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Density-Independent High Moisture Content Measurement Using Phase Shifts at Two Microwave Frequencies

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ABSTRACT

Density-independent high moisture content measurement is required in actual production line. In this paper, the experimental results for high moisture content measurement using microwave free-space technique are presented. The method is based on a ratio of phase shifts at two microwave frequencies after propagating through a sample. The experiments were performed with three kinds of sawdust named Momizai, Cedar and Douglas Fir. In the high moisture content above 130%, the root mean square error (RMSE) of moisture determination by the method for three kinds of sawdust are 9.0%, 17.0%, 22.8%, respectively.

KEYWORDS: High moisture content, density-independent, measurement, microwave phase shift, sawdust.

INTRODUCTION

Density-independent high moisture content measurement is required in actual production line. For example, it is necessary to measure high moisture content of tea leaves in green tea production line, where the fresh tea leaves with moisture content as high as above 350% on a dry basis are dried to be green tea product with 8% moisture content [Okamura et al., 1998; Zhang et al., 2006]. The moisture measurement method is also expected to be able to determine the moisture content independent of sample density because variation of sample density is the main error source in the moisture measurement by the microwave techniques [Meyer et al.,1981; Nyfors et al., 1989; Kraszewski et al., 1996; Trabelsi et al., 1998; Zhang et al., 1999].

Microwave free-space technique has received great attention in the moisture content measurement, because the technique is contactless, nondestructive, and requires no special preparation of the sample. A useful method using the microwave free-space technique to determine moisture content independent density and thickness is based on the measurement of attenuation and phase shift at a microwave frequency [Meyer et al., 1981; Nyfors et al., 1989; Kraszewski et al., 1996;]. It was shown to be able to determine the moisture content for many materials such as wheat, wool, corn etc. [Meyer et al., 1981; Nyfors et al., 1989; Kraszewski et al., 1996;]. A dielectric-based method was reported recently to measure the moisture content and density [Trabelsi et al., 1998; 2005]. The reported method was proved with the microwave free-space technique, and the good results have been shown on the material of wheat, soybeans, corn and etc. We have proposed a new method for density-independent moisture measurement