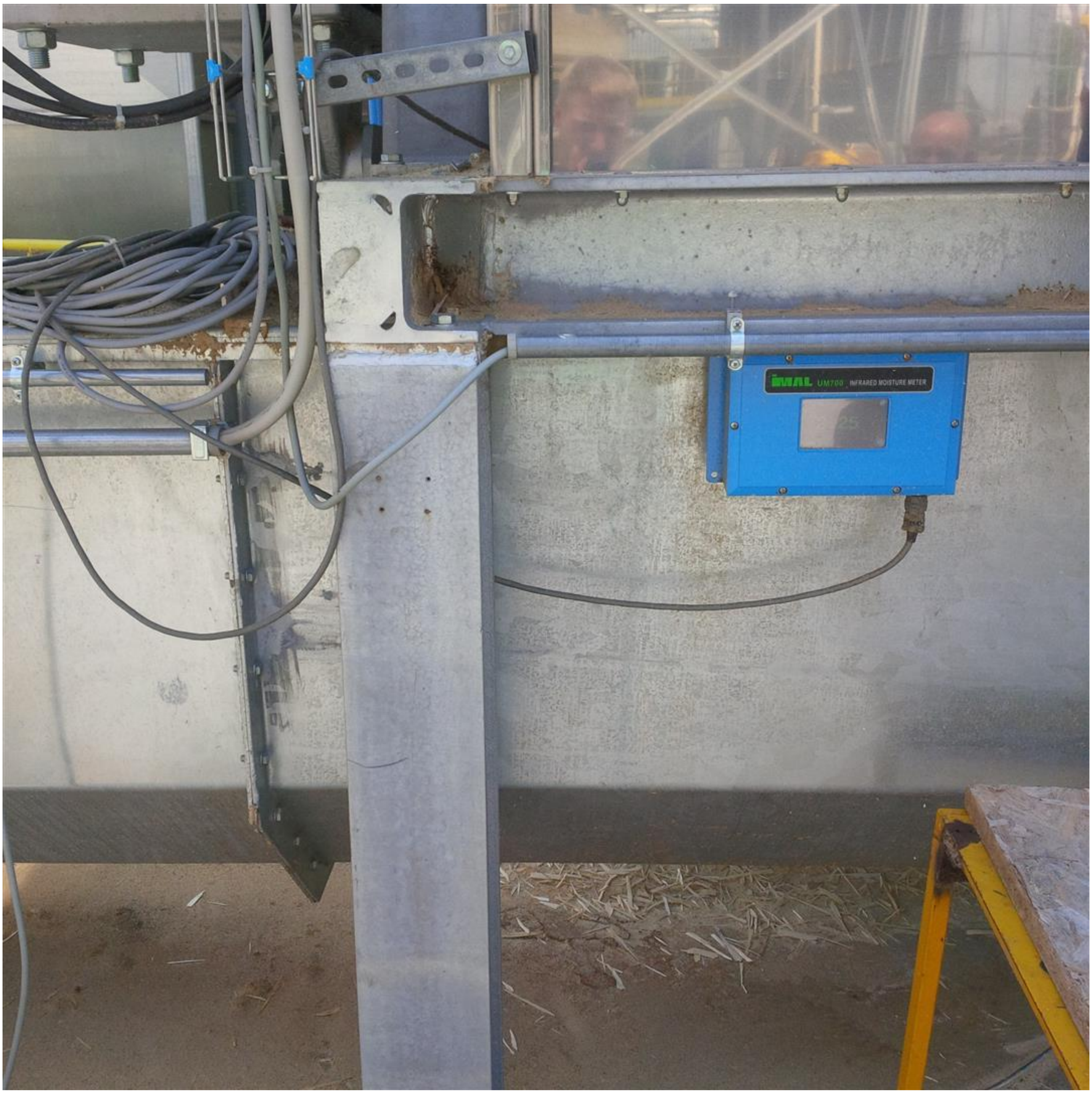

Figure 11 – moisture sensor at the discharge screw

Figure 12 – detail view of the moisture sensor

2.2 INFLUENCE FACTORS TOWARDS VOC REDUCTIONS

In general, the emission of VOC´s (volatile organic compounds) depends on the kind of wood which is processed and the temperatures all over the process. According to the available literature, VOC´s are generated if wood resins gets heated up. With increasing temperature also the amount of evaporated VOC´s increases. Evaluating the different kinds of wood and their potential to evaporate VOC´s, it is also stated in the different literature that only conifers produces resins and by this fact also only drying conifers can evaporate VOC´s. The reason can be found in the intercellular structure of the wood, only conifers contents resin producing cells.

As in this special project only poplar wood is used, no VOC´s are emitted. This is also stated in the dust and VOC measuring report from IBL/IPAN:

origin	flowrate (Nm3/h)	H emission	Day/year	h/anno	medium	max. concentration (mg/Nm3)	annual concentration (kg)
dryer	450000	24/24	315	7560	dust	10	340200
dryer	450000	24/24	315	7560	VOC	---	----

Table 2 – result of dust and VOC measurement

As visible, only dust was existing in the exhaust air in a measurable concentration. This confirms the information from several literature that only conifers contents VOC evaporating resins.

3 CONCLUSIONS

In front of the evaluation of the project results, it must be considered that a comparison of the results is very difficult because of very changing conditions in concern of the raw material.

At the start of the project, the averagely retention time of the strands inside the dryer tunnel was 27 minutes at a hot air temperature of 79,6°C. Increasing the hot air temperature by additional heat exchangers, modification of the material distribution by changed position of the distribution screw through, improvement of the turning device and optimizing of the speed of the single fans as it was possible to decrease the retention time to averagely 15 minutes. This means a reduction of 44,4%, and there is still some potential for further reduction. Theoretically a further increase of the height of the product layer leads to a further improvement, but this needs to be researched in detail first. Nevertheless the project target can be evaluated as reached as it´s a complex theme with many correlations to consider.

In view of reduction of the VOC emissions the project target is also reached, even if it is more a matter of the used material. A transfer of the technology to other kinds of wood (especially conifers) must be made to prove the results, but just from the theoretical side the VOC emissions from the belt dryer with it´s low temperature drying process (max. 110°C) should be much lower than from the state-of the art technology for drying OSB-strands, the drum dryer with it´s high temperature drying process (up to 500°C possible).