

Evaluation of Wood Based Panel Properties and Delamination Detection by means of Ultrasound

Based on current Technology of Online Sonic Measurement

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If a panel board (such as particleboard, MDF or OSB) is measured non-contact by ultrasound most of the sonic energy is reflected at the panel surface. Only a fraction (about 10%) penetrates the panel. Only this small amount of sonic energy is used for measurement and it has many physical and technological influences. Today's online systems evaluate the absorption of the sonic energy which is affected by various types of sound resistance. Frequency analysis or run-time measurements are not considered by today's delamination detection systems.

Factors influencing the measurement of the sonic power

1. Following factors influence the resistance of ultrasound penetrating a panel:

A. Temperature:

The higher the panel temperature the higher the sonic resistance. The temperature of the panel across the production direction is not constant or uniform. The center area of the panel is typically higher temperature than at the edges.

B. Moisture:

This is similar with the internal gas pressure characteristics which show a decreasing trend from the middle to the panel edges. Besides the temperature changes there are also variations in moisture content.

C. Low Density:

The lower the panel density the greater the sonic resistance. Variations in the density crosswise to the production could be intentional, i.e. to produce a higher density at the panel edges or it could be unwanted density changes, i.e. by forming failures.

D. Density Variation:

Proportioning variations of the top layer and the middle layer cause variation in the density and have a corresponding influence to the sonic resistance.

E. Material:

The panel structure of OSB causes varying sound resistance. The size and geometry of the wood chips, fibers and strands influence the sonic resistance.

F. Thickness:

The thicker the panel the greater the sonic resistance. Consequently thickness variations (thickness tolerances) influence the sonic resistance.

G. Resin:

The type of resin (PMDI, UF) causes different curing characteristics. These processes are influenced by the temperature and follow the profiles of temperature and steam across the panel production line.

H. Resin Bond:

The lower the bond of the resin the greater the sonic resistance confirming the bond quality also has an influence on the sonic resistance.

2. Following parameters outside of the panel influence the ultrasound:

A. Air Temperature:

The higher the air temperature between the sonic sensors and the panel surface the greater the sonic resistance. The air temperature follows the temperature profile across the width of the panel.

B. Air Turbulence:

Air turbulence near the sonic sensors as a result of the panel conveyor has a negative influence on the sonic signal. This condition is not constant. For example, if a panel is accelerated while going through the measuring system, this will result in a clear change of the sonic power.

C. Sonic Measuring Signal – Not Bond Quality:

The physical and technological influences which affect the sonic resistance and as a consequence the measuring signal are substantial. Reliable and reproducible connections between the ultrasound signal and the bond quality has not been proven scientifically up to now.

3. Power Sonic Resonance Method (patented)

A. The weaker the measuring signal the greater the mentioned disturbing factors affect the measuring result. Or: The stronger the measuring signals the smaller the disturbing factors are. Electronic Wood Systems uses a patented method whereby the ultrasound is coupled into the panel by resonance. This physical effect results in a 100 times stronger ultrasound absorption. With PSR the influence of the disturbing factors are explicitly decreased.

B. The unique design of the EWS system shows that absolutely no precaution exists to protect the ultrasound against external environmental influences. The design of the system is totally done without precautions against dust, heat, steam or external noise. Because of the strong penetrating energy the measuring gauge is nearly maintenance free. The measuring signal stays stable over a long time in spite of the harsh environmental conditions. This allows maintenance to be done during normal periodic production shut downs.

C. EWS delamination detection systems utilizing Power Sonic Resonance method (PSR) are in use worldwide for more than 10 years. Recently the excellent technical features of an EWS delamination detection system has been proven when located directly behind a continuous press at KUNZ, Gschwend for particleboard with low density and thickness of 55 mm (2.28 inch). Today there is no other system available on the market to detect blows in such thick particleboard. The technical limits of the EWS system have not yet been reached in production. The system remains maintenance free during production and the strength of the ultrasound allows developing and displaying multi-level color pictures of the ultrasound even on extremely thick panels. The superiority of the patented Power Sonic Resonance method of EWS is also proven in nine (9) LVL lines (laminated veneer lumber) up to 150 mm (6 inch) thick. The EWS delamination detection system can be installed right next to trim saws and sanders because strong external sound does not influence

the measurement accuracy. An additional advantage is that measurements can be done very close to the panel edges. There is no sound travelling around the panel edges which would disturb the measurement.

