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FACTORY OF THE FUTURE – TOWARD A NEAR-ZERO ENVIRONMENTAL FOOTPRINT IN WOOD PANELS MANUFACTURING

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ABSTRACT

Factory of the Future – "Demonstration of the production of wood panels with near zero environmental footprint" is a project funded by the Life+ Programme of the European Commission. Now in its first of three years of running, this project aims to create, through an "eco-design of a factory" concept, a largely near self-sufficient production facility in Sanem (Luxembourg) with low environmental impact by combining the best practices in the field of production and use of energy, water and raw materials supply. The use of Life Cycle Assessment (LCA) applied to the entire production site and then to specific products is envisioned for monitoring the progress towards near-zero environmental footprint and for communication purposes.

KRONOSPAN AND ITS PRODUCTS

Kronospan facility in Sanem (Luxembourg) produces around 500 versions of two types of wood panels boards used mainly in building sector, furniture and packaging: oriented strand boards (OSBs) and medium-density fibreboards (MDFs).

OSB is a wood panel built up in three layers of strands (wood flakes) bonded in with a resin in different orientations i.e. the outer layers strands are arranged at right angles to those in the middle layer (CEN, 1997).

The OSB production at Kronospan is made in several steps (Figure 1): "logging"(reception and storage of wood logs); "flaking" (debarking and stranding of logs flaking); "drying"(drying of wood strands from 50 to 150% of moisture content to 5%); "screening"(screening of dry strands to separate the finest); "blending and forming" (blending of strands with adhesives mixture, wax and hardener and forming in order to obtain a mat), and "pressing"(strong pressure is applied to the mat to get the OSB).An additional final step of sanding and finishing could be required for some OSB products according to their use (Benetto et al., 2009).

MDF is a composite panel product composed primarily of cellulosic fibres bonded and cured under heat and pressure (ANSI, 2002).

The current production process of MDF (Figure 1) consists of a reduction of wood in small chips, which are then proportioned, filtered, washed, softened thermally, and mechanically transformed into fibres, which are then mixed with a synthetic resin being used as adhesive. The pasted fibres are then dried, assembled and compressed in a hot press to give it the desired thickness.

