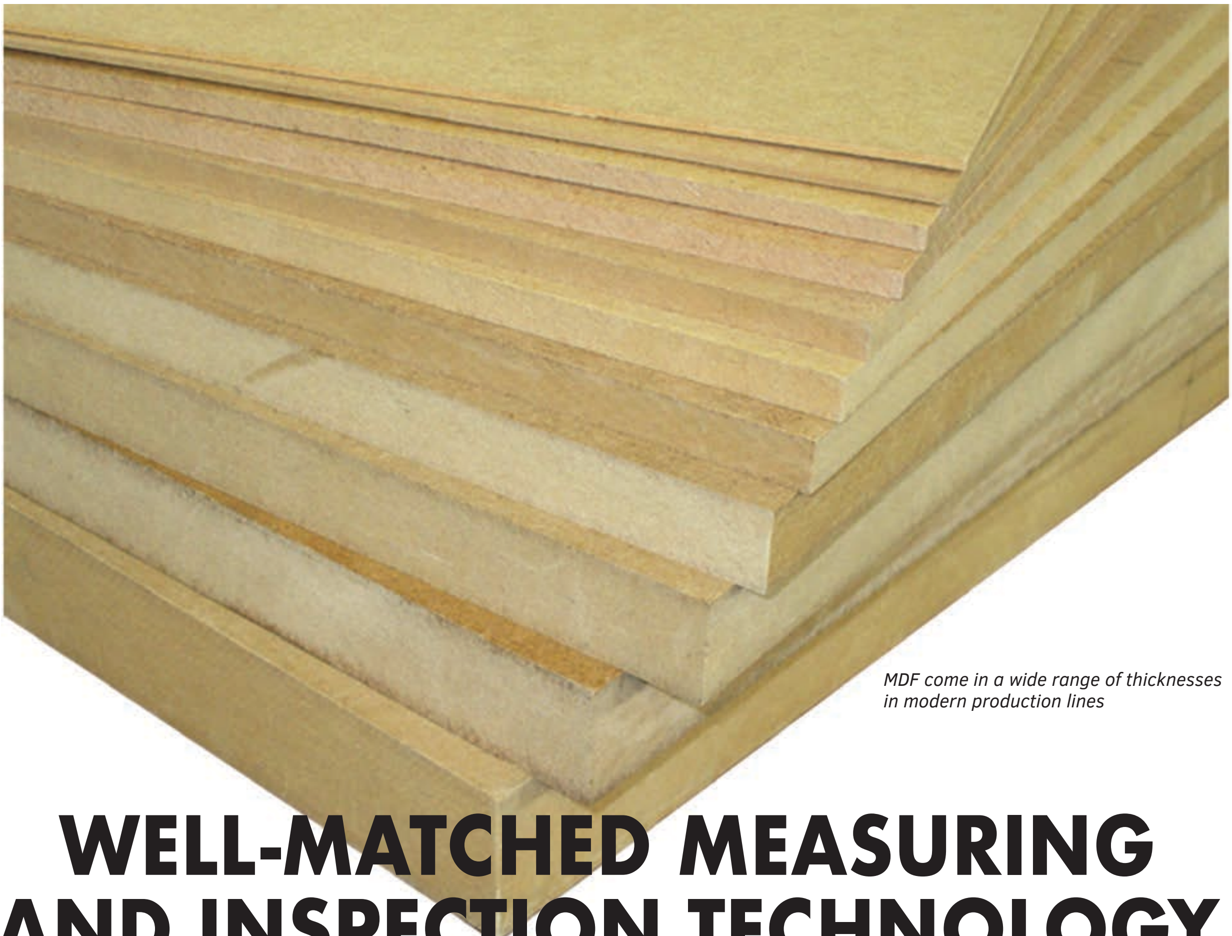

MDF come in a wide range of thicknesses in modern production lines

WELL-MATCHED MEASURING AND INSPECTION TECHNOLOGY FOR THIN MDF PRODUCTION

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The efficient production of a high-quality medium-density fibreboard (MDF) is fundamentally attributable to the available raw material, capability of the installed machinery and manufacturer's knowledge. However, inline measuring and control systems also play a major role in meeting the increasing requirements. Electronic Wood Systems (EWS) shares with us their quality inspection and measuring systems for wood-based panel manufacturing.