4. Physical and technological limits of the ultrasound evaluation

A. Technically it is possible to display a varying measuring signal in any number of color graduations. But, because the strength of the measuring signal is affected by several parameters inside and outside of the panel, the sonic picture is limited by interpretation. Consequently the selection of only a single influencing factor like the mechanical strength or the bond quality is not possible.

B. The number of colors should be pre-chosen with a realistic view to the practical use. A multi-level picture of the ultrasound allows only a few approximate interpretations, which, of course, could be an advantage. For example, problems in the forming or unacceptable variations of the material moisture content are reflected in the ultrasound picture. From this it can be clearly concluded that the change of the sonic power not necessarily refers to a change of the bond quality. Color changes of a sound picture can be a result of numerous other changes too.

C. The EWS system is able to visualize up to 250 colors. Most users limit the number of colors to a sensible quantity. With this the operation of the machine is simplified. The operator of the press should get only the information which is understandable and which can guide him to a sound conclusion. Too many color levels on the control monitor can be confusing or can end up in wrong interpretations by the operator.

D. Reliable and useful information regarding the bond quality of a panel cannot be done with a measurement of the ultrasound value as was previously explained by physical and technological facts.

E. The number of colors used is only a question of the individual system configuration and cannot be brought into connection with the efficiency of a measuring system. The decision for the chosen number of colors should be done by the production manager. He surely will try to find a practical oriented significance of the displayed information. At least a definite use is only given if there is a possibility to control the production process based on color changes.

F. A graphic which shows the trend of the maximum and minimum extreme values of the sonic power over a number of panels provides a lot of useful information. The alteration of the minimum extreme value draws the conclusion that the panel production quality goes down. An increasing difference between the maximum and minimum sonic value indicates an increasing varying homogeneity of the panel quality. This information is very useful to the operator.

G. With this function, which is a feature of the EWS system, it is possible to control the start up and slow down processes and the development of blows can be avoided as well.

5. Calibration controlled as needed

A. The calibration of the EWS systems is done during normal production. Because of this it is possible to react to certain influencing parameters automatically. If the ultrasonic sensors are moved out of the production line for calibration, it would no longer be possible to consider these influencing parameters of the dynamic process. For example, the temperature and the steam pressure changes across the width of production. If these influencing changes are left out of consideration they would be transferred to the sonic picture. This is absolutely not wanted because these important factors should be taken into consideration. In blow detection systems only a calibration which takes place during normal production enables an optimal adjustment in response to changes of the panel properties.

B. Due to the powerful penetrating sonic signals the measuring system from EWS does not need to be cleaned in short intervals. Maintenance can be limited to the normal shut down times of the production line. This is an advantage, especially in continuous panel production lines.

6. Conclusions:

A. The bond quality is only one of the numerous parameters which have some influence on the measured strength of the ultrasonic signal. It is not possible to measure or to separately display the panel bond quality.

B. The number of colors of a sonic picture should be chosen in a way that the operator is able to draw some intelligent conclusion out of it.

C. A single sonic picture is less informative, but the view to the minimum and maximum extreme values over a special number of panels allows making reliable conclusions about the production process. This enables the process to be optimized and to increase the production capacity. The development of blows can be significantly reduced.

D. The Power Sonic Resonance method of EWS allows long term maintenance, whereby they can be done during the normal production downtime. Calibrations are possible during the running production process so that influencing parameters like temperature, steam pressure and density can be taken into consideration.

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Electronic Wood Systems GmbH is one of the leading suppliers for measurement systems for the wood based panel industry. The company is based in Hameln, Germany just 50km (30 miles) south of Hannover. The company is ISO 9001:2000 approved. The North American market is served by Electronic Wood Systems Int. Beaverton (Oregon). Spare parts and technical service are available. The scope of supply includes thickness gauges, blow detection, density measurement, moisture measurement, laboratory density profile analysers. New development is the non-contact board scale CONTI-SCALE.