Advanced X-ray Technology for Individual Measuring and Inspection Tasks on Mats and Panels

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X-ray systems for versatile tasks are prevalent in wood-based panel production for many years. However, the latest research and development enables new systems with innovative features to meet the increasing requirements. But what is the fundamental point in the development of capable and reliable X-ray technology and what are relevant parameters for the customer?

The application of X-rays for industrial inspection and measuring tasks is comparable to photography by digital cameras to some extent. Making good photographs is a question of, e. g., direct and diffuse lighting, nature and distance of the objects as well as the camera considering aperture setting and sensor sensitivity. Here, wrong exposure (too weak/strong direct light) as well as too much diffuse light cause poor image quality considering brightness, contrast, and sharpness. Transferring this example to X-ray technology, well-suited radiation parameters, the consideration of material properties as well as the application of appropriate components are essential aspects of the devices.

Regarding X-ray systems for inspection and measurement of mat and panel parameters, there are two main aspects of the devices to be pointed out here; i. e., X-ray energy and detector sensitivity, both taking the nature of the material under investigation into account. This is the brief conclusion of comprehensive research in this field. The explicit consideration of the physical background as well as a good portion of industrial-suited system design are essential for the achievable accuracy and precision as well as reliability of X-ray measuring devices.

APPENDIX: TECHNOLOGY TRENDS & DEVELOPMENTS

The different X-ray systems follow similar principles, however, feature individual designs in order to fulfil the versatile tasks and to meet the challenging requirements in panel production. The detection of metal and non-metal foreign bodies in the mat before the hot-press by means of X-rays is a first example for an imaging method by analogy with photography.

The foreign body detection (FBD) device as part of the X-ray system EcoScan evaluates the continuously acquired X-ray images by an intelligent algorithm with up to three detection levels. The image acquisition of the EcoScan FBD is performed by a scanning linear array sensor, which is a line camera sensitive to X-rays (Figure 4). A high spatial resolution is

Figure 1: Traversing area weight gauge MASS-SCAN X ME with MultiEnergy technology for various measuring tasks in panel production

Figure 2: Inline panel scale CONTI-SCALE X ME for density measurement integrated with minimum spare requirements

realised by a small pixel size and pitch across as well as a fast sensor readout repetition rate along the mat. For reliable detection, a certain pixel coverage by the object is required (i. e. for good contrast in the X-ray image). Furthermore, high X-ray power is required to obtain sufficient radiation intensity on the imaging sensors due to wide beam geometry and short sample time (comparable to bright light for short camera exposure time).

On the contrary, area weight gauges feature a different design and should be operated which much lower X-ray power. It is comparable to photography, where too bright light and overexposure result in bad images with invisible details. Note, a good foreign body detection device is a poor system for area weight gauging and vice versa.

For area weight and density measurement on mats and panels, individual X-ray energy adaption is considered as the key feature and finally only works with respective detectors in coordination with further measuring parameters.

Here, the high-precision area weight gauge EcoScan FLY with the self-adjusting flying measuring heads as part of the EcoScan system

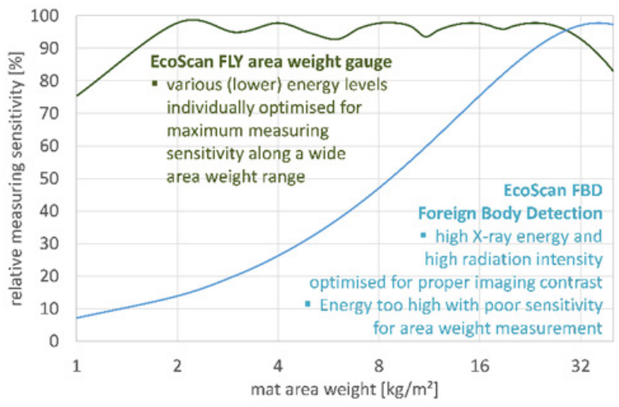

Figure 3: EcoScan FLY high-precision area weight measurement by self-adjusting flying measuring heads

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in the forming line is a first example. It was developed for high-performance applications, e. g. in fast production lines for thin MDF down to 1.5 mm. On the basis of previous EWS X-ray devices, the EcoScan FLY employs the advanced MultiEnergy Technology yielding a measuring resolution of ±0.5 % throughout a wide area weight range. Here, the (rather low) X-ray energies are fully automatic adapted to the measured area weight such that the relative measuring sensitivity is equivalently high (green plot in Figure 3). Contrary to this, the X-ray energy level of the EcoScan FBD (blue plot in Figure 3) would be much too high with considerably decreased sensitivity for area weight gauging in the relevant range.

For typical measuring tasks in modern panel production lines with wide product ranges regarding thickness, density, and area weight, the EWS inline X-ray gauges are capable to provide equivalently high accuracy and precision along the total range. On basis of the MultiEnergy technology, the X-ray systems

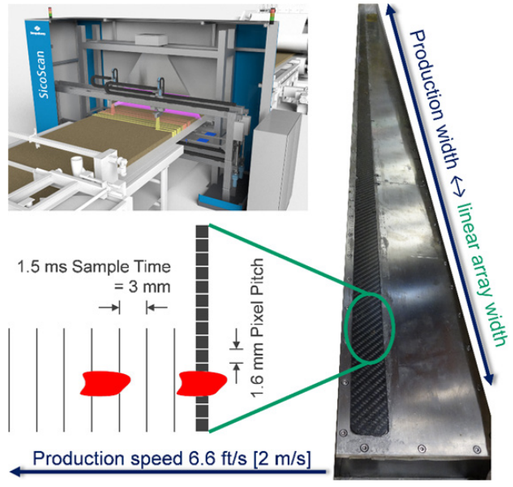

Figure 4: EcoScan FBD reliable foreign body detection by high-performance linear array scanning technology.

- MASS-SCAN X ME (traversing area weight gauge in the forming line and for insulation boards, Figure 1) and
- CONTI-SCALE X ME (continuous panel scale with minimum space requirement after the cross-cut saws, Figure 2).

are a well-proven combination for mat and panel density control. Regardless of the obviously different setups, both devices utilise low-power X-ray units, sensitive high-speed detectors, and similar internal procedures for calibration, measuring signal evaluation as well as measuring parameter setting via recipe data.

Another example is the density profile measurement vertical to the panel plane by means of the laboratory X-ray device DENSE-LAB X on small specimens. It is well-designed for most of the conventional wood-based panels MDF, particleboard, OSB, and other with densities in the range 300 ... 1500 kg/m³. However, it was found that lighter material such as lignocellulosic-fibre insulation board or foamed plastics require an enhancement of the internal X-ray system considering the physics to obtain appropriate measuring accuracy for density profiles in the range 50 ... 350 kg/m³. Accordingly, a low-energy version was developed and introduced as DENSE- LAB X light (Figure 5) in order to maintain a lean system design.

Figure 5: Laboratory Density Profile Analyser DENSE LAB X light with optimised X-ray technology for insulation material

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To conclude the fundamental point in the development of X-ray technology, it is mainly about setting appropriate X-ray parameters for the respective measuring tasks and employing respectively suited components. However, the installed X-ray systems must perform this autonomously without the need of any operator action. Finally, such modern inline measuring and control systems are a key factor for digitalisation and Industry 4.0 in wood-based panel production and help the user optimising process and quality.