Good-quality MDF production begins at the forming line, with a homogenous and clean fibre mat provided by Siempelkamp's MDF-Mat Formers, including StarFormer and Equalizer. Here, EWS' X-ray mat inspection and measuring system, EcoScan, serves as a reliable instrument for monitoring the mat parameters. The system, developed by EWS and Siempelkamp, comprises individual sub-systems for area weight measurement and foreign body detection (FBD), with a special focus on fast-running production lines even for MDF panels as thin as 1.5 mm.

Impurities, or metal and non-metal foreign bodies in the fibre mat, are unacceptable for both hot press protection and panel quality. The FBD system, EcoScan FBD, scans the entire mat and provides control signals in order to reject the defective material. The X-ray imaging method is comparable to digital photography; good photographs depend on appropriate lighting, the nature of, and distance to, the objects and the camera's sensor resolution and sensitivity. Similarly, using an intelligent algorithm, EcoScan's FBD unit evaluates continuously acquired X-ray images, allowing for common signal variation and regular mat inhomogeneity to avoid false detections. Up to three detection levels are available in the manual setting or via a recipe. The image acquisition of the EcoScan FBD is performed by a scanning linear array sensor – a line camera sensitive to X-rays (Figure 1). High spatial resolution comes from a small pixel size and pitch (1.6 mm across), as well as a fast sensor read-out repetition rate, with a 1.5 ms sample

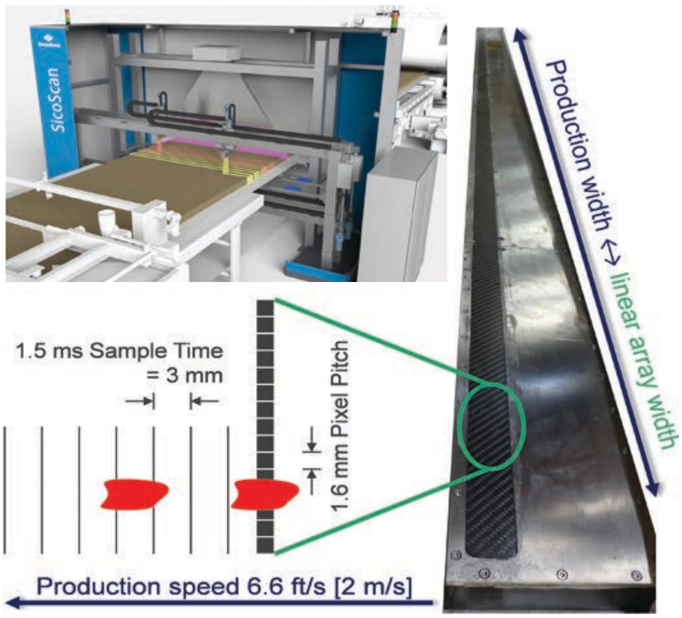

Figure 1. EcoScan FBD using high-performance linear array scanning technology

time covering <3 mm of the mat, depending on speed. For reliable FBD, a certain pixel coverage of the scanned object is required for good contrast in the X-ray image. A high-detection resolution is also attributed to optimised X-ray energy and sensitivity of the sensor elements in the linear array. The FBD operates with high X-ray power to obtain a sufficiently high radiation intensity on the imaging sensors. This is because of the large distance between the radiation source and detector line, the extent of the fan beam to cover the complete mat width and the short sample time (comparable to bright light for a short camera exposure time). Customers have individual possibilities to adjust the detection settings depending on the application, with three typical foreign body types: metal, high density (eg, resin lumps) and quality (eg, small metal detection in oriental strand boards or rubber particle visualisation and counting in MDF). An optional marking unit with heat-resistant ink for marking individual detections on the mat surface enables downgrading of the panel downstream from the hot press.

In contrast to FBD, area weight measurement of panels with thicknesses ranging from 1.5 mm to 40 mm requires a differently designed X-ray system. EcoScan's high-precision area weight gauge utilises unique double-traversing and self-adjusting flying measuring heads (FLY), which employ MultiEnergy Technology – finely graduated X-ray energies consistently yielding a high measuring resolution of ± 0.5 % over a wide area-weight range, and accurate absolute values.

An enhanced detector with short sample time enables fast traversing of the measuring heads. For example, the two synchronised traverses allows a cross-scan of an 8 ft mat every 2.5 seconds. However, lower X-ray energies are automatically adapted to the measured area weight, such that the relative measuring sensitivity is equivalently high along the relevant range (green plot in Figure 2). This yields maximum relative signal differences (X-ray measuring contrast) with small area weight variations between the measuring positions. The X-ray energy level of the EcoScan FBD (blue plot in Figure 2) would be too high, with considerably decreased sensitivity, for area weight measurement in the relevant range. This is because its parameters are optimised for high radiation intensity and proper imaging contrast for FBD.