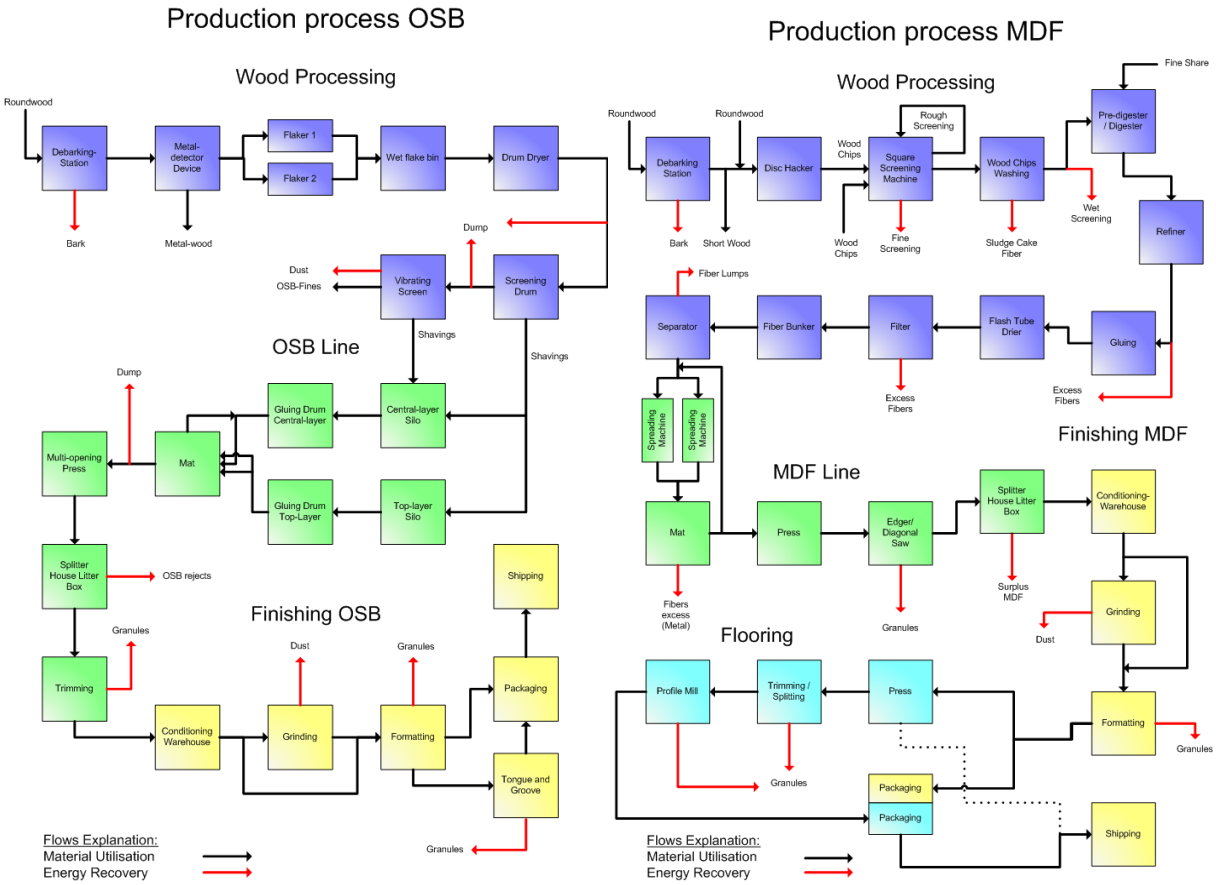

Figure 1.Kronospan OSB and MDF flow sheet

PAST EFFORTS OF REDUCING ENVIRONMENTAL IMPACT

Several projects have already been successfully implemented on Sanem site, dedicated to the improvement of the products and production process, both from an environmental and technical point of view:

- The first wood fired thermal oil boiler with a "self-cleaning" construction (the "Flossenkessel") was installed leading to a higher production and efficiency;
- Wet Electro Static Precipitators (WESP) were installed to the OSB and MDF presses, the first to be used in wood-based panel industry;
- The development of the world's first exhaust gas cleaning installation for the MDF-dryer, a two stage washing unit with chemical treatment of organic compounds solved

in the water.
- An innovative drying system was implemented for the production of OSB panels resulting in a dramatic decrease of VOC was achieved, exceeding 95%, as well as a 10-20% decrease in fossil fuel use and GHG emissions on-site (Benetto et al., 2009).This project has been awarded the title of "Best of the Best" from a shortlist of 22 "Best" LIFE Environment projects in 2008-2009.

With these steps Kronospan already has an impressive record of innovation and environmental improvement. The current project aims to make another huge leap forward.

ECO-DESIGN OF THE FACTORY OF THE FUTURE

The wood panel industry is generally very environment oriented, as protecting natural resources goes hand in hand with ensuring future availability of wood and thus business continuation. A list of typical efforts towards this direction is outlined below:

- Non-reusable and non-recyclable materials are used for energy production, typically large amounts (up to 90%) of wood biomass;
- Energy efficiency is increased as much as possible;
- Waste water is recycled for e.g. glue mixing, washing of raw materials,...

However, not all facilities use the same input wood type and have the same availability of waste wood. Therefore efforts are very much dependent on the situation of the particular production facility.

In the case of the Kronospan's production site in Sanem, while previous improvement has always targeted specific parts of the production line, within this project the aim is to achieve a full-scale demonstration of a the concept of "eco-design of a factory". This will be achieved by letting all elements work synergistically allowing relying almost on renewable resources, such as rain water and wood waste, while the production volume and quality is maintained.

The idea is to combine the already present cutting edge installations in both production lines (OSB and MDF) with new equipment, such as a Combined Heat and Power (CHP) unit and rain capturing units.

The improvements of present equipment needed are estimated thorough an analysis of the current production lines, determining the exact state with respect to the objectives. For instance, wood production requires thermal energy (heat) for the drying process, and electricity for other equipment (e.g. conveyor belts, presses, etc.). Maximum energy efficiency and minimum fossil energy use will be ensured through enhancements as follows:

- The energy efficiency of the OSB production line is significantly increased by a pre-drying of the wet wood flakes using excess heat from the process;
- Heat and electricity could be produced from renewable sources using a cogeneration process, excess electricity being provided to the local power grid;
- The remaining energy required for the production of OSB and MDF panels would be powered almost entirely by biomass.

Important quantities of drinking water are used today for cleaning and steam generation. In order to lower the consumption the water efficiency of the steam generator will be increased

with around 20%. After the installation of the capturing units, over 50% of the current consumption will be assured by rain water and around 15% from the condensation water, recycled from the OSB production process.

The expected results are to cut the current use of fossil fuels for thermal energy by 90%; cut over 80% of the current CO_2 eq. emissions from fossil fuels and cut 70-75% of the currently consumed town water. The facility could also generate biomass origin electricity to the power grid, equivalent to the household use of over 22 000 persons.

Special attention is given to the management of the supply chain, from a lifecycle perspective, in order to increase the availability of the raw material without pressuring on the forests cycle and minimizing the transport distances. The biomass will be covered for the largest part by on-site sources with a 40% of the required wood and the remainder will be purchased from nearby certificated management forests. To this aim, the use of LCA is instrumental to avoid the move of pollution along the lifecycle of the products as well as to monitor and prove the progress towards near-zero environmental footprint. LCA will allow to downscale the environmental improvements reached at the site level to the specific families and types of products.

CONCLUSION

This project will demonstrate a viability of a new concept: “the eco-design of a factory”. The project will innovate the production methodology to reach a low environmental footprint wood panel production line, which is at the same time economically sustainable. An increased autonomy in the manufacturing processes also means that the production process are less vulnerable to fluctuations in fuel, raw material and water prices, thus increasing in the future economic viability of the project.

This demonstration will become a window of any other industry to understand that the concept could be successful both in technical and financial terms in a wide range of industries.

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