REDUCING AN ENERGY REFLECTION FROM APPLICATOR FOR MICROWAVE WOOD TREATMENTS

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ABSTRACT

The microwave processing of wood is a widely used as high intensity microwave treatment creates changes in wood structure, which might significantly contribute to the development needs of timber industry, by accelerating wood drying time, relieving of growth stresses, facilitating preservative impregnation and enabling the production of solid wood products.

Microwave wood modification requires the application of very intensive microwave energy (up to 30 kW/cm^2) for very short periods. To achieve such a high intensity and to ensure its subsequent release in the wood requires the development of new equipment (applicators and radiators) utilising a range of different frequencies (between 0.4 to 24 GHz).

During microwave processing the electric field spatial distribution is inherently non-uniform and has crests at specific locations, which change positions as dielectric properties and the microwave absorption of the material change as the temperature increases. Correspondingly, the strength of the electric field (and thus the heating) is reduced in the core of a sample because the microwaves are absorbed.

In wood applications, multimode “oversize waveguide” applicator’s size is determined by wood board size and reasonable conveyer tunnel production arrangement. The interaction of wood with microwave field and changes in fundamental materials properties during processing makes design and development of microwave applicator very complex. Multimode applicator design involves a number of basic parameters including uniformity of heating, required microwave power, applicator size, leakage suppression, reflection, etc.

Since one of the main problems in microwave processing of wood at such intensive microwave energy is the high reflection energy from applicator and moist wood towards the generators, the aim of this paper is to describe a new practical way able to complement the applicator and highly reduce the energy reflection to the generators and to show its performance through the experimental tests and computer simulation and modelling results.

Firstly, in this paper is described the experimental scale-up applicator for which the reducing energy reflection device is built (Fig.1). The entire applicator device is made up from three specific applicators: box applicator, which provides the mild intensity treatment, tapper applicator and 115x115 mm conveyor applicator. The taper (reduced hight) applicator is a modification on the box applicator and is employed for very high intensity microwave radiation. Higher feed rates and shorter microwave interaction times are possible with this applicator. In addition to reducing the zone of interaction for the microwave and wood the taper section functions as a lens, concentrating the supplied microwave energy. The 115x115 mm conveyor is used in conjunction with the box and taper applicators. Installation can be carried out with the vector E parallel or perpendicular to the grain orientation. This gives a total of 4 configurations for this unit.

Secondly, the reflection coefficients of the empty applicator device and supplied with a piece of wet Eucalyptus globulus timber, were measured by means of a Vector Network Analyser (HP 8720C VNA), and the values of 0.6 and 0.53 respectively for the S11 parameters magnitude gives a reflected energy proportion of 36% and 28% correspondingly.

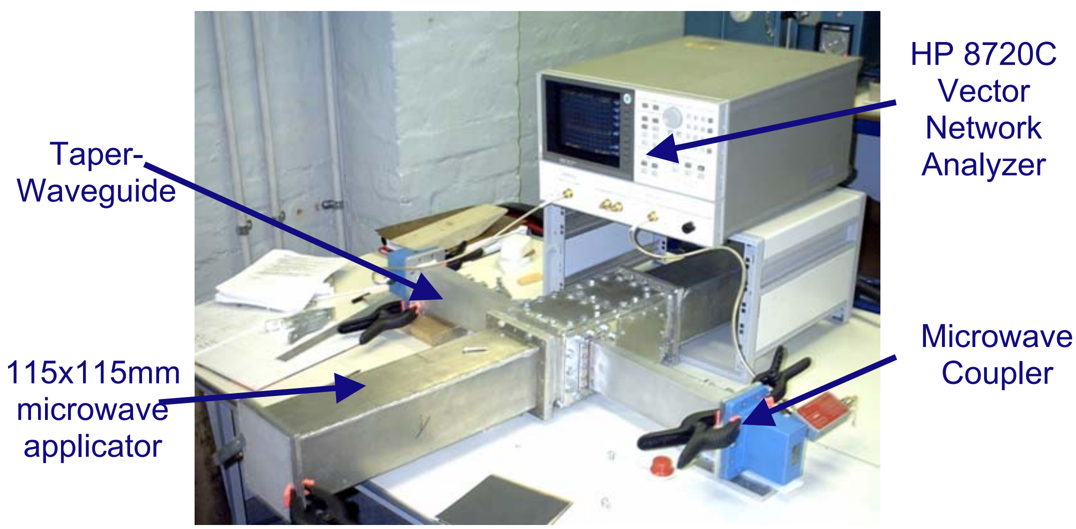

Figure 1: Laboratory measurements equipment setup

Subsequently, the technical way for reducing the microwave energy reflection for the described applicator configuration is presented. By using the computer simulation software, CST Microwave Studio 5.0.1, the device design accuracy and efficiency was increased exponentially. The practical design consists in placing a piece of suitable ceramics/plastics (in a our experiments Teflon (PTFE), which fits the transversal section of the box applicator, at the applicator end attached to the 115x115mm conveyor-applicator (Fig.2). The main role in reducing the energy reflation is played by the Teflon piece ends shapes: triangular prism towards the generator and parabolic shape towards the conveyor applicator. For such a construction, the computer simulation gives a value of 0.38 for S11 parameter magnitude (gamma) in the case in which the conveyor applicator is feed with a piece of *Eucalyptus globulus* timber of 68% moisture content, which means that only 13% from the applied power is reflected.

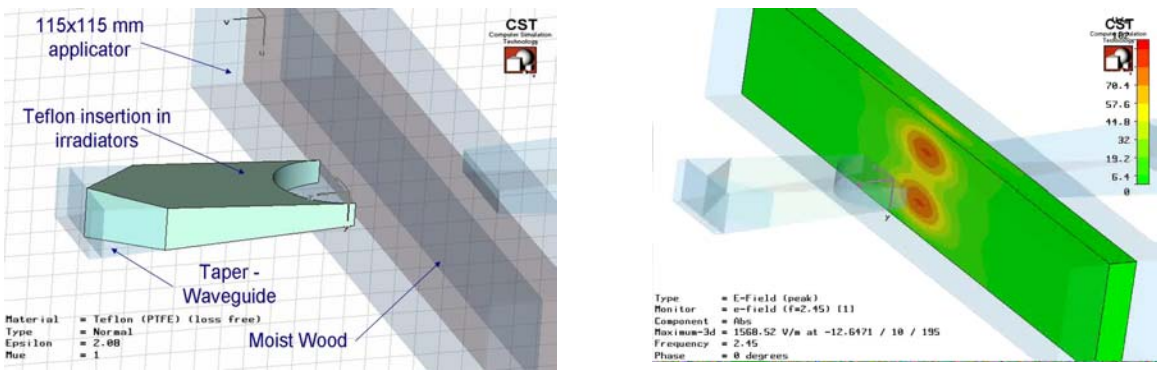

Figure 2: CST computer modelling and simulation setup and results

Finally, the paper presents the experimental tests of the reducing microwave energy reflection device, which gives a "gamma" value of 0.39 for the conveyor applicator supplied with wet wood and 0.12 for an empty applicator.

To sum up, by using the described technique, it is showed that the reflected energy is reduced with more than 50% than the case of using the microwave applicator device without the special designed Teflon piece. This gives a helpful tool to accomplish the proposed microwave wood modification project.