The EcoScan FLY's "little brother" – MASS-SCAN X ME (Figure 3) – is a single-head traversing area weight gauge with ± 0.6% to 0.8 % measuring resolution. It is commonly applied in particleboard-forming lines with up to three connected units covering the panel layers. However, it is also appropriate for applications in regular MDF lines with mainly >7 mm panel thicknesses. Moisture content measurement using infrared moisture analyser MT-SCAN completes the forming line measuring equipment at several relevant positions.

Downstream of the hot press, thickness gauge and blow detection systems are essential devices for final panel quality and process performance monitoring (Figure 5). Because panel producers are faced with decreasing panel thickness tolerances, they need an inline measuring instrument with almost calliper-like accuracy.

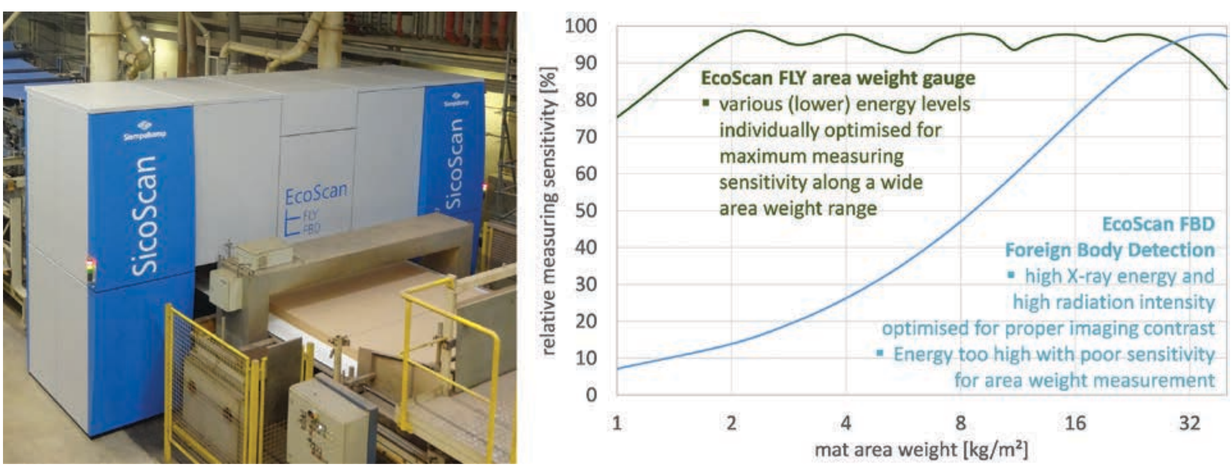

Figure 2. EcoScan FLY high-precision area weight measurement using self-adjusting flying measuring heads

Figure 3. Traversing area weight gauge MASS-SCAN X ME with MultiEnergy technology for various measuring tasks in panel production

EWS' THICK-SCAN is a reliable and cost-effective thickness gauge that is also suited for installation in the sanding line. The integration of the thickness gauge into process automation is a well-established application for panel thickness control in modern production lines.

The application of ultrasound for panel inspection has been a common principle for decades, enabling the detection of internal defects such as delamination, blows and voids. EWS' blow detection system BLOW-SCAN features a linear array of ultrasonic sensors with an individual number of inspection channels across the panel width. The sound transmission amplitude through the panel, measured by each pair of transducers (transmitter below and receiver above the panel), drops significantly when there is an internal defect. Regarding detection capability, lateral (sensor pitch and size) and longitudinal (scanning performance = sample time with over-sampling) spatial resolution must be specified, where individual guarantee values for defect sizes are defined. A typical configuration comes with a 100 mm pitch of 50 mm sensors and 8 ms sample time (Figure 4), resulting in 150 mm by 50 mm guaranteed detectable defect size. In addition, there is a variation of the signal depending on various panel quality parameters, which is displayed in a multi-coloured ultrasound image. This optimises production capacity, to run the line close to its specific limits with regard to press time and panel thickness, based on the readings of the signal distribution across the panel. Today, there is a trend towards higher spatial resolution for the detection of smaller defect sizes, which is also considered to be relevant for thin-MDF production. To this end, fundamental research and development is in progress to produce an effective system with outstanding features – and a new generation of ultrasonic technology – in the near future.

It is worthy to note that both thickness-measuring and blow-detection systems are designed for panel evaluation and require gaps between the panels on a regular basis for individual zero-calibration of the sensors. This is to compensate for pollution, temperature drift and other impact factors. Therefore, the devices must be installed downstream of the diagonal saw section. Complete with integration of fully automated empty-gap-measuring procedures, this is considered to be the fastest and most practical solution.

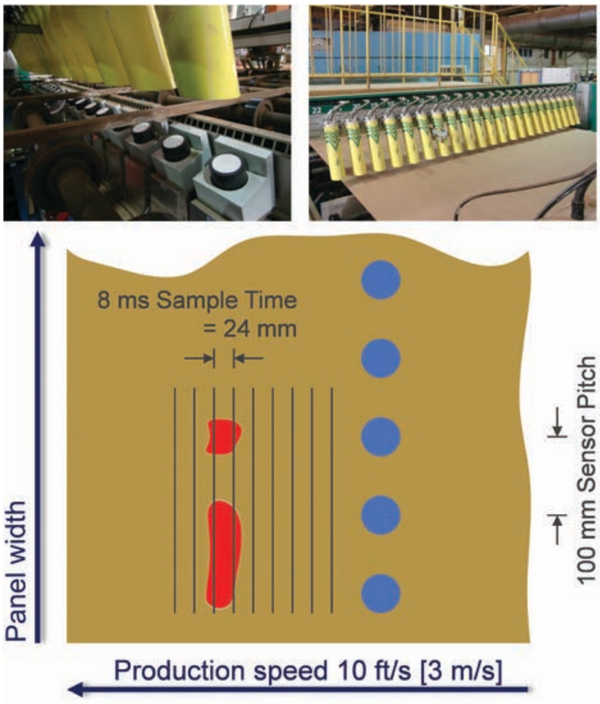

Figure 4. BLOW-SCAN configuration for 150 mm² by 50 mm² guaranteed detectable defect size (lower red dot)

Figure 5. SicoScan panel evaluation systems powered by EWS technology with thickness gauge, blow detection and non-contact panel scale downstream of Siempelkamp's diagonal saw section

The ensemble of panel evaluation systems in the cooling and stacking line downstream of the diagonal saw section is typically completed by a panel scale. Here, the continuous non-contact system CONTI-SCALE X ME (Figure 5) is considered to be a more reasonable solution compared to the previous mechanical unit, especially in the case of thin panels with low weight. It is important to consider that the conveyor already provides a tare weight in the order of 2,000 kg on the load cells of the mechanical scale, which may show uncertainties of up to ± 40 kg. Therefore, such a huge mechanical device is not practical for thin-MDF with panel weights down to 15 kg. On the contrary, the CONTI-SCALE X ME is a lean and precise area-weight-measuring device utilising low-power X-ray units, sensitive high-speed detectors and similar internal procedures for calibration, signal evaluation, and parameter settings via recipe data like the EcoScan FLY or MASS-SCAN X ME. Using MultiEnergy Technology, the X-ray parameters are fully automatically adapted to the current panel properties, resulting in a consistently high measuring resolution of ± 0.6% to 0.8 % of the measured area weight. With corresponding track-wise data from the thickness gauge, the cross-profile and average panel density are calculated and displayed, and panel weight can be derived by considering its dimensions. Moreover, there is a minimum gap requirement of only 335 mm and it can even be installed instead of a roller within the conveyor.

Additionally, a low-energy version of the laboratory density profile measuring device was developed. DENSE-LAB X light features an enhanced internal X-ray system to obtain appropriate measuring accuracy of the measured profiles in the density range of 50 kg/m³ to 350 kg/m³ (compared to a 300 kg/m³ to 1500 kg/m³ range in standard devices). As well as the X-ray technology adaptations, it comes with the well-established features of the standard device. Here, it was only logical to create individual devices, either for standard or for low-density panels, to maintain a lean system design without resulting in an expensive all-in-one solution.

All the described measuring and inspection systems are standard in modern production lines – for example SicoScan integrated in Siempelkamp projects (Figure 5) – and are also available for individual upgrades of existing plants. Once installed and adjusted to the customer's needs, the X-ray systems are aimed at zero operator interaction. Inline measuring and control systems are a key factor for Industry 4.0 in wood-based panel production. There are high standards required of panel producers, which consequently puts high requirements on their process equipment. Here, the application of reliable measuring and inspection systems helps to enhance total efficiency, avoid over-metering, ensure constant product quality and achieve overall savings